

# **TSCA NEW CHEMICALS PROGRAM**

## **(NCP)**

### **CHEMICAL CATEGORIES**

Office of Pollution Prevention and Toxics  
New Chemicals Division  
1201 Pennsylvania Ave., NW  
Washington, D.C. 20460

Contacts:

Kelly Schumacher ([schumacher.kelly@epa.gov](mailto:schumacher.kelly@epa.gov)) (human health hazard)  
Hector Malagon ([malagon.hector@epa.gov](mailto:malagon.hector@epa.gov)) (environmental hazard)  
Sara Moses ([moses.sara@epa.gov](mailto:moses.sara@epa.gov)) (fate and transport)

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## INTRODUCTION

### **Disclaimer and Purpose of This Document:**

EPA's Office of Pollution Prevention and Toxics (OPPT) groups chemicals with shared chemical and toxicological properties into categories so that PMN reviews are facilitated. PMN submitters and EPA reviewers benefit from the accumulated data and past decisions represented by a category. EPA considers all PMNs, including new chemical substances which fall within such categories, on a case-by-case basis and uses the most appropriate structural analogue to support any concerns for health or environmental effects. For any new chemical substance, if EPA determines, under TSCA section 5(e), that the substance "may present an unreasonable risk of injury to health or the environment," the PMN substance can be subjected to appropriate control actions and/or testing under TSCA section 5(e). This "may present" finding is developed through the application of category-based or chemical-by-chemical assessment of hazard endpoints and case-specific exposure assessment.

The categories included in this compilation represent chemicals for which sufficient assessment experience has been accumulated so that hazard concerns and testing recommendations vary little from chemical to chemical within the category. Thus, these categories do not necessarily represent the chemicals of greatest concern to the Agency. By the same token, the categories are also not intended to be a comprehensive list of all substances that may be subject to further action in the New Chemicals Program.

If a new chemical substance is structurally similar to a substance for which EPA has positive toxicity data and there is sufficient exposure, EPA may regulate that substance under section 5(e) of the Toxic Substances Control Act (TSCA) based on its potential unreasonable risk. The hazard potential of a PMN substance is dependent on the molecular weight of the compound, the presence/absence of activating/deactivating substituents, other physical/chemical properties, and the likely route of exposure. Typically, concerns are confined to chemicals with molecular weights <1,000 whenever inhalation exposure to humans or environmental release is expected, and to species <500 when dermal exposure to humans is expected.

This document contains references to the "Harmonized Test Guidelines" developed by EPA's Office of Prevention, Pesticides and Toxic Substances (renamed the Office of Chemical Safety and Pollution Prevention in 2010) for use in the testing of pesticides and toxic substances, and the development of test data that must be submitted to the Agency for review under Federal regulations. These Harmonized Test Guidelines can be found at <http://www.epa.gov/ocspp/pubs/frs/home/guidelin.htm>. This document also contains references to test guidelines developed by the Organization for Economic Cooperation and Development (OECD). These OECD test guidelines are available from the OECD Bookshop at <http://www.oecdbookshop.org> or SourceOECD at <http://www.sourceoecd.org>.

Additional information on testing conditions and testing options for specific PMN chemical substances that appear to fall within one of these categories is available by contacting the New Chemicals Management Branch at 202-564-8469 or the TSCA Hotline at 202-554-1404. This

document is intended to serve only as a guide for PMN submitters. PMN submitters are urged to have protocols and testing schemes evaluated by the New Chemicals Program prior to commencing testing on a PMN substance. However, under no circumstance does such an evaluation mean that the new chemical substance is not subject to further review during any TSCA section 5 review period for the PMN substance or that additional testing or regulatory action may not be recommended. Finally, even if EPA does not make the potential unreasonable risk finding for a new chemical substance, the Agency may still recommend the use of engineering controls or personal protective equipment to reduce exposures in the workplace if the PMN substance is a potential irritant or sensitizer.

### **Additional Resources/Tools for the TSCA New Chemicals Program:**

The hazard and risk assessment of new industrial chemicals is within the purview of U.S. EPA's Office of Pollution Prevention and Toxics within EPA's Office of Chemical Safety and Pollution Prevention (OCSPP). Under the Toxic Substances Control Act (TSCA), OPPT is charged with regulating all phases of the life cycle of industrial chemicals including environmental and human health impacts resulting from the manufacturing, processing, use, and disposal of a substance. TSCA has no minimum data set requirements for new chemicals entering commerce, and therefore, OPPT has developed a suite of predictive approaches that are used to fill data gaps where little or no experimental data exists.

In addition to the use of the New Chemical Category Statements presented in this document to assist in chemical management decisions, Structure Activity Relationships (SARs) is a technique routinely used under the New Chemicals Program to estimate the toxicity of industrial chemicals being reviewed in response to PMN submissions. The predictive approaches are used to support OPPT chemical management decisions within the TSCA framework and are also used in the analysis of existing chemicals. For more information on the use of these tools to estimate physical-chemical properties, environmental fate, ecological and human health hazards, and exposures and releases please refer to the web pages listed below:

- **Estimations Programs Interface for Windows Suite – EPI Suite** – A suite of models used to estimate numerous physical-chemical properties, environmental fate, and partitioning of a chemical based on structure. Link for EPI Suite: <http://www.epa.gov/opptintr/exposure/pubs/episuite.htm>
- **Ecological Structure Activity Relationships – ECOSAR** – A hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. ECOSAR is available as stand alone product or as part of the EPI Suite package of programs. Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>
- **Human Health Non-Cancer Screening Protocol** – In this protocol, analogs are chosen for the chemical of interest along with associated health effects data to perform read-across activities to predict human health effects in the absence of sufficient measured data. An outline of this protocol can be reviewed at: <http://www.epa.gov/oppt/sf/pubs/noncan-screen.htm>. Additionally, to assist users in this task, EPA has recently created a new tool to assist in the selection of analogs and to help identify publicly available experimental data for chemicals of interest called the

**Analog Identification Methodology** which can be accessed at <http://aim.epa.gov>

- **The Cancer Expert System – OncoLogic** – A cancer hazard expert system software package which relies on the known carcinogenic effects of chemicals to predict cancer hazard of new substances based on structural similarity. The software estimates carcinogenic potential of a substance by initiating expert rules for determining cancer potential created from many sources of publicly available carcinogenicity data. OncoLogic is capable of estimating carcinogenic potential for organics, polymers, fibers, and metals. Link for OncoLogic: <http://www.epa.gov/oppt/newchems/tools/oncologic.htm>
- **Chemical Screening Tool for Exposures and Environmental Releases – ChemSTEER** – A modeling program to estimate occupational exposures and environmental releases of a chemical through manufacture, processing and use. This software uses EPA validated models to predict environmental releases and worker exposure to a chemical from manufacturing, processing, and use. Link for ChemSTEER: <http://www.epa.gov/opptintr/exposure/pubs/chemsteerd1.htm>
- **Exposure and Fate Assessment Screening Tool – E-FAST** – A windows based package that incorporates several screening level exposure models. E-FAST provides screening level estimations of environmental concentration and human exposure due to releases of a chemical to the environment. Link for E-FAST: <http://www.epa.gov/opptintr/exposure/pubs/efast.htm>

EPA offers training in the use and interpretation of these models through workshops under the **Sustainable Futures Initiative**. The goal of the Sustainable Futures training workshops is to assist the public in learning more about the application and interpretation of OCSPP's predictive methods, to build on the chemical expertise developed by EPA through chemical regulation activities, and to promote the technology transfer of EPA expertise to other chemical stakeholders. To learn more about the program and workshops please visit the Sustainable Futures website at: <http://www.epa.gov/oppt/sf/>.

#### **Changes Made to this August 2010 Revision:**

- The introductory section was revised to include a section entitled “Additional Resources/Tools for the TSCA New Chemicals Program” and this section of the Introduction was added to identify changes made in this August 2010 version of the document.
- The previous 2002 version of this document contained references to EPA Office of Pollution Prevention and Toxics (OPPT) test guidelines that originally appeared in title 40, chapter I, subchapter R of the Code of Federal Regulations (CFR). Since that time, the "Harmonized Test Guidelines" have been developed by EPA's Office of Prevention, Pesticides and Toxic Substances (renamed the Office of Chemical Safety and Pollution Prevention in 2010) for use in the testing of pesticides and toxic substances, and the development of test data that must be submitted to the Agency for review under Federal regulations. These Harmonized Test Guidelines can be found at <http://www.epa.gov/ocspp/pubs/frs/home/guidelin.htm>. This current version of the Chemical Categories report now contains references to the Harmonized Test Guidelines rather than the OPPT test guidelines. For example, the fish acute toxicity test at 40 CFR 797.1400 has been replaced by Harmonized Test Guideline 850.1075, and the Ready

Biodegradability test at 40 CFR 796.3180, etc. has been replaced by Harmonized Test Guideline 835.3110.

- OPPT has made minor revisions to the following categories to reflect updated structure-activity relationships (SARs) for certain classes which are available in version 1.0 of ECOSAR. In addition to SARs for classes represented in this category document, ECOSAR contains many other classes for which SARs are available. For access to these SARs and the underlying chemical training sets, please access the class-specific documents available in the help menu of the ECOSAR 1.0 model which is available for download at: (<http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>).
  - Aldehydes
  - Anilines
  - Azides
  - Diazoniums
  - Epoxides
  - Imides
  - Phenols
  - Phosphinate Esters
  - Polynitroaromatics
  - Thiols
  - Substituted Triazines
- One additional chemical category has been added to the document: Nitriles, allylic and vinyl.
- For those categories for which biodegradation and/or photolysis testing are identified, the recommended guidelines have been changed to reference certain OECD test guidelines.

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**Definition.** This category includes carbonyl chlorides ( $R-C[=O]Cl$ ) and sulfochlorides ( $R-S[=O]Cl$ ) where R may be either aliphatic or aromatic. Toxicity is limited by the fact that this class of compounds hydrolyzes and also, probably, if the octanol/water partition coefficient ( $K_{ow}$ ) is above a log  $K_{ow}$  value of 8. It has been assumed that these compounds need to be absorbed to be toxic; therefore, compounds with MWs > 1000 will probably be excluded in the future once this assumption is confirmed with toxicity information. However, toxicity information is needed to confirm this assumption.

**Hazard Concerns.** Acute toxicity for three members of this category are available and all have been shown to be moderately toxic to aquatic organisms (i.e., acute toxicity values between 1 and 100 mg/L): benzoyl chloride, fish 96-h LC50 = 35.0 mg/L, an aromatic dicarboxyl dichloride, fish 96-h LC50 = 6.2 mg/L, and benzene sulfochloride, fish 48-h LC50 = 3.0 mg/L. All of these tests have been done with the static method using nominal concentrations. It is unclear just how acid chlorides are toxic to aquatic organisms. It is known that acid chlorides hydrolyze to the carboxylic/sulfonic acid and HCl. It is not known if the toxic effect is the result of (1) absorption of the acid chloride and hydrolysis within the membrane, or (2) the HCl produced from the hydrolysis. It is known that the carboxylic/sulfonic-acid hydrolysis products are of low toxicity.

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW when enough information is obtained. In general, when the log  $K_{ow}$  value is < 8, the environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log  $K_{ow}$  is > 8, testing will be requested until enough information is obtained to determine whether these compounds will have no toxic effects at saturation. Generally, members of this category will have MWs of less than 1000, but testing of members with a MW > 1000 may be requested to confirm whether acid chlorides have to be absorbed to be toxic.

**General Testing Strategy.** The testing strategy for acid chlorides will consist of two steps. (1) Hydrolysis (Harmonized Test Guideline 835.2120) will be recommended. Depending on the outcome of this environmental fate testing and reassessment, (2) the aquatic base set of environmental toxicity tests will be recommended for aquatic exposures with the fish acute toxicity test done once or twice.

Chronic toxicity testing for aquatic organisms include: the fish early life state toxicity test, the daphnid partial life cycle toxicity test and the algal toxicity test.

The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, the earthworm acute toxicity test and the soil microbial community bioassay) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test, the plant uptake test, and the soil microbial community bioassay.

October, 1990

**Definition.** Organic dyes are divided into four classes depending on the type of electronic charge of the dye: nonionic (neutral dyes); anionic (negative charge or acid dyes); cationic (positive charge) dyes; and amphoteric (mixture of positive and negative charges on same molecule) dyes. Nonionic or neutral dyes are assessed as neutral organic chemicals for which there is a separate category description, and cationic dyes also have a separate category description. Amphoteric dyes are assessed either as cationic or anionic dyes depending on dominant net charge.

**Hazard Concerns.** Analysis of over 200 acid dyes (Auer et al. 1990, Nabholz 1990, Sigman et al. 1983, Tonogai et al. 1979, Little and Lamb 1972, ADMI 1974) have indicated that some monoacid and diacid dyes can show moderate to high toxicity (i.e., acute values < 100 mg/L and < 1 mg/L) to fish and aquatic organisms. Dyes with three or more acid groups showed low toxicity (i.e., acute values > 100 mg/L) towards fish and invertebrates. Some metal chelated dyes, i.e., Al, Co, Cr, Fe, have shown moderate toxicity towards fish and daphnids and the toxicity has not been explained by the residual free (un-chelated) metal ion in the dye product. All acid dyes showed moderate toxicity towards green algae. Analysis of available data (Auer et al. 1990, Nabholz 1990) has suggested that effects to algae were not the result of direct toxicity but represented an indirect effect due to shading. Senior regulatory decision-makers in OPPT (then OTS) decided in 1988 that the risk to algae from indirect (shading) toxicity was not an unreasonable risk for two main reasons: (1) algae grew quickly as soon as the dye was diluted, and (2) the release of colored effluents in the U. S. generally results in immediate complaints by citizens to their local authorities, e.g., county and state governments. The rapid response by the public generally results in quick regulatory action by local officials.

Since there is no SAR for acid dyes (Auer et al. 1990), hazard profiles for monoacid dyes are developed using measured data or data for the nearest analog(s).

**Boundaries.** Acids dyes must have some water solubility and molecular weights generally need to be near or below 1000.

### **General Testing Strategy.**

#### **I. Release to Aquatic Ecosystems:**

Tier 1. Because of the above boundary conditions, and the need to assess human exposure as well as environmental toxicity, if there is insufficient knowledge about the water solubility of the dye, then it should be measured (Harmonized Test Guideline 830.7860). The fish and daphnid acute toxicity tests from the aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations, and effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations.

If there is no significant risk from the PMN after the results of the fish and daphnid acute toxicity tests have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water—Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270) If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set.

Tier 4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; and statistical analysis of effective concentrations at days 7, 14, 21, and 28.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21.

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability—CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

## II. Release to Terrestrial Ecosystems:

The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200] and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

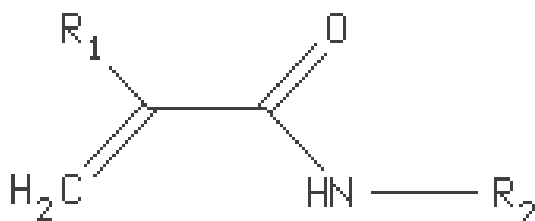
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- July, 1991; revised June, 1994; revised June 2010

**Category:** Acrylamides

Human Health and Environmental Toxicity

**Definition.** Any new chemical with the following structure is considered to be a member of the category:



R1 = H (acrylamides)

= CH<sub>3</sub> (methacrylamides)

R2 = anything

A typical acrylamide in the new chemical program is used as a monomer and has a molecular weight of  $\leq 500$ . The acrylamides of greatest concern are those with a labile substituent, e.g., methylol acrylamides, that may release acrylamide *per se* under metabolic conditions. For toxicity to aquatic organisms, there is a concern for all substituted acrylamides with molecular weights of  $< 1000$  and log Kow of  $< 8.0$ .

**Hazard Concerns.** Based on analogy to acrylamide *per se*, members of the class are considered potential carcinogens, heritable mutagens, reproductive and developmental toxicants, and toxic to aquatic organisms. Acrylamides are also potential neurotoxins based on data for a number of low molecular weight acrylamides.

**Boundaries.** Structures with an acrylamide equivalent weight of  $\geq 5,000$  are presumed not to pose a hazard under any conditions. Typically, concerns are confined to those species with molecular weights  $< 1,000$  whenever inhalation (or environmental) exposure is expected, and to species  $< 500$  when dermal, but not inhalation, exposure to humans is expected.

**Occupational Exposure Controls.** Because acrylamides are expected to be absorbed via the dermal route, glove permeation testing conducted in accordance with standard ASTM testing protocols may be required, depending upon estimated workplace exposures and the hazard identified for the particular acrylamide submitted as a PMN.

## **General Testing Strategy.**

Tier 1. To properly assess human and environmental toxicity or exposure, certain physical-chemical or environmental fate properties need to be measured:

- Water solubility (Harmonized Test Guideline 830.7860)
- Kow (Harmonized Test Guideline 830.7570 or 830.7550; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method)
- Vapor pressure (Harmonized Test Guideline 830.7950)
- Melting point-melting range (Harmonized Test Guideline 830.7200)

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

The physical state and electronic charge of the PMN substance should also be reported.

Tier 2. EPA considers the following tests to be the most appropriate for acrylamides found to pose an unreasonable risk to human health:

- 90-day subchronic toxicity (Harmonized Test Guideline 870.3100) with functional observational battery and neuropathology (Harmonized Test Guideline 870.6200).
- A rodent dominant lethal assay (Harmonized Test Guideline 870.5450). If positive, a rodent heritable translocation test (Harmonized Test Guideline 870.5460) would be the appropriate followup test.
- A 2-year carcinogenicity test (Harmonized Test Guideline 870.4200) in rats and mice.

To address environmental toxicity concerns, the following testing is recommended, for acrylamides with  $\log K_{ow} \leq 5$ : acute aquatic toxicity testing in algae, daphnid, and fish. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control <2 mg TOC/L; the highest treatment concentration on a mean measured-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active

ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; and the highest treatment concentration on a mean measured-basis equal to the aqueous solubility limit. Solvent can be used to assist the PMN substance to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN substance beyond its aqueous solubility limit.

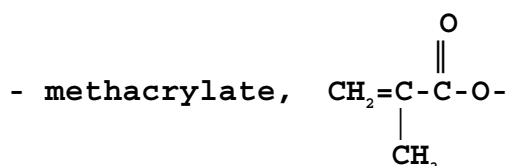
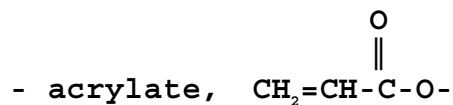
For acrylamides with  $\log K_{ow} >5$  and  $<8$ , aquatic toxicity testing should be for chronic effects only: (1) fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing with rainbow trout (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; and statistical analysis of effective concentrations at days 30, 45, 60, 75, and 90; (2) daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; and (3) algal toxicity testing (Harmonized Test Guideline 850.5400), with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; and the highest treatment concentration on a mean measured-basis equal to the aqueous solubility limit. Solvent can be used to assist the PMN substance to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN substance beyond its aqueous solubility limit.

November 1990; revised July 1993; revised October 1995; revised June 2010

**Category:** Acrylates/Methacrylates

Environmental Toxicity  
(Human Health, case-by-case)

**Definition.** Any molecular structure containing one or more of the following reactive groups is considered to be a member of the class:



**Hazard Concerns.**

Human Health: As a result of testing conducted under an agreement between the Agency and the Specialty Acrylates and Methacrylates (SAM) Panel of the Chemical Manufacturers Association (CMA), EPA no longer controls new chemical acrylates or methacrylates as a category based on health concerns. However, if a new acrylate is structurally similar to a substance for which EPA has positive toxicity data, EPA may regulate that substance under TSCA section 5(e) based on its potential unreasonable risk. This will be done on a case-by-case basis and is expected to effectively eliminate most regulation of acrylates, especially higher molecular weight and polymeric substances. Despite the fact that EPA no longer expects to make a potential unreasonable risk to human health finding for many of the new acrylates, EPA still recommends the use of engineering controls or personal protective equipment to reduce exposures in the workplace in recognition of their potential as irritants and sensitizers.

Environmental Toxicity: The ecotoxicity of acrylates and methacrylates is a function of the octanol-water partition coefficient (log P or log Kow). They exhibit simple narcosis at log Kow values >5, but display excess toxicity at lower log Kow values. The toxicity of acrylates and methacrylates can be predicted by a QSAR (quantitative structure-activity relationship), although there are some members of the class such as allyl methacrylate that are significantly more toxic than predicted by the QSAR.

**Boundaries.** Typically, environmental toxicity concerns are confined to those chemicals with molecular weights <1,000. Acute and chronic toxicity is possible for chemicals with log Kow values <5, and chronic toxicity is possible for chemicals with log Kow values <8.



## **General Testing Strategy**

Tier 1. To properly assess environmental toxicity or exposure, certain physical-chemical or environmental fate properties need to be measured:

- Water solubility (Harmonized Test Guideline 830.7860)
- Kow (Harmonized Test Guideline 830.7550, 830.7560, or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method)
- Vapor pressure (Harmonized Test Guideline 830.7950)
- Melting point-melting range (Harmonized Test Guideline 830.7200)

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

The physical state and electronic charge of the PMN substance should also be reported.

Tier 2. To address environmental toxicity concerns, the following testing is recommended: acute aquatic toxicity testing in algae (Harmonized Test Guideline 850.5400), daphnid (Harmonized Test Guideline 850.1010), and fish (Harmonized Test Guideline 850.1075) (all tests using measured concentrations; algae: static method, daphnid and fish: flow-through method).

September, 1988; revised July, 1993; revised January, 1997; revised June 2010.

**Category: Aldehydes**

Environmental Toxicity

**Definition.** Aldehydes are a class of organic compounds characterized by the functional group R-C(=O)-H. Aldehydes are ionizable in water and exhibit excess aquatic toxicity in addition to narcosis. **Polyaldehydes** are more toxic than monoaldehydes to aquatic organisms and **acrylic/vinyl/allylic aldehydes**, e.g., acrolein, are more toxic than polyaldehydes. Vinyl/allylic/acrylic aldehydes are a class of organic compounds characterized by both the aldehyde, R-C(=O)-H, and vinyl, H<sub>2</sub>C=C-R, or allylic, R-C=C-R, functional groups. Allylic and vinyl aldehydes, e.g., acrolein, C=CC(=O), exhibit excess toxicity.

**Hazard Concerns:** It is assumed that aldehydes need to be absorbed to be toxic, therefore, aldehydes with MW >1000 will be excluded from this category. Acute toxicity for aldehydes is known to be limited by the octanol/water partition coefficient (K<sub>ow</sub>). Above a log K<sub>ow</sub> value of >6.0, aldehydes show no effects at saturation for acute effects during 96-h exposures to fish. Aldehydes which are solids at room temperature may show no toxicity at saturation at lower K<sub>ow</sub> values depending on the melting point, i.e., the higher the melting point at a given K<sub>ow</sub>, the greater the likelihood that no toxicity will be observed at saturation. For solids, the no effects at saturation has to be determined on a case-by-case basis. There are no measured upper K<sub>ow</sub> limits for chronic toxicity at this time, but it may not be much above a log K<sub>ow</sub> = 8. Future testing will determine K<sub>ow</sub> limits. The aquatic toxicity for aldehydes may be determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>]

**Environmental Fate:**

**Boundaries:** MW <1000. Log K<sub>ow</sub> <6.0 for acute toxicity to fish and aquatic invertebrates; log K<sub>ow</sub> <6.4 for toxicity to green algae as a 96-h EC50; and log K<sub>ow</sub> assumed to be <8.0 for chronic toxicity to aquatic organisms, but could be higher.

**General Testing Strategy:**

I. Release to Aquatic Ecosystems:

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the aldehyde to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of

the aldehyde beyond its aqueous solubility limit. Stock solutions in water should be adjusted to pH near 7.0.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the aldehyde to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the aldehyde beyond its aqueous solubility limit. Stock solutions in water should be adjusted to pH near 7.0.

If there is no significant risk from the aldehyde after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the aldehyde after the results of biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because the 7-d ELS toxicity test may underestimate chronic toxicity measured by the 28-d ELS toxicity test when the Chronic Values are compared. Stock solutions in water should be adjusted to pH near 7.0.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective

concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because the fish 7-d ELS toxicity test may underestimate chronic toxicity measured by the fish 28-d ELS toxicity test when the chronic values are compared.

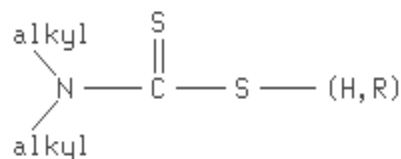
II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200] and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

July, 1996; revised June 2010

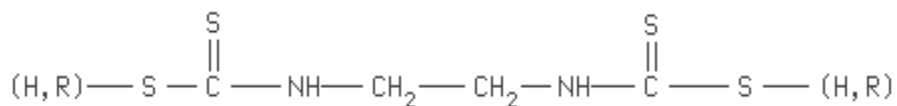
**Category:** Aliphatic Amines

Environmental Toxicity

**Definition.** This category includes primary amines, secondary amines and tertiary amines; or monoalkyl amines, dialkyl amines and trialkyl amines, respectively. This group includes alkanes, alkenes and alkynes; substitutions on carbon (alkyl) chains may include but not be limited to halogens and hydroxyls; insertions in alkyl chain may include but not be limited to ethoxys, propoxys, ethers, sulfides, disulfides and polysulfides; amine oxides are also included in this category; fatty polyamines (e.g., diamines, triamines, tetraamines, pentamines, etc) are also included; amines may either be un-ionized (free) or ionized; and strong ion pairs may also be included.



N,N-dialkyldithiocarbamate



ethylenebisdithiocarbamate

**Hazard Concerns:** Members of this category can be highly toxic to all groups of freshwater organisms (i.e., fish, aquatic invertebrates and green algae). Toxicity is related to the length of the hydrophobic carbon chains: the longer (or greater the number of carbons) the chain the more toxic to aquatic organisms when the number of amines is constant; and the greater the number of amines, the greater the toxicity given a constant carbon chain length. Small aliphatic amines are more toxic to algae than fish and invertebrates; higher molecular weight amines are equally toxic to all aquatic organisms. Small aliphatic amines which are un-ionized are more toxic to fish than when they are ionized; toxicity to algae appears to be unaffected by ionization. Strong ion pairs are generally much less toxic to fish and invertebrates because of solubility limitations, but remain highly toxic to green algae. The toxicity of each amine will be predicted using structure-activity relationships (SARs) and analogs contained in a generic standard environmental hazard review for aliphatic amines.

**Boundaries:** There are no lower boundaries and the upper boundary is unknown at this time. It is known that a C13-NH<sub>3</sub> Cl is still toxic to fish at less than 1 mg/L. An upper boundary for carbon chain length will probably be about 20 carbons but more information is needed at this time. Generally, members of this category will have molecular weights less than 1000.

## **General Testing Strategy**

Tier 1. The base set of environmental toxicity tests in clean dilution water and two fish acute toxicity tests done in the presence of humic acid (i.e., TOC) will be recommended. These tests will be done under static methods with nominal concentrations. Smaller amines (e.g., Schiff bases) are expected to demonstrate less mitigation by humic acid (larger log Kow, greater mitigation; increase log Kow correlates to increased MW). If hydrolysis 1/2 life is less than one hour, test the hydrolysis product; if it is greater than one hour, test parent material.

Tier 2. If TOC significantly reduces the toxicity to water column species, then toxicity testing for toxicity to benthic organisms (i.e., organisms that ingest sediment) will be recommended; however, if TOC does not significantly reduce the toxicity to water column species, then chronic toxicity with fish and aquatic invertebrates will be recommended as well as aerobic biodegradation testing.

Aerobic biodegradability according to either of the following test guidelines:

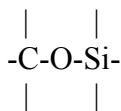
- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

September 1988; revised November 1995; revised June 2010

**Category:** Alkoxysilanes

Human Health  
Environmental Toxicity

**Definition.** Any molecular structure containing one or more of the following reactive groups is considered to be a member of the category.



The "typical" new chemical of concern is a polymer with a substantial fraction of species with molecular weights <1000 and pendant trimethoxy- or triethoxysilane groups.

**Hazard Concerns.**

Health - Concern for lung toxicity from inhalation of vapors or aerosols is based on data for a number of low-molecular-weight alkoxysilanes. Trimethoxysilane (TMS) is clearly the most toxic member of the class causing irreversible lung effects at low doses, but the Agency does not consider it appropriate to use TMS as a regulatory benchmark for all alkoxysilanes.

For trimethoxysilane monomers and polymers with a low trimethoxysilyl equivalent weight, a NOAEL of 10 ppm (about 11 mg/kg/day) based on a 90-day study with vinyltrimethoxysilane in monkeys is deemed an appropriate generic benchmark.

Alkoxysilanes in which the alkyl substituent is **not** a methyl group do not appear to be as toxic as methoxysilanes. The New Chemicals Program currently uses a generic benchmark NOAEL of 75 mg/kg/day, based on a 90-day inhalation study with tri(isopropenoxy)silane, for alkoxysilanes other than methoxysilanes.

Ecotoxicity - Alkoxysilanes are highly toxic to algae and moderately toxic to aquatic invertebrates. For example, the daphnid 48-hr LC<sub>50</sub> for dimethyldiethoxysilane is 1.25 mg/L, and the 15-day algal EC<sub>95s</sub> for vinyltriethoxysilane, tetraethoxy-silane, and trifluoropropenyl(methyl)diethoxysilane are all approximately 10 µg/L.

**Boundaries.** Methoxy- and ethoxysilanes are presumed not to pose a hazard under any conditions if the equivalent weight is > 5,000 and no more than 25% of species have molecular weights less than 1,000 and no more than 10% of species have molecular weights less than 500. For alkoxysilanes with alkyl substituents larger than propyl groups, the equivalent weight cutoff is 1,000. The degree of concern depends on the relative abundance of lower molecular weight species, but there is no molecular weight threshold above which there would be no concern.

To better define the boundaries of the category, EPA seeks testing on a limited number of alkoxysilanes that focuses on (1) the relationship between molecular weight (or alkoxysilyl

equivalent weight) and inhalation toxicity and (2) the importance of increasing alkoxy chain length in limiting toxicity.

### **General Testing Strategy**

The Agency recommends the following testing as appropriate to address health and environmental toxicity concerns for this category:

1. 90-day subchronic test in rodents by the inhalation route (Harmonized Test Guideline 870.3100).
2. Hydrolysis (Harmonized Test Guideline 835.2120) . If  $t_{1/2}$  is less than one hour, base set ecotoxicity testing (see "3," below) is conducted with the hydrolysis products only. If  $t_{1/2}$  is greater than one hour, base set ecotoxicity testing is conducted with the parent material; the PMN submitter has the option of also testing with the hydrolysis products.
3. Base-set ecotoxicity testing to include fish (Harmonized Test Guideline 850.1075) using the static method, daphnids (Harmonized Test Guideline 850.1010) using the static method and algae (Harmonized Test Guideline 850.5400) using the static method, all nominal concentrations. Direct dilution of the test alkoxy silane and organisms is added within 10 minutes. The static-renewal method is used for fish and daphnid test, plus an additional fish test using aged stock solution.

Results of the acute ecotoxicity testing may trigger chronic fish (Harmonized Test Guideline 850.1400) and daphnid (Harmonized Test Guideline 850.1300) testing.

4. Physical-chemical or environmental fate testing including, as appropriate:
  - Melting point (Harmonized Test Guideline 830.7200) or boiling point (Harmonized Test Guideline 830.7220)
  - Water solubility (Harmonized Test Guideline 830.7840 or 830.7860)
  - Log  $K_{ow}$  (Harmonized Test Guideline 830.7550, 830.7560 or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method )
  - Vapor pressure (Harmonized Test Guideline 830.7950)
  - Phototransformation of Chemicals in Water—Direct Photolysis (OECD 316) or Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270).

Need for water solubility, log  $K_{ow}$ , and photolysis testing determined by outcome of above hydrolysis testing.

September, 1988; revised June, 1994



**Category: Aluminum Compounds**

**Risk Management Statement.** Greatest concern is for soluble forms of aluminum (Al). If water solubility is greater than 1 part per billion (1 ppb), the Agency will prohibit releases of the PMN substance to water pending the submission of environmental toxicity testing.

**Definition.** This category includes inorganic salts of Al, complexes between Al and organic acids or chelates of Al by polyanionic monomers, and organoAl compounds, i.e., Al covalently-bonded with carbon. For example, some inorganic Al salts include: Al hydroxide, Al chloride, Al fluoride, Al nitrate, Al phosphate, and Al sulfate. Not included in this category are dyes complexed with Al (see dye categories addressed elsewhere within this "TSCA New Chemicals Program Chemical Categories" document).

**Hazard Concerns.** Soluble salts of Al are known to be highly toxic to green algae and moderately toxic to fish and aquatic invertebrates at pH values between 6.5 to 9.0 and in terms of soluble Al in mg Al/L. Toxicity information is available for Al chloride, Al sulfate, and Na aluminate. The Office of Water (USEPA, 1988, EPA440/5-86-008) cited Seipt et al. (1984, Water Air Soil Pollut. 23:81-95) who concluded that "the simple hydroxides (Al(OH)<sup>2+</sup> and Al(OH)<sub>2</sub><sup>+</sup>) are regarded as the most dangerous forms while organically bound Al and polymeric forms are less toxic or essentially harmless." The Office of Water (USEPA, 1988) also concluded that solutions of Al in water approach chemical equilibrium rather slowly and that Al can form strong complexes with fulvic and humic acids.

The toxicity profile for soluble Al salts, listed below, is based on (1) available measured (M) toxicity data, (2) mg Al/L (ppm Al), (3) pH between 6.5 and 9.0, and (4) moderate hardness (about 150.0 mg/L as CaCO<sub>3</sub>).

fish (FHM) 96-h LC50	=	35.0	M, pH 7.3, H220
fish (RT) 96-h LC50	=	8.6	M, pH 7.5, H47
fish (RT) 96-h LC50	=	7.4	M, pH 6.6, H47
fish (RT) 96-h LC50	=	14.6	M, pH 7.3, H47
mean RT 96-h LC50	=	10.0	Predicted, n3
fish (BT) 96-h LC50	=	3.6	M, pH 6.5, H?
mean fish 96-h LC50	=	11.0	Predicted, n3
daphnid (Cd) 48-h LC50	=	1.9	M, pH 7.4, H50
daphnid (Cd) 48-h LC50	=	3.7	M, pH 7.7, H47
mean Cd 48-h LC50	=	2.7	Predicted, n2
daphnid (Dm) 48-h LC50	=	3.9	M, pH 7.0, H45
daphnid (Dm) 48-h LC50	=	38.0	M, pH 7.1, H220
mean Dm 48-h LC50	=	12.0	Predicted, n2
mean daphnid 48-h LC50	=	5.7	Predicted, n2

OW FW Acute WQC	=	1.5	
green algal 96-h EC50	=	0.570	Measured, pH 7.6, H15
green algal 96-h EC50	=	0.460	Measured, pH 8.2, H15
mean algal 96-h EC50	=	0.510	Predicted, n2
fish (FHM) ChV	=	3.3	Measured, pH 7.7, H220
fish (FHM) ACR	=	11.0	Measured
daphnid (Dm) ChV	=	0.742	Measured, pH 8.3, H220
daphnid (Dm) ChV	=	0.320	Measured, pH 7.7, H45
mean Dm ChV	=	0.490	Predicted, n2
Dm ACR	=	24.0	Measured
daphnid (Cd) ChV	=	1.9	Measured, pH 7.2, H50
Cd ACR	=	1.4	Measured
mean daphnid ChV	=	0.970	Predicted, n2
mean daphnid ACR	=	5.9	Measured
OW FW Chronic WQC	=	0.087	
algal ChV	=	0.100	Predicted, EC50/4

### Biological Fate

Fish (BT-eyed embryo) 30-d BCF (wb)	=	50.0	Measured, pH 7.2, H242
Fish (BT-fry) 30-d BCF (wb)	=	136.0	Measured, pH 7.2, H242
mean fish BCF	=	93.0	Predicted, n2

The toxicity profile for soluble inorganic complexes of Al can be predicted via MW adjustment of the toxicity for Al to the toxicity of the complex.

### **Ca Al hydroxy phosphites [141 728-04-3]**

$\text{Ca}_x \text{Al}_2(\text{OH})_{2(x+3-y)} (\text{HPO}_3)_y \cdot m\text{H}_2\text{O}$  with  $x = 2$  to  $12$ ,  $(2x+5) \div 2 > y > 0$ , and  $m = 0$  to  $12$ ; typical composition = 31% Ca, 9.5% Al, & 8.0% P; solid with mp  $> 250$  °C (dec); S = 680 mg/L; pH 11.5;

Effect	Concentration (mg/L)		
	Complex	Al	Notes
fish 96-h LC50	120.0	11.0	Predicted
fish 96-h LC50	409.0	6.0	Measured
daphnid 48-h LC50	60.0	5.7	Predicted
daphnid 48-h LC50	24.0	nm	Measured

green algal 96-h EC50	5.4	0.510	Predicted
fish ChV	35.0	3.3	Predicted
daphnid ChV	10.0	0.970	Predicted
algal ChV	1.0	0.100	Predicted

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**Na Al fluoride [15 096-52-3]**

sodium fluoaluminate; sodium fluoride aluminum; cryolite; kryolith; M12,2673; Na<sub>3</sub> Al F<sub>6</sub>; MW210; composition: 13% Al; solid with mp 1000 °C; S = 610 mg/L with pH 6.2; used as an insecticide since 1929;

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Effect	Concentration (mg/L)		
	Complex	Al	Notes
fish 96-h LC50	85.0	11.0	Predicted
fish 96-h LC50	21.0	2.8	Measured
daphnid 48-h LC50	44.0	5.7	Predicted
green algal 96-h EC50	3.9	0.510	Predicted
fish ChV	25.0	3.3	Predicted
daphnid ChV	7.5	0.970	Predicted
algal ChV	0.770	0.100	Predicted

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The toxicity profile for chelates of Al with polyanionic monomers can be predicted via MW adjustment of the toxicity for Al to the toxicity of the chelate.

The toxicity profile for organoAl compounds are developed for only the hydrolysis product(s) of Al. OrganoAl compounds are unstable in air and water. MethylAl and ethylAl are pyrophoric and dodecylAl slowly hydrolyses in water.

**Boundaries.** The toxicity of Al compounds depends on their water solubility, the bioavailability of Al, and their stability. The most important property determining the toxicity of Al compounds is water solubility. Water solubility cannot be predicted accurately and has to be measured. Molecular weight (MW) is only important when Al complexes are water soluble and stable. Stable complexes of Al with MWs > 1000 are not expected to be absorbed by aquatic organisms and Al is not expected to be bioavailable even if they are water soluble. Therefore, only unstable Al compounds with MWs < 1000 are expected to be toxic.

**General Testing Strategy**

Tier 1. Fate testing. Physical state (Harmonized Test Guideline 830.6303) and

corresponding property, i.e., melting point-melting point range (Harmonized Test Guideline 830.7200) or boiling point-boiling point range (Harmonized Test Guideline 830.7220), water solubility (Harmonized Test Guideline 830.7840 or 7860), octanol/water partition coefficient ( $K_{ow}$ ) (Harmonized Test Guideline 830.7550, 7560 or 7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method), and vapor pressure (Harmonized Test Guideline 830.7950); and/or

Acute environmental toxicity testing. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures: fish acute toxicity, daphnid acute toxicity, and green algal toxicity. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the static method; effective concentrations will be based on 100% active ingredients (ai) and nominal concentrations; the total organic carbon (TOC) concentration of dilution water in the control must be less than 2.0 mg TOC/L; TOC must be measured in the control just prior to the start of the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can not be used; and hardness of dilution water has to be less than 180.0 mg/L as  $CaCO_3$ .

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with the static method; effective concentrations based on 100% ai and nominal concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with no more than 0.300 mg/L EDTA as a final concentration; the TOC of the test/growth medium should be less than 2.0 mg TOC/L; TOC should be measured just prior to the start of the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; and solvent can not used; .

In addition fish-toxicity-mitigation testing (Harmonized Test Guideline 850.1085) with known amounts of humic acid (HA) added to dilution water, i.e., 20 mg HA/L and 10 mg HA/L, will be recommended.

If there is no significant risk from the AI compound after the results of tier one testing set have been integrated into the risk assessment, then no further testing will be recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Fate testing. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
  - Ready Biodegradability– $CO_2$  in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)
- and/or

Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with the flow-through method; effective concentrations based on 100% ai and mean measured concentrations of soluble AI; statistical analysis of effective concentrations at days 7, 14, 21, and 28; the TOC of dilution water in the control should be less than 2.0 mg TOC/L; TOC should be measured in the controls just prior to and during the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can not be used; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>; and

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with the flow-through method; effective concentrations based on 100% ai and mean measured concentrations of soluble AI; statistical analysis of effective concentrations at days 7, 14, and 21; the TOC of dilution water in the control should not exceed 2.0 mg TOC/L; TOC must be measured in the controls just prior to and during the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can not be used; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>.

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests will be recommended for terrestrial exposures. The terrestrial base set includes: the early seeding growth test (Harmonized Test Guideline 850.4230), the earthworm toxicity test (Harmonized Test Guideline 850.6200), the soil microbial community bioassay (Harmonized Test Guideline 850.5100), and the avian acute oral toxicity test (Harmonized Test Guideline 850.2100). Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the avian reproduction test (Harmonized Test Guideline 850.2300).

### **Abbreviations.**

ACR10 = acute-to-chronic ratio = 10;  
ai = active ingredients;  
BCF = bioconcentration factor;  
BT = brook trout;  
Cd = *Ceriodaphnia*;  
ChV = Chronic value;  
Dm = *Daphnia magna*;  
EC = effective concentration;  
FHM = fathead minnow;  
FT = flow-through method;  
FW = fresh water;  
H = hardness in mg CaCO<sub>3</sub>/L;  
H? = hardness unknown;  
LOEC = lowest-observed-effect concentration;  
M = measured concentrations;  
n# = sample size used in calculation of the mean;  
nm = not measured;  
NOEC = no-observed-effect concentration;  
OW = Office of Water;

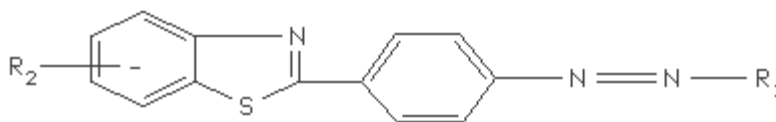
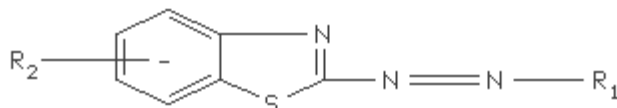
P = predicted;  
RT = rainbow trout;  
S = static method;  
SAR = structure activity relationship;  
SR24 = static renewal method with renewals every 24 h;  
TOC = total organic carbon;  
Wb = whole body;  
WQC = water quality criterion;

August, 1997; revised June 2010

**Category: Aminobenzothiazole Azo Dyes**

Human Health  
Environmental Toxicity

**Definition.** Any disperse azo dye containing the substructure 2-aminobenzothiazole or 2-(p-amino)phenylbenzothiazole, or phenyl ring-substituted derivatives of the same, is considered to be a member of the category.



**Hazard Concerns.** There are oncogenicity/mutagenicity concerns for intact aminobenzothiazole azo dyes by analogy to dimethyl aminostyryl benzothiazole and Butter Yellow-type dyes, such as 4-ethyl-N,N-diethylaminoazobenzene. In addition, there are liver and thyroid concerns for reduction products by analogy to 2-aminothiazole, and neuro-toxicity concerns by analogy to chlorinated 2-aminobenzothiazole. Ecotoxicity concerns are generally chronic concerns only and are based on QSAR predictions for neutral organic compounds. Neutral organic compounds are an established ecotoxicity category, of which these dyes are part of the disperse dye subclass.

**Boundaries.** The boundaries are not strictly defined. For a typical member of the category, R<sub>1</sub> = N- and/or ring substituted p-aminophenyl groups, and R<sub>2</sub> = halogens or nitro groups.

**General Testing Strategy**

The New Chemicals Program considers the following tests to be the most appropriate for aminobenzothiazole azo dyes found to pose an unreasonable risk:

- In vivo mouse micronucleus assay in bone marrow by the i.p. route (Harmonized Test Guideline 850.5395).

- 90-day subchronic toxicity test in rats by the oral route, with special attention to the thyroid and liver (Harmonized Test Guideline 870.3100).

- Fish early life stage test (Harmonized Test Guideline 850.1400).
- Chronic daphnid test (Harmonized Test Guideline 850.1300).
- Algae toxicity test (Harmonized Test Guideline 850.5400).

If the mouse micronucleus assay is positive, further characterization of the potential cancer risk may be recommended: 2-year cancer bioassay by the oral route in 2 species of rodents (Harmonized Test Guideline 870.4200).

Potentially significant ecotoxicity risk, as well as human health risks, resulting from releases to water **ONLY**, may be addressed by environmental fate testing prior to the chronic ecotoxicity and human health testing. The results of the environmental fate testing may preclude the need for further testing.

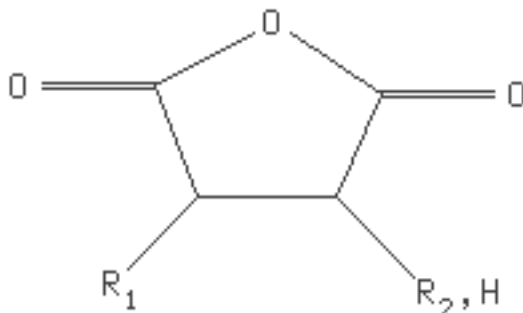
- Jar test to determine the settling rate and extent of removal of suspended solids from solution (draft protocol available).

If the results of the jar test do not mitigate the health and/or ecotoxicity concerns, further characterization of the environmental fate of the dye may be recommended.

January, 1992; revised June 2006.



**Definition.** Any molecular structure containing one or more carboxylic acid anhydride groups is considered to be a member of the category for new chemical purposes. Members of the class include new carboxylic acid anhydrides as well as new oligomers, polymers, prepolymers, or reaction products of existing carboxylic acid anhydrides. As illustrated below, a typical new chemical carboxylic acid anhydride of concern is a polymer or oligomer containing a monomer such as maleic anhydride.



**Hazard Concerns.** Carboxylic acid anhydrides are of concern for potential pulmonary sensitization based on data for phthalic, trimellitic, isopropylidene bis(phthalic), and sulfonyl bis(phthalic) anhydrides. Carboxylic acid anhydrides are also of concern for potential developmental or reproductive toxicity based on data for maleic, succinic, and phthalic anhydrides.

**Boundaries.** Structures with a carboxylic acid anhydride equivalent weight of  $\geq 5,000$  are presumed not to pose a hazard under any conditions. Typically, concerns for health effects are confined to those species with molecular weights  $< 1,000$ .

The new chemical program has thus far been concerned only with those carboxylic acid anhydrides with potentially significant inhalation exposure, and has pursued developmental toxicity only for low molecular weight ( $< 500$ ) carboxylic acid anhydrides which are thought to have a significant potential for systemic uptake via the lung. For pulmonary sensitization, extensive systemic uptake may not be necessary for a biological response and we have therefore sought to regulate some oligomeric or polymeric carboxylic acid anhydrides only for that effect.

### General Testing Strategy

The following tests are usually prescribed for carboxylic acid anhydrides found to pose a potentially unreasonable risk:

- Pulmonary sensitization by either the method of Karol (Toxicol. Appl. Pharmacol. 68:229-241, 1983), or an equivalent method.
- Oral developmental toxicity study in two species (Harmonized Test Guideline 870.3700).

May, 1991

**Category: Anilines**

Environmental Toxicity

**Definition.** This category includes all anilines, both monoanilines and polyanilines. It is assumed that these compounds need to be absorbed to be toxic; therefore, compounds with MWs > 1000 will be excluded from this category. Acute toxicity for anilines which are liquids at room temperature is known to be limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a  $\log K_{ow}$  value of  $\geq 7.38$ , anilines show no effects at saturation during 96-h exposures (Veith and Broderius (1987)). Anilines which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, no effects at saturation should be determined on a case-by-case basis. There are no known  $K_{ow}$  limits for chronic toxicity at this time, but it may not be much above a  $\log K_{ow} = 8$  for liquid anilines.

**Hazard Concerns.** Analysis of the aquatic toxicity for anilines has been reviewed in various publications and has been determined through SAR Analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>].

Publications. Fish 96-h LC50 (Veith and Broderius 1987); fish 14-d LC50 (Deneer et al 1987); fish 14-d LC50 (Hermens et al 1984); daphnids 48-h LC100 (Nendza and Seydel 1988a and 1988b); and green algal 96-h EC50 (Nendza and Seydel 1988a and 1988b).

Aromatic diamines (i.e., two amines on one benzene) and dinitroanilines are known to be more toxic than predicted by these SARs.

Members of this category exhibit toxicity ranging from low toxicity (i.e., > 100 mg/L) to high toxicity (i.e., < 1 mg/L) depending on their  $K_{ow}$ , MW and substitutions (e.g., dinitroanilines).

**Environmental Fate.** Some studies have shown that certain anilines are subject to rapid direct and indirect photolysis under environmentally realistic conditions (Leifer 1990).

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity expected with  $\log K_{ow} < 7.38$ ; no effects at saturation during 96-h exposures when  $\log K_{ow} \geq 7.38$ . Chronic toxicity has no known upper bound for  $\log K_{ow}$ , but it is probably near 8. MW will be < 1000. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the  $\log K_{ow}$  is  $\geq 7.38$ , chronic toxicity testing with fish and daphnids will be recommended.

## **General Testing Strategy.**

### **I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

If there is no significant risk from the PMN after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set. For example, the most sensitive species from the environmental base set has an EC50 value = 2.0 mg PMN/L (based on 100% active ingredients [AI]), therefore, prepare a 5.0 mg PMN per liter stock solution based on 100% AI using the standard humic-containing solution. This stock solution is exposed to sunlight for at least 6 half-lives to ensure that all of the PMN has been photolyzed, and then this stock solution is used to retest the most sensitive aquatic species to determine if the photolysis products of the PMN are more or less toxic than the PMN.

Tier 4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al (1990) have demonstrated that the fish 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the fish 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200] and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

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May, 1991; revised June 2010

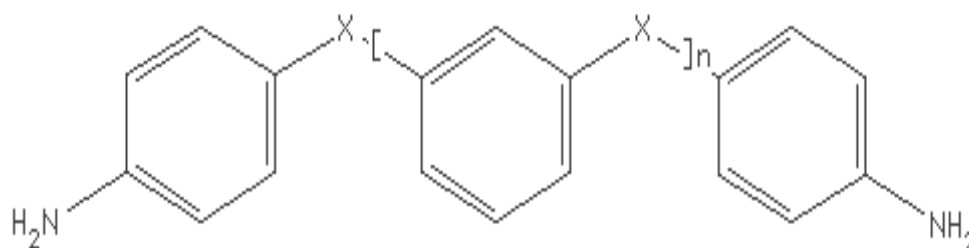
### Subcategory of Anilines: Dianilines

Human Health  
Environmental Toxicity

**Definition.** A PMN must have the following minimum structural requirements to be considered a member of this category:

1. The structure must have at least two phenyl rings with a bridging carbon, oxygen, nitrogen, or sulfur
2. Each terminal phenyl ring must have a primary amino group (or a group that can be readily metabolized to a primary amino group) either meta- or para- to the bridging atom

Compounds with one or more additional phenyl ring(s), with or without ring substituents, and one or more bridging atoms are also included in the category.



$\text{X} = \text{C}, \text{N}, \text{O} \text{ or } \text{S}$

$n \geq 0$

Minimum Structure for Dianiline Category

The compounds of greatest concern are those having  $\text{X} = \text{C}, \text{N}, \text{ or } \text{O}$  and  $n = 0$  or  $1$ .

**Hazard Concerns.** Members of the class are considered to be potential carcinogens and mutagens by analogy to 4,4'-methylenedianiline, 4,4'-methylene bis(o-toluidine), and 4,4'-oxydianiline. Class members are potential retinotoxic agents by analogy to 4,4'-methylenedianiline, 4,4'-oxydianiline, and the diaminodiphenyl alkane drugs and are also potential reproductive and systemic toxicants by analogy to 4,4'-methylenedianiline.

## General Testing Strategy

The New Chemicals Program has considered the following toxicity tests to be the most appropriate for dianilines found to pose an unreasonable risk:

### I. Exposure to Humans

- Rat acute oral retinopathy screening study (protocol to be approved by EPA)
- Pigmented rat 90-day subchronic toxicity study by the oral route (Harmonized Test Guideline 870.3100) or inhalation route (Harmonized Test Guideline 870.3465) to include histopathological examination of the eyes and reproductive organs (eyes to be examined by both light and electron microscopy)
- 2-year carcinogenicity bioassay (Harmonized Test Guideline 870.4200) in rats and mice

In the 90-day subchronic toxicity study, the company may opt to carry a group of animals at each dose level for a 90-day recovery period to determine whether potential retinopathy is reversible.

For some compounds in this class, short-term mutagenicity testing may be appropriate. When appropriate, specific testing will be determined by EPA mutagenicity assessors on a case by case basis by referral to "short question."

Where the general population is at a significant risk from drinking water exposure (via surface water releases) to PMN chemicals of this class, the following fate testing may be appropriate:

- Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270)
- Aerobic biodegradability according to either of the following test guidelines:
  - Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
  - Ready Biodegradability—CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

(See aniline category description for details)

Results of the above fate tests may mitigate concern for drinking water exposure to PMN of this class. However, fate test results WILL NOT CHANGE AGENCY CONCERNS FOR OCCUPATIONAL EXPOSURE to PMNs of this category.

## II. Release to Aquatic Ecosystems

Tier 1. Because of the above boundary conditions, and the need to assess human exposure as well as environmental toxicity, if there is insufficient knowledge about the water solubility of the dye, then it should be measured (Harmonized Test Guideline 830.7860). The fish and daphnid acute toxicity tests from the aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations, and effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations.

If there is no significant risk from the PMN after the results of the fish and daphnid acute toxicity tests have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set.

Tier 4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; and statistical analysis of effective concentrations at days 7, 14, 21, and 28.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; and statistical analysis of effective concentrations at days 7, 14, and 21.

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)



### III. Release to Terrestrial Ecosystems:

The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200] and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

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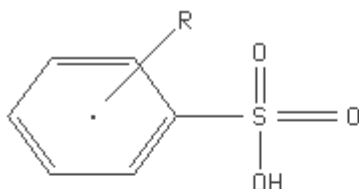
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August 1991; revised January 1995; revised October 1995; revised June 2010

**Category: Anionic Surfactants**

Environmental Toxicity

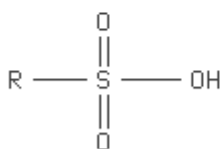
**Definition.** Any molecular structure with a net negative charge and having surfactant activity is a member of this category. The category includes for example, alkyl sulfonates, alkyl benzene sulfonates, alkyl silicic acids, alkyl phosphates, alkyl carboxylic acids, or combinations of these anionic groups, e.g., alkyl sulfonate with carboxylic acid substitutions.



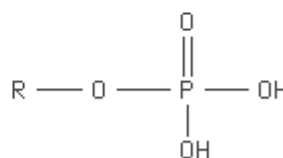
alkyl benzene sulfonate (LAS)

SOME EXAMPLES ARE:

R = straight chain alkyls



alkyl sulfonate



alkyl phosphate

**Hazard Concerns.** Anionic surfactants are toxic to a wide variety of aquatic organisms. Toxicity increases exponentially with increasing carbon chain length up to 16 carbons [for linear alkyl sulfonate (LAS) surfactants], and then decreases with additional carbons. At a chain length of 16 carbons, fish and daphnids are most sensitive, but at lower chain lengths green algae are more sensitive than fish and daphnids. There are a number of structure-activity relationships (SARs) to predict the toxicity of members of this category. Most are parabolic regression equations and others rely on nearest analog methodology.

**Boundaries.** There is no molecular weight boundary. Surfactants with molecular weights > 1000 are still toxic. Acute toxicity may be low, i.e., > 100 mg/L, if a strong cationic surfactant counterion and the anionic surfactant form a tight ion pair.

**Testing.** To address ecotoxicity concerns, base set acute aquatic toxicity testing (green algae: static method, daphnid and fish: flow-through method, all measured concentrations).

Tier 1. The acute aquatic base set of environmental toxicity tests will be recommended for aquatic exposures and the terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test, the earthworm acute toxicity test and the soil microbial community bioassay) will be recommended for any terrestrial exposures.

Acute fish toxicity test  
Acute daphnid toxicity test  
Green algae toxicity test

Harmonized Test Guideline 850.1075  
Harmonized Test Guideline 850.1010  
Harmonized Test Guideline 850.5400

Early seedling growth test	Harmonized Test Guideline 850.4230
Earthworm acute toxicity test	Harmonized Test Guideline 850.6200
Soil microbial community bioassay	Harmonized Test Guideline 850.5100

Tier 2. If acute toxicity testing indicates a significant risk, then environmental fate testing in the form of aerobic biodegradation testing is recommended according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

Tier 3. In addition, if acute toxicity testing indicates a significant risk, then chronic aquatic toxicity testing with fish and aquatic invertebrates will be recommended.

Fish early life stage test	Harmonized Test Guideline 850.1400
Daphnid chronic toxicity testing	Harmonized Test Guideline 850.1300

September 1988; revised September, 1996; revised June 2010

**Definition.** Azides are a class of chemicals consisting of both inorganic and organic compounds and characterized by the functional group  $N=N=N$ . Substitutions may be either metals or organic compounds, e.g., acetic acid and benzene. So far, only monomeric aromatic azide compounds have been submitted as PMNs. No aliphatic azides, e.g., alkyl azides, have been submitted as PMNs. Aliphatic azides may be too explosive to isolate, however, diazidoacetic acid ester is known to exist and has been tested in rats.

**Hazard Concerns.** It is assumed that azides have to be absorbed to be toxic, therefore, azides with  $MW > 1000$  will be excluded from this category. Acute toxicity for monomeric azides is assumed to be correlated and limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a  $\log K_{ow}$  value of  $> 5.0$ , azides are assumed to show no effects at saturation during 96-hour exposures to fish. Organic azides which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on their melting point and/or their water solubility. For example, for organic azides, the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be occur at saturation. For solids, no effects at saturation has to be determined on a case-by-case basis. The upper  $K_{ow}$  limits for chronic toxicity are approximately  $\log K_{ow} = 8$ .

The toxicity for inorganic azides has to be determined by integrating the toxicity of Na azide with the toxicity of any other inorganic element, e.g., Pb, with a MW adjustment for differences in toxicity between Na azide and the other inorganic element. Na azide [26628-22-8] has been tested by the USEPA ERL-Duluth: fathead minnow 96-h  $LC_{50} = 5.46$  mg/L based on a flow-through method with nominal concentrations.

The SAR for organic azides is based on (1) sodium azide value, (2) a calculated  $\log K_{ow}$ , and (3) no acute effects to fish at saturation assumed to occur at a  $\log K_{ow} \geq 5.0$  which is equivalent to a log fish 96-h  $LC_{50} = -2.5$  in millimoles per liter.

**Environmental Fate:** Na azide is known to hydrolyze in water to form hydrazoic acid (or hydrogen azide,  $NH_3$ , [7782-79-8], MW43, M12,4815). Hydrogen azide is extremely explosive according to Merck. In addition, azides can be transformed to nitrenes by *uv* light.

**Boundaries:**  $MW < 1000$ .  $\log K_{ow} < 5.0$  for acute toxicity to fish and aquatic invertebrates;  $\log K_{ow} < 6.4$  for toxicity to green algae as a 96-h  $EC_{50}$ ; and  $\log K_{ow}$  assumed to be  $< 8.0$  for chronic toxicity to aquatic organisms, but could be higher.

## **General Testing Strategy:**

### **I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (ai) and mean measured concentrations; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the aldehyde to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical significantly above its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (ai) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the aldehyde to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical significantly above its aqueous solubility limit.

If there is no significant risk from the PMN chemical after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the PMN chemical after the results of biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; ideally, mean measured concentrations in the

highest treatment concentration should be equal the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN significantly above its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because the 7-d ELS toxicity test may underestimate chronic toxicity measured by the 28-d ELS toxicity test when the Chronic Values are compared.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN significantly above its aqueous solubility limit; and the 7-d daphnid short-term chronic toxicity test cannot be substituted for the 21-d toxicity test because the daphnid 7-d short-term toxicity test may underestimate chronic toxicity measured by the 21-d toxicity test when the chronic values are compared.

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

### **References:**

Abbe, G. (1969). Decomposition and addition reactions of organic azides. Chemical Review, 69, 345-363.

Scriven, E.F. (Ed.). (1984). Azides and nitrenes: Reactivity and utility. pp.95-204. New York: Academic Press.

September 1996; revised June 2010; revised June 2010

**Definition.** This category includes all benzotriazoles.

**Hazard Concerns.** The toxicity for benzotriazoles with -NH has been determined through SAR Analysis (Clements 1988). Benzotriazoles with -NH are known to be more toxic than neutral organic chemicals, and this excess toxicity decreases with increasing  $K_{ow}$ . The toxicity of benzotriazoles with aliphatic substitutions on the nitrogen are expected to act like neutral organic compounds. Other substitutions on the N, e.g., -SH, may be evaluated on a case-by-case basis.

Members of this category exhibit toxicity ranging from low toxicity (i.e.,  $> 100$  mg/L) to high toxicity (i.e.,  $< 1$  mg/L) depending on their  $K_{ow}$ , MW, and melting point.

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$ , MW, and melting point (mp). These compounds need to be absorbed to be toxic; therefore, compounds with MWs  $< 1000$  are expected to cause toxicity, while compounds with MWs  $> 1000$  are not expected to show toxicity at saturation.

Acute toxicity for benzotriazoles which are liquids at room temperature is known to be limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a  $\log K_{ow}$  value of 5.0, benzotriazoles typically show no effects at saturation during 96-h exposures (Clements 1988). Benzotriazoles which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no acute toxicity will be observed at saturation. For solids, the no-effects-at-saturation point for acute toxicity has to be determined on a case-by-case basis.

The  $\log K_{ow}$  limit for chronic toxicity is set at 8 for liquid benzotriazoles. For solids, chronic toxicity testing will determine the  $K_{ow}$  limit.

Therefore, acute toxicity is expected when  $\log K_{ow} \leq 5.0$  and  $MW < 1000$ ; no effects at saturation during 96-h exposures are expected when  $\log K_{ow} > 5.0$  and  $MW < 1000$ . The upper boundary for chronic toxicity is typically 8.0. Only chronic toxicity is expected when  $\log K_{ow} > 5.0$  and  $< 8.0$ , and  $MW < 1000$ . Whenever  $MW > 1000$ , no effects are expected at saturation because it is assumed that benzotriazoles have to be absorbed to be toxic.

Aerobic biodegradation is expected to be the dominant route of transformation in the environment.

## **General Testing Strategy.**

### **I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested chemical; and solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical beyond its aqueous solubility limit.

The algal toxicity test (Harmonized Test Guideline 850.5400) should be done with the static method; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the chemical; and solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical beyond its aqueous solubility limit.

If there is no significant risk from the benzotriazole after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the benzotriazole after the results of the aerobic biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit for the chemical; solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for



the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen). Both anilines and benzotriazoles with -NH are more toxic than predicted based on narcosis alone, i.e., both benzotriazoles and anilines have excess toxicity due to a more specific mode(s) of toxic action. A seven day exposure may not allow enough time for this excess toxicity to be expressed either because of not enough exposure and/or not enough time for metabolic activation.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the chemical; solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical above its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test (Van Leeuwen et al 1990).

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200], the avian acute oral toxicity test [Harmonized Test Guideline 850.2100], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), the avian reproductive toxicity test (Harmonized Test Guideline 850.2300), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

## **References**

Clements, RG (editor). 1988. Estimating toxicity of industrial chemicals to aquatic organisms using structure-activity relationships. EPA-560-6-88-001. Washington, DC: Environmental Effects Branch, Health and Environmental Review Division, Office of Toxic Substances (TS-796), United States Environmental Protection Agency. Available from the National Technical Information Service, Springfield, VA 22161, PB89-117592.

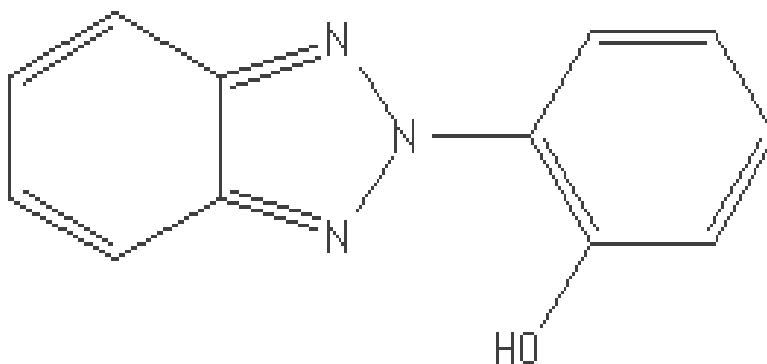
Van Leeuwen CJ, Adema DMM, and Hermens J. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. *Aquatic Toxicology* 16:321-334.

March, 1992; revised June 2010

**Category:** Benzotriazole-hindered phenols

Human Health  
Environmental Toxicity  
(see Phenols)

**Definition.** Any molecular structure containing the following substructure is considered to be a member of the category. The predominant use of members of this category is as a UV light stabilizer in coating or plastic formulations.



Note: Health effects may vary depending on the nature of the ring substituents.

**Hazard Concerns.**

I. Health

Systemic toxicity based on 8(e) and PMN data on analogues. These data are generally consistent across compounds, with the following endpoints occurring in subacute, subchronic, and chronic oral feeding studies in rats and dogs in which doses ranged from 5 to 15,000 ppm.

Increased organ weights (liver and kidney, with associated histopathology at higher doses); hematological effects (decreased hemoglobin, packed cell volume, and erythrocytes); and immune system effects (weight changes in thymus, spleen, lymph nodes; decreased leukocytes).

Generally, treatment-related effects are dose-related, increasing in frequency and severity with increasing dose. Males appear to be more sensitive than females, and similar toxic effects occur in both rats and dogs.

The lowest available NOAEL for systemic effects, from a 90-day rat study, is 5 ppm, or 0.25 mg/kg/day.

Reproductive toxicity - Concern is also based on 8(e) and PMN data on analogues. As with systemic toxicity, the data are generally consistent with the following endpoints occurring in subacute and subchronic oral feeding studies in rats and dogs in which doses ranged from 5 to

15,000 ppm.

Atrophy of the seminal vesicles, significant reduction in absolute and relative testes weight, significant reduction in absolute and relative prostate weight, and abnormal spermatogenesis. A subchronic dog study also provided evidence of female reproductive toxicity.

Generally, treatment-related effects are dose-related, increasing in both frequency and severity with increasing dose. Males appear to be more sensitive than females, and similar toxic effects occur in both rats and dogs.

The lowest NOAEL for reproductive toxicity, from a 90-day dog study, is 15 mg/kg/day.

Dermal sensitization - Dermal sensitization test data were positive in 3/4 compounds tested. Two of the compounds showed strong sensitizing potential based on results obtained from maximization tests in which 70% and 90% of the treated guinea pigs became sensitized, respectively.

## II. Environmental

The environmental concerns for the substances described in this category have already been described in the Phenol category.

**Boundaries.** Not enough is known about the structure-activity relationships of these compounds to set any boundaries on members of the category; compounds with both "small" and "large" substituents have shown effects, and the effects are generally consistent from compound to compound.

### General Testing Strategy

#### I. Health

Systemic Toxicity and Reproductive Toxicity. A 90-day gavage study in rats with special attention to hematology; weight and histopathology of lymphoid organs (spleen, thymus, and bone marrow); cellularity of the bone marrow, thymus, and spleen; and histopathology of the liver, kidney, heart, and all endocrine glands for which weight changes are observed. Particular attention should be directed toward achieving satisfactory quality from fixation and embedding of the testes, following the recommendations of Russell et al. [Russell LD, Ettlin RA, Sinha Hikim AP, Clegg ED. 1990. Histological and histopathological evaluation of the testis. Cache River Press, Clearwater, FL].

A gavage study, as opposed to an oral feeding study, is recommended because decreased body weight gain, final body weight, and/or food consumption have been reported in some oral feeding studies with analogues.

If immunopathology and hematology in the 90-day study support the concern for adverse effects of the PMN substances on the immune system, then a further battery of tests, such as the NTP's Immunotoxicology Tier II Screening Panel, will be recommended.

Dermal Sensitization. Because dermal sensitization is not routinely pursued under TSCA 5(e) as a regulatory endpoint, testing is not recommended. A letter may be sent to the PMN submitter expressing the Agency's belief that the compounds are likely to be dermal sensitizers and that protective measures should be taken for workers.

## II. Environmental Toxicity

If exposure to the aquatic environment demonstrates a potential risk, testing of the substances described in this category is the same as that prescribed for the Phenols category.

June, 1993.

**Category: Boron Compounds**

Human Health  
Environmental Toxicity

**Definition.** This category includes borates, organoborates, borate esters, boron hydrides, boranes, and boroxines.

I. Human Health

**Hazard Concerns.** Reproductive toxicity (males/females), blood toxicity, and neurotoxicity. The Agency has an oral RfD for boron of 0.09 mg/kg/day (uncertainty factor 100) based on the finding of testicular atrophy and spermatogenic arrest in dogs in a 2-yr feeding study (Weir and Fisher 1972, as summarized in IRIS 1995). [All toxicity information presented here are summarized in an assessment of various aqueous cleaner chemicals prepared in 1990 for the Office of Air and Radiation. Reproductive toxicity information is also summarized in IRIS 1995.]

Reproductive Toxicity. The most significant effect seen in animals is reproductive toxicity (i.e., sterility in males and females, and testicular atrophy in males). A three-generation reproductive study in rats demonstrated sterility in males (lack of spermatozoa in atrophied testes) and females (decreased ovulation) after exposure to 58.5 mg boron/kg in the diet. NOAEL (rats) 17.5 mg boron/kg. Sterility was also found in males (at 50 or 100 mg boron/kg) in a serial mating adjunct to a 60-day feeding study; NOAEL (rats) 25 mg boron/kg.

Data from oral subchronic and chronic studies in rats, dogs, and mice also provide evidence that boron produces adverse effects on the male reproductive system. A statistically significant reduction in relative and absolute testes weights was seen in a 2-yr and a 90-day dietary study in male rats at 58.5 and 26.3 mg boron/kg, respectively. NOAEL's (rats) 17.5 and 8.8 mg boron/kg, respectively. In male rats, dietary exposure to 50 mg/kg boron resulted in a significant reduction in fertility, a significant reduction in epididymal weight, and a reduction in sperm number after 30 days of treatment. A significant reduction in testicular weight and further reduction in sperm occurred after 60 days of treatment. NOAEL (rats) 25 mg boron/kg. Similar results were observed in several drinking water studies in rats.

In male dogs, dietary exposure to 29.4 mg boron/kg for 2 yr resulted in severe testicular atrophy and spermatogenic arrest. NOAEL (dogs) 8.8 mg boron/kg. In male and female dogs, dietary exposure to 43.8 and 4.4 mg boron/kg for 90 days did not affect the female reproductive system, but produced decreased testes weights (statistically significant at 43.8 mg boron/kg). NOAEL (dogs) 0.4 mg boron/kg. In male mice, dietary exposure to 131 mg boron/kg for 103 wk (only dose tested) caused an increased incidence of testicular atrophy and interstitial hyperplasia.

Blood Toxicity. In a chronic feeding study in rats, packed cell volume and hemoglobin levels were significantly decreased in males and females at 58.5 mg boron/kg. NOAEL (rats) 17.5 mg boron/kg. In a subchronic drinking water study in rats, a significant decrease in plasma

triglyceride levels was noted at 23.7 and 47.4 mg boron/kg (only doses tested). LOAEL (rats) 23.7 mg boron/kg. In a subchronic feeding study in dogs, 43.8 mg boron/kg but not 4.4 or 0.4 mg boron/kg produced decreased packed cell volumes and hemoglobin levels. NOAEL (dogs) 4.4 mg boron/kg. In a subchronic feeding study in mice, minimal to mild extramedullary hematopoiesis of the spleen was observed in all dosed groups (ca. 34, 68, 136, 272, or 544 mg boron/kg). LOAEL (mice) 34 mg boron/kg. There is also a case study in which an infant exposed to 43 mg boron/kg/day for 12 weeks developed anemia.

Neurotoxicity. Ingestion of borax by human infants results in neurotoxicity. Case reports of nine infants who were exposed by sucking pacifiers dipped in a borax-honey mixture document similar findings of neurological symptoms (not specified) and seizures. For seven infants, doses are reported as 2 to 3 g borax/wk for 4 to 10 wk (ca. 4 to 16 mg boron/kg/day). Serum boron levels measured in three of the seven infants were elevated. For the other two infants, doses are reported as 125 mg borax/kg over a 12-wk period and 9 g borax over a 5-wk period (ca. 43 and 8 mg boron/kg/day, respectively). The effects appear to be reversible upon cessation of exposure. Neurotoxicity testing is not recommended because animal studies do not appear to be predictive of this effect.

**Boundaries.** The boundaries of this category are not yet well defined for health effects. All of the toxicity data are on boric acid or borax. A molecular weight cutoff of 1,000 is proposed, but there is no information from available toxicity data on a proper water solubility cutoff.

**General Testing Strategy.** The OECD reproductive toxicity screen (OECD 421) with special additional attention to hematology. If this screen is positive for reproductive toxicity, a reproductive fertility study in rats according to Harmonized Test Guideline 870.3800 is recommended.

In cases in which exposures are exclusively dermal, a dermal absorption study (either in vivo or in vitro) could be conducted to refine the dermal risk assessment. If the in vivo study is selected, the test material should not be corrosive. If there is some uncertainty as to the corrosivity of the neat test material, a dermal irritation study should be undertaken first. If the neat material is corrosive, dilution to a noncorrosive concentration with a vehicle such as acetone or the alcohol used to make the ester is recommended.

## II. Environmental Toxicity

Most of the toxicity information for boron compounds is for boric acid and sodium tetraborate. These boron compounds show low acute toxicity towards fish (250.0 mg/L as a mean acute toxicity value) and daphnids (70.0 mg/L as a mean acute toxicity value), but moderate toxicity towards green algae (20.0 mg/L as a mean EC50 value). However, these compounds exhibit large acute to chronic ratios (ACR) towards fish (125 as a mean ACR) and the difference between the EC50 value and the chronic value (ChV) in green algae is large (about 117 as a mean difference). The mean ACR for daphnids is 8. The mean ChVs for fish, daphnids, and

green algae are 2.0 mg/L, 9.0 mg/L, and 0.170 mg/L, respectively. Green algae appears to be the most sensitive group of species with respect to boric acid and sodium tetraborate.

There are only screening data for fish for borate esters, specifically, only for tributylborate. These screening data showed no effects at 10.0 mg/L for 24 hours towards three species of fish. However, the purity of the tributylborate was not given.

The only data for boranes are for tert-butylamine borane. These data are: fish 96-h LC50 = 13.0 mg/L, daphnid 96-h LC50 = 0.700 mg/L, green algal 7-d EC50 = 3.0 mg/L, and algal ChV = 0.300 mg/L.

The only toxicity information for boron hydrides are for mammals. These data show that all boron hydrides are highly toxic and more toxic than borates.

The major environmental hazard concerns for this category are for chronic toxicity towards fish and toxicity towards green algae.

Since there are no SARs for boron compounds, hazard profiles are developed using the nearest analog(s).

**Boundaries.** Boron compounds must have water solubilities equal to or greater than 1.0 µg/L (ppb) and molecular weights generally need to be near or below 1000.

**Environmental Fate.** Certain borates are subject to hydrolysis under environmentally realistic conditions.

### **General Testing Strategy.**

The following testing strategy will address aquatic toxicity concerns:

#### **I. Release to Aquatic Ecosystems:**

Tier 1a. If the hydrolysis rate for any member of this class is predicted to be slow ( $t_{1/2} > 2$  days) or if hydrolysis will result in one or more products which are expected to be just as toxic as the parent borate, then the fish and daphnid acute toxicity tests from the aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

If there is no significant risk from the PMN after the results of the environmental base set of tests have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 1b. If the hydrolysis rate for any member of this class is predicted to be rapid ( $t_{1/2} < 2$  days) and if hydrolysis will result in products which are expected to be significantly less toxic as the parent borate, then hydrolysis testing (Harmonized Test Guideline 835.2120) will be recommended.

If the resulting hydrolysis  $t_{1/2}$  is  $< 2$  days, then this result will be integrated into a new risk assessment for the PMN. However, the resulting hydrolysis  $t_{1/2} > 2$  days, then the environmental base set will be recommended.

If there is no significant risk from the PMN after the results of the environmental base set of tests have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; and statistical analysis of effective concentrations at days 7, 14, 21, and 28.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21.

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)



II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200] and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

July, 1991; revised August, 1997; revised June 2010.

**Definition.** Any dye bearing one or more net permanent positive charges is considered to be a member of this class. A "typical" new chemical of concern is a water soluble monoazo dye with a single delocalized positive charge.

**Hazard Concerns.** Water soluble cationic dyes are toxic to fish, daphnids, and algae. Poorly soluble dyes tend to be toxic only to algae. No relationship between structure and activity has been found for cationic dyes.

**Boundaries.** There are no established boundaries for cationic dyes. There is no molecular weight threshold - one dye with a molecular weight of 3,000 and bearing four positive charges was found to be toxic to fish.

**Testing.** To address environmental concerns, the base set of environmental toxicity tests (i.e., the fish acute toxicity test, the daphnid acute toxicity test and the green algal toxicity test) is recommended. These tests are to be done using the static method and nominal concentrations. In addition, two additional fish acute toxicity tests are recommended with known amounts of humic acid added to the dilution water. This testing is necessary to measure the mitigating effects of dissolved organic carbon (DOC) on the toxicity of the cationic dye. One test will be done with 20 mg humic acid/L in dilution and the second test will have 10 mg humic acid/L in dilution water. Total organic carbon (TOC) will be measured three times in each test and the TOC of the clean dilution water will also be measured at the beginning of the test.

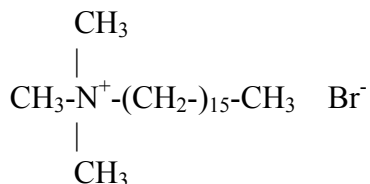
If DOC mitigates the environmental risk to water column organisms, then testing using natural sediments and organisms known to ingest sediment may be recommended.

March, 1990

**Category:** Cationic (quaternary ammonium) surfactants Environmental Toxicity

**Definition.**

Any cationic surfactant is a member of this category, for example:



**Hazard Concerns.** Cationic surfactants are biocidal to a wide array of species in the environment. Toxicity increases exponentially with increasing carbon chain length up to 16 carbons and then decreases with increasing chain length. QSAR (quantitative structure-activity relationships) have been developed to predict toxicity.

**Boundaries.** Little toxicity is observed when the carbon chain length exceeds 22. Tight ion pairs will not be significantly toxic.

**General Testing Strategy.** To address ecotoxicity concerns, base set aquatic toxicity testing in algae, daphnids, and fish, plus humic acid testing in fish (20 mg/L and 10 mg/l humic acid in dilution water) is recommended. All testing uses static method, nominal concentrations.

March, 1990

**Category: Cobalt**

## Environmental Toxicity

This category includes but is not limited to inorganic and organic compounds of cobalt (Co), e.g., soluble cobalt cations, cobalt esters, and organocobalt compounds.

**Hazard Concerns.**

Most of the toxicity information for inorganic cobalt compounds is for the soluble salts: chloride, nitrate, and sulfate. There are no known data for organoCo compounds, organic acid chelates with Co, or for Co esters.

The best toxicity data for Co are listed below with predicted (P) and measured (M) toxicity values indicated and effective concentrations in mg Co/L (ppm):

fish (FHM) 96-h LC <sub>50</sub>	=	48.0	M S,?,H130,Cl (Ref. E86)
daphnid 48-h LC <sub>50</sub>	=	1.32	M Cl (Ref. B&S74)
daphnid 48-h LC <sub>50</sub>	=	1.11	M S,N,H45,Cl (Ref. B&C72)
WQ 2° acute value	=	0.195	P (Ref. S96)
green algal 7-d EC <sub>50</sub>	=	0.160	M S,? NO3,Cl,SO4 (Ref. St81)
RTELS 28-d LC <sub>50</sub>	=	0.470	M SR12h,?,H104,NO3 (Ref. B78)
fish ChEC <sub>20</sub>	=	0.810	M (Ref. S96)
fish Chronic Value (ChV)	=	0.290	M S96
fish ACR	=	170.0	P
daphnid ChEC <sub>20</sub>	=	0.004	M (Ref. S96)
daphnid ChV	=	0.010	M S,N,H45,Cl (Ref. B&C72)
daphnid ChV	=	0.005	M (Ref. S96)
daphnid ACR	=	110.0	P (Ref. B&C72)
WQ 2° chronic value	=	0.003	P (Ref. S96)
algal ChV	=	0.040	P EC50÷ChV=4

## Abbreviations:

ACR	=	acute-to-chronic ratio;
Ch	=	chronic;
ChV	=	chronic value;
CC	=	concern concentration;
ELS	=	early life stage;
FHM	=	fathead minnow;
H	=	hardness as CaCO <sub>3</sub> ;
N	=	nominal concentrations;
?	=	method unknown;
RT	=	rainbow trout;
S	=	static method;

SR12h = static renewal method with renewals every 12 hours; and  
WQ = water quality value.

Predictions were based on SARs for inorganic Co compounds; pH 7; hardness <180.0 mg/L as CaCO<sub>3</sub>; 100% active ingredients; mean measured concentrations of Co; and total organic carbon (TOC) <2.0 mg/L.

Environmental concerns for Co compounds:

moderate concern for acute toxicity to fish;  
moderate concern for acute toxicity to daphnids;  
high concern for toxicity to green algae;  
moderate concern for chronic toxicity to fish;  
high concern for chronic toxicity to daphnids;  
high concern for toxicity to green algae;

assessment factor (AsF)	=	10.0
COC for fish	=	0.030
COC for daphnids	=	0.001
COC for green algae	=	0.004

The aquatic toxicity for the chelates and esters of Co are expected to be less than predicted using toxicity data based on the soluble ion and with a MW adjustment.

The aquatic toxicity for organoCo could be higher than predicted using toxicity data based on the soluble ion and with a MW adjustment because the organic portion could enhance uptake in aquatic organisms. It is assumed that (1) the MWs of organoCo compounds would have to be less than 1000 daltons and (2) the log K<sub>ow</sub> of any organoCo would have to be less than 8.0 for toxicity to aquatic organisms to occur. It is also assumed that the aquatic toxicity of organoCo compounds will increase with increasing K<sub>ow</sub> when the log K<sub>ow</sub> <8.0.

The major environmental toxicity concerns for this category are for chronic toxicity towards daphnids and toxicity towards green algae. The acute-to-chronic ratios of Co towards fish and daphnids are both greater than 100. The SAR method for Co compounds is the nearest analog(s) method.

**Boundaries.** Cobalt compounds must have water solubilities equal to or greater than 1.0 µg/L (ppb) and molecular weights generally need to be near or below 1000. The log K<sub>ow</sub> of organoCo compounds has to be <8.0.

## General Testing Strategy:

### I. Release to Aquatic Ecosystems:

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the test chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical beyond its aqueous solubility limit. Stock solutions in water should be adjusted to pH near 7.0.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the test chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical beyond its aqueous solubility limit. Stock solutions in water should be adjusted to pH near 7.0.

If there is no significant risk from the test chemical after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. For organoCo compounds, or chelates or esters of Co, aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the test chemical after the results of biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations;

effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; solvent can be used to assist the test chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because the 7-d ELS toxicity test may underestimate chronic toxicity measured by the 28-d ELS toxicity test when the Chronic Values are compared. Stock solutions in water should be adjusted to pH near 7.0.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; solvent can be used to assist the test chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because the fish 7-d ELS toxicity test may underestimate chronic toxicity measured by the fish 28-d ELS toxicity test when the chronic values are compared.

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, the earthworm toxicity test and the soil microbial community bioassay) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test, the plant uptake test, and the soil microbial community bioassay.

## References.

B78 = Birge. 1978. USDOE Tech Info  
B&C72 = Biesinger&Christensen. 1972. J Fish Res Brd Can 29:1691  
B&S74 = Baudouin&Scoppa. 1974. Bull Environ Contam Toxicol 12:745  
E86 = Ewell etal. 1986. Environ Toxicol Chem 5:831  
S96 = Suter, GW. 1996. Environ Toxicol Chem 15:1234  
St81 = Stokes. 1981. J Plant Nutrit 3:667

September, 1996; revised June 2010.

**Category: Diazoniums**

## Environmental Toxicity

This category includes only aromatic diazoniums ( $N\equiv N^+$ ). Aliphatic diazoniums are very explosive and are only used as synthesizing agents. Aromatic diazoniums are used as fungicides on seeds and in soil, e.g., Fenaminosulf. It is known that diazoniums need to be absorbed to be toxic. Test data submitted to the Agency in the New Chemicals Program showed that diazo compounds with an average molecular weight ( $MW_n$ ) > 1000 have no effects at saturation to fish in the acute toxicity test. Therefore, compounds with  $MW_n$ 's > 1000 will be excluded from this category regardless of water solubility. In the NEAT state, diazoniums are solids, i.e., salts, and are most are soluble in aqueous media. Acute toxicity for diazoniums is assumed to be limited by the octanol/water partition coefficient ( $K_{ow}$ ) and MW. Above a log  $K_{ow}$  value of 8.0 and/or  $MW > 1000$ , diazoniums are not expected to be toxic at saturation during 96-h exposures. Diazoniums are expected to be similar to anilines with respect to their  $K_{ow}$  cutoff value for acute toxicity. The acute toxicity of anilines diminishes at about a log  $K_{ow} = 7.0$  (Veith and Broderius 1987). There are no known  $K_{ow}$  limits for chronic toxicity at this time, but it may not be much above a log  $K_{ow} = 10.0$  for diazoniums.

**Hazard Concerns.** Only the acute toxicity to fish for diazoniums has been determined by EPA through SAR Analysis using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>]. Daphnids are assumed to have similar sensitivity to fish, but green algae are expected to be more sensitive based on the use of diazoniums as fungicides.

**Environmental Fate:** Diazonium fungicides, e.g., Fenaminosulf, are sensitive to light but are stabilized with Na sulphite. Fenaminosulf is stable in alkaline media. Diazoniums are also used in photography, e.g., diazo reproduction paper and film. Therefore, diazoniums are expected to be subject to rapid direct and indirect photolysis under environmentally realistic conditions. Diazoniums are also expected to slowly hydrolyze to phenols.

**Boundaries.:** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity expected with log  $K_{ow} < 8.0$  with a missing fragment for  $N\equiv N^+$ ; no effects at saturation during 96-h exposures when log  $K_{ow} \geq 8.0$ . Chronic toxicity has no known upper bound for log  $K_{ow}$ , but it is probably near 10.0 with a missing fragment for  $N\equiv N^+$ . MW must be < 1000. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log  $K_{ow}$  is  $\geq 10.0$ , chronic toxicity testing with fish and daphnids will be recommended.



## **General Testing Strategy.**

### **I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. Since diazonium compounds are photosensitive to uv light, it is best to avoid the use of fluorescent lights in toxicity tests. If they are used, then glass filters should be used. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis cannot exceed the PMN's aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

If there is no significant risk from the PMN after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set. For example, the most sensitive species from the environmental base set has an EC50 value = 2.0 mg/L (based on 100% active ingredients [AI]), therefore, prepare a 5.0 mg/L stock solution based on 100% AI using the standard humic-containing solution. This stock solution is exposed to sunlight for at least 6 half-lives to ensure that all of the PMN has been photolyzed, and then this stock solution is used to retest the most sensitive aquatic species to determine if the photolysis products of the PMN are more or less toxic than the PMN.

Tier 4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the PMN; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al (1990) have demonstrated that the fish 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the fish 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200], the avian acute oral toxicity test [Harmonized Test Guideline 850.2100], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), avian reproduction toxicity test (Harmonized Test Guideline 850.2300), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

### **References.**

Van Leeuwen CJ, Adema DMM, and Hermens J. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. *Aquatic Toxicology* 16:321-334.

Veith GD and Broderius SJ. 1987. Structure-toxicity relationships for industrial chemicals causing type (II) narcosis syndrome. In Kaiser KLE (ed), *QSAR In Environmental Toxicology -II*, pp. 385-391. Reidel Publishing Company.

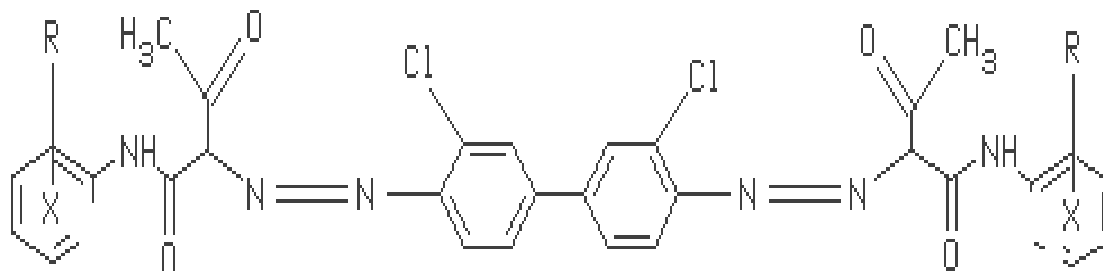
November, 1991; revised June 2010

**Category:** Dichlorobenzidine-based Pigments

Human Health  
Environmental Toxicity

**Other Names:** Diarylide Pigments, DCB Pigments, Pigment Yellows

**Definition:** Any diazo pigment containing the substructure, dichlorobenzidine, and coupled with acetoacetanilide.



R = substituent of the coupling component

**Hazard Concerns.** There are oncogenicity/mutagenicity concerns for dichlorobenzidine-based pigments based on the potential release of 3,3'-dichlorobenzidine and on the presence of residual (unbound) dichlorobenzidine. DCB is a known animal carcinogen and a suspect human carcinogen. In addition, DCB is known to bioconcentrate in the tissues of aquatic organisms.

**Boundaries.** Concern for the intact pigment is restricted to uses at temperatures exceeding 200°C. Data submitted to the Agency under TSCA section 8(e) show that DCB pigments break down to release DCB as a vapor from colored polymers when heated to extrusion temperatures (> 200°C) and, from sheetmetal coatings during curing. Though little information exists on the biodegradation of pigments in sediments, data on other low water soluble colorants, indicate that biodegradation may occur over a period of months, possibly resulting in the release of DCB.

**General Testing Strategy.**

EPA's New Chemicals Program considers the following tests to be appropriate to address the potential for DCB pigments to pose a significant risk to health or the environment:

1. Monitoring data to detect the presence of DCB under actual conditions of use; temperature, dwell time, % pigment in polymer or coating, and type of polymer or coating.
2. If there are releases to water, an anaerobic biodegradation assay.

**References:**

Appleton HT, Sikka HC. 1980. Accumulation, elimination, and metabolism of 3,3'-dichlorobenzidine in the bluegill sunfish. *Environ Sci Technol* 14:50-54.

Pliss GB. 1963. On some regular relationship between carcinogenicity of aminobiphenyl derivatives and the structure of the substance. *Acta Unio Int Cancrum* 19:499-501.

Stula EF, Sherman H, Reinhardt CF. 1975. Experimental neoplasia in rats from oral administration of 3,3'-dichlorobenzidine, 4,4'-methylene-bis(2-chloroaniline), and 4,4'-methylene-bis(2-methylaniline). *Toxicol Appl Pharmacol* 32:159-176.

Stula EF, Barnes JR, Sherman H. 1978. Liver and urinary bladder tumors in dogs from 3,3-dichlorobenzidine. 1978. *J Environ Pathol Toxicol* 1:475-490.

TSCA Section 8(e) Documents:

8EHQ-0490-0962 INIT

8EHQ-0590-0962 SUPPL

8EHQ-0690-0962 FLWP

8EHQ-0790-0962 SUPPL

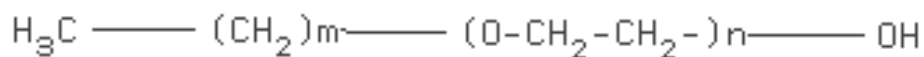
8EHQ-0890-0962 SUPPL

March, 1994

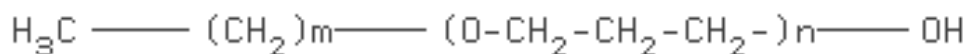
**Category: Dithiocarbamates**

Environmental Toxicity

**Definition.** This category includes N,N-dialkyldithiocarbamates (DDC); ethylenebisdithiocarbamates (BDC); and their metal salts which include but are not limited to zinc, sodium, iron, manganese, copper, lead, mercury, silver and selenium. The alkyl groups of the DDCs generally include, methyl through butyl, but may be larger. This category also includes the degradation products of DDC and BDC which may include disulfide moieties, sulfide moieties, thiourea moieties, urea moieties, polymeric sulfide moieties, dithizaole-3-thiones, cyclic thioureas and cyclic ureas as indicated in the generic environmental hazard assessment.



alkyl ethoxylate



alkyl propoxylate

**Hazard Concerns:** Many members of this category are commercial insecticides, fungicides, disinfectants, rodenticides, antioxidants, slimicides, algacides, bactericides and heavy metal chelators. Their mode of toxic action apparently results from interference with metallo-enzymes in living cells; the toxicity has been attributed to either DDCs and BDCs or their degradation products. All of the known dithiocarbamates are acutely toxic to fish, algae and bacteria at < 10 mg/L, and to aquatic invertebrates at < 1 mg/L. Chronic toxicity to fish and aquatic invertebrates ranges from 0.001 to 2 mg/L and 0.011 to 0.111 mg/L, respectively. In general, the SARs for the dithiocarbamates and their degradation products are sigmoidal with acute and chronic toxicity increasing with increasing K<sub>ow</sub>. The sigmoidal relationship between K<sub>ow</sub> and toxicity of the dithiocarbamates is very poor statistically. Consequently, toxicity predictions will be made using either the closest analog or averaging data for the two closest analogs which bracket the dithiocarbamate under question. The SAR for the degradation products is much more robust and a series of SARs will be used to predict acute toxicity of degradation products toward fish, daphnids and Photobacterim phosphoreum; and chronic toxicity toward fish, daphnids and green algae.

**Boundaries.** There are no known lower boundaries. The upper boundaries are based on K<sub>ow</sub> and MW. When the log K<sub>ow</sub> value is < 5, the environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log K<sub>ow</sub> is between 5 and < 19, only chronic toxicity testing will be recommended. When the log K<sub>ow</sub> is ≥ 19, no testing will be requested because no toxic effects at saturation will be expected. Generally, members of this category will have MWs of less than 1000.

## **General Testing Strategy**

Tier 1. The acute aquatic base set of environmental toxicity tests will be recommended for aquatic exposures and the terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, the earthworm acute toxicity test and the soil microbial community bioassay) will be recommended for terrestrial exposures.

Tier 2. If acute toxicity testing indicates a significant risk, then chronic toxicity with fish and aquatic invertebrates will be recommended as well as aerobic biodegradation testing.

Aerobic biodegradability can be determined using either of the following test guidelines:

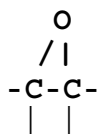
- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

August 1989; revised November 1995; revised June 2010

**Category: Epoxides**

Human Health  
Environmental Toxicity

**Definition.** Any molecular structure containing one or more epoxy groups is considered to be a member of the category:



**Hazard Concerns.**

**Human Health:** concerns for epoxides are for cancer and reproductive effects based on data for several analogous chemicals. There is greater concern for primary epoxides, than for epoxides with substitutions on both of the epoxy carbons

**Environmental Toxicity:** is a function of the octanol-water partition coefficient. Compounds with log Kow 's >5 act as neutral organics producing simple narcosis, but at lower log Kow 's, epoxides display toxicity greater than that predicted for simple narcotics. The aquatic toxicity for epoxides and polyepoxides has been determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>].

**Boundaries.** Structures with epoxy equivalent weights of  $\geq 1,000$  are presumed not to pose a hazard under any conditions. Concerns are confined to those species with molecular weights <1,000. Health concerns are restricted to species with molecular weights <500 if exposure is limited to the dermal route.

**Testing.** To address health concerns the following tests are usually recommended for members of this class: (1) a lifetime cancer bioassay by the expected route of exposure, and (2) a 90-day subchronic with attention to pathology of the reproductive organs. To address ecotoxicity concerns, base set acute aquatic toxicity testing (algae: static method, daphnid and fish: flow-through method, all measured concentrations).

September, 1988; revised June 2010



## Category: Esters

## Environmental Toxicity

**Definition.** This category includes all esters, polyesters, vinyl esters, allylic esters, propargylic esters, aliphatic esters, aromatic esters, carboxylic acid esters, and sulfonate esters. These compounds need to be absorbed to be toxic; therefore, compounds with MWs > 1000 will be excluded from this category. Acute toxicity for esters which are liquids at room temperature is known to be limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a log  $K_{ow}$  value of  $\geq 5.0$ , esters show no effects at saturation during 96-h exposures (Veith et al 1984). Esters which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no acute toxicity will be observed at saturation. For solids, the no-effects-at-saturation point has to be determined on a case-by-case basis. The  $K_{ow}$  limit for chronic toxicity is set at a log  $K_{ow} = 8$  for liquid esters. For solid esters, chronic toxicity testing will determine this  $K_{ow}$  limit.

**Hazard Concerns.** The toxicity for simple esters has been determined through SAR Analysis (Clements 1988). Esters are known to be more toxic than neutral organic chemicals, and this excess toxicity decreases with increasing  $K_{ow}$ . The toxicity for vinyl esters, allylic esters, and propargylic esters is expected to be greater than for simple esters. Again, the additional excess toxicity of these vinyl esters, allylic esters, and propargylic esters is expected to decrease with increasing  $K_{ow}$ .

Members of this category exhibit toxicity ranging from low toxicity (i.e., > 100 mg/L) to high toxicity (i.e., < 1 mg/L) depending on their  $K_{ow}$ , MW, and melting point.

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity is expected when log  $K_{ow} < 5.0$ ; no effects at saturation during 96-h exposures when log  $K_{ow} > 5.0$ . The upper boundary for chronic toxicity is 8.0. MW will be < 1000. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log  $K_{ow}$  is > 5.0, chronic toxicity testing with fish and daphnids will be recommended.

**Fate:** Esters are subject to both abiotic and biotic hydrolysis, i.e., ester hydrolysis, and aerobic biodegradation. Aerobic biodegradation is expected to be the dominant route of transformation in the environment.

### General Testing Strategy.

#### Release to Aquatic Ecosystems:

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; the highest treatment concentration on a nominal-basis

should not exceed the aqueous solubility limit; and solvent can be used to assist the ester to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the ester beyond its aqueous solubility limit.

The algal toxicity test (Harmonized Test Guideline 850.5400) should be done with the static method; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the ester; and solvent can be used to assist the ester to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the ester beyond its aqueous solubility limit.

If there is no significant risk from the ester after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the ester after the results of the aerobic biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested chemical; solvent can be used to assist the ester to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the ester beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen). Both anilines and esters are more toxic than predicted based on narcosis alone, i.e., both esters and anilines have excess toxicity due to a more specific mode(s) of toxic action. A seven day exposure may not allow enough time for this excess toxicity to be expressed either because of not enough exposure and/or not enough time for metabolic activation.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through

methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the ester; solvent can be used to assist the ester to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the ester above its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test (Van Leeuwen et al 1990).

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200], the avian acute oral toxicity test [Harmonized Test Guideline 850.2100], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), avian reproduction toxicity test (Harmonized Test Guideline 850.2300), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

### **References.**

Clements, RG (editor). 1988. Estimating toxicity of industrial chemicals to aquatic organisms using structure-activity relationships. EPA-560-6-88-001. Washington, DC: Environmental Effects Branch, Health and Environmental Review Division, Office of Toxic Substances (TS-796), United States Environmental Protection Agency. Available from the National Technical Information Service, Springfield, VA 22161, PB89-117592.

Van Leeuwen CJ, Adema DMM, and Hermens J. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. *Aquatic Toxicology* 16:321-334.

Veith GD, DeFoe D, and Knuth M. 1984. Structure-activity relationships for screening organic chemicals for potential ecotoxicity effects. *Drug Metabolism Reviews* 15(7):1295-1003.

November, 1991; revised June 2010

**Definition.** The ethylene glycol ether category is defined as follows:



n = 1, 2, or 3

R = alkyl C<sub>7</sub> or less or phenyl or alkyl substituted phenyl

R' = H or alkyl C<sub>7</sub> or less or any group that can be chemically or metabolically removed to yield a glycol ether

**Hazard Concerns.** Short-chain ethylene glycol ethers are absorbed by all routes of exposure and have caused irritation of skin, eyes, and mucous membranes; hemolysis, bone-marrow damage, and leukopenia of both lymphocytes and granulocytes; direct and indirect kidney damage; liver damage, immunotoxicity, and central nervous system (CNS) depression. Short-chain ethylene glycol ethers are also developmental and reproductive toxicants. 2-Phenoxyethanol is known to cause hemolysis and eye irritation.

**Boundaries.** There is evidence that developmental toxicity is reduced going from the methyl to the butyl ether, and that it is reduced going from the ethylene glycol to the triethylene glycol. However, there is still a concern for maternal toxicity as reflected in developmental and subchronic toxicity studies. The systemic toxicity of longer-chain glycol ethers and alkylphenyl glycol ethers is uncertain because data are not available. The alkyl chain length of C<sub>7</sub> or less was chosen as a boundary for short-chain ethylene glycol ethers based on the available data.

### General Testing Strategy

The New Chemicals Program considers the following tests to be the most appropriate for ethylene glycol ethers with sufficient exposure to potentially pose an unreasonable risk:

Tier 1. Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Screen Test (OECD Guideline 422). If signs of hematuria are seen, red and white blood cell counts should be taken 2 days later except for female animals during pregnancy and lactation.

Tier 2. The need for further testing would be determined by the results of Tier 1. This could include any of the following tests.

- Prenatal Developmental Toxicity via the most appropriate route (Harmonized Test Guideline 870.3700)

- 2-Generation Reproduction Study via the most appropriate route (Harmonized Test Guideline 3800)

- 90-Day Subchronic Study via the most appropriate route (Harmonized Test Guideline 870.3465 – inhalation route; 870.3250 - dermal route; 870.3150 - oral route)

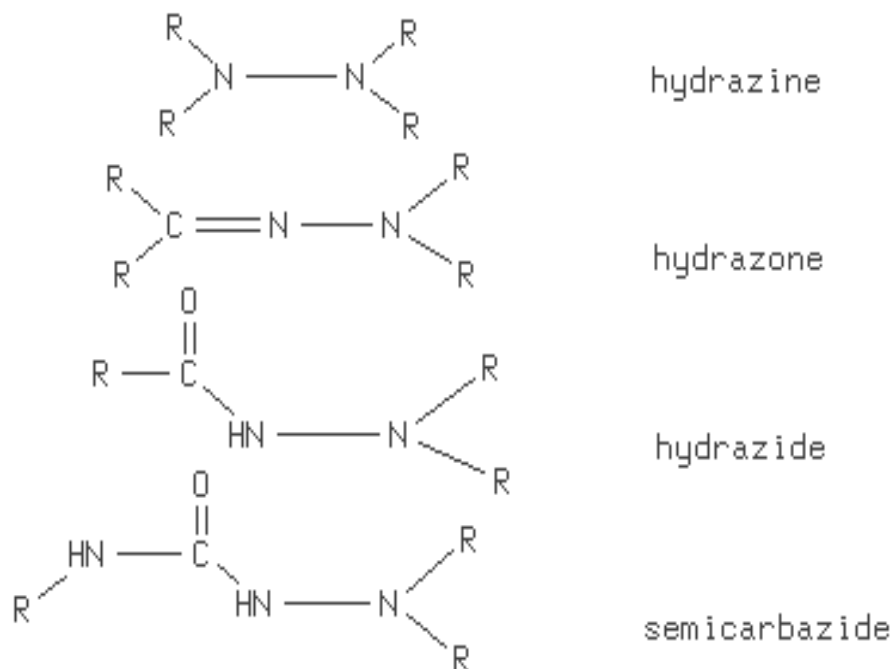
- Immunotoxicity Study via the most appropriate route (Harmonized Test Guideline 870.7800)

June 1992, revised December 1997

Category: Hydrazines and Related Compounds

Human Health  
Environmental Toxicity

**Definition:** Any structure containing one or more of the following groups is considered to be a member of the category:



R is unlimited except by molecular weight

**Hazard Concerns:** Concerns for carcinogenicity and chronic effects to liver, kidney, and blood are based on data for a number of hydrazines and related chemicals. In humans, hydrazine, itself, may affect the central nervous system, liver, and kidneys. The toxic effects of hydrazine exposure to humans may range from mild skin and eye irritation, and skin sensitization, to severe irritation and burns, pulmonary edema, CNS depression, as well as liver and kidney damage, which can lead to death. Hydrazine may also present a serious hazard to plant life and aquatic organisms. Ecotoxicity concerns are based on structure activity relationships (SAR) using data for a number of hydrazines and hydrazides. Hydrazine itself, (N<sub>2</sub>H<sub>4</sub>), is known to be acutely toxic to aquatic organisms at low levels, algae at < 100 ppb, 200 ppb for fish, and 30 ppb for daphnids.

**Boundaries:** There are no established boundaries for this category. The "typical" new chemical member of the category is a discrete (class I) chemical with a molecular weight <500. There is a greater concern for chemicals with few substitutions on the functional group than for

those with multiple substitutions.

### **General Testing Strategy**

EPA considers the following tests to be appropriate to address health and ecotoxicity concerns:

- Lifetime cancer bioassay by the expected route of exposure in two species of rodents (Harmonized Test Guideline 870.4200).
- 90-Day subchronic in one species of rodent by the expected route of exposure to assess effects to the liver, kidney, and blood (Harmonized Test Guideline 870.3100).
- Base-set ecotoxicity testing to include fish (Harmonized Test Guideline 850.1075) using the flow-through method, daphnids (Harmonized Test Guideline 850.1010) using the flow-through method and algae (Harmonized Test Guideline 850.5400) using the static method, all measured concentrations.

Results of the acute ecotoxicity testing may trigger chronic fish (Harmonized Test Guideline 850.1400) and daphnid (Harmonized Test Guideline 850.1010) testing.

Environmental fate testing including, as appropriate, melting point (Harmonized Test Guideline 830.7200) or boiling point (Harmonized Test Guideline 830.7220), water solubility (Harmonized Test Guideline 830.7840 or 830.7860), log  $K_{ow}$  (Harmonized Test Guideline 830.7550, 830.7560 or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method), vapor pressure (Harmonized Test Guideline 830.7950) and hydrolysis (Harmonized Test Guideline 830.2120).

For aromatic hydrazines and related compounds, the following additional testing is recommended:

- Phototransformation of Chemicals in Water—Direct Photolysis (OECD 316) or Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270)
- Aerobic biodegradability according to either of the following test guidelines:
  - Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
  - Ready Biodegradability—CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

### **References.**

1. Bhide, S.V., R.A. D'Souza, M.M. Sawai, & K.J. Ranadive (1976). International Journal of Cancer 18: 530.

2. Biancifiori, C (1970). *Journal of the National Cancer Institute* 44: 943.
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4. Biancifiori, C., E. Bucciarelli, D.B. Clayson, & F.E. Santilli (1964). *British Journal of Cancer* 18: 543.
5. Hydrazine-RM2 Exit Document. OPPT Office Director's Meeting, Monday, December 13, 1993.
6. Juhasz, J., J. Balo, & B. Szende (1966). *Nature (London)* 210: 1377.
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9. Toth, B. (1972). *International Journal of Cancer* 9: 109.

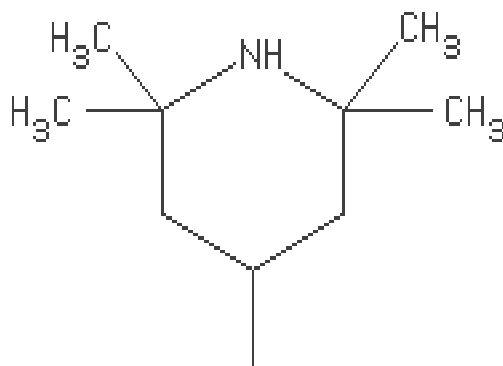
September, 1988; revised June, 1994, revised October 1995; revised June 2010.



**Category:** Hindered Amines

Human Health

**Definition.** The category is at present not well defined. A "typical" new chemical hindered amine of concern has two or more hindered amine functional groups, usually the 2,2,6,6-tetramethyl-4-piperidinyl group, and is used as a UV light stabilizer.



**Hazard Concerns.** Health concerns for the category are based on data submitted to the Agency under §8(e) of TSCA for Tinuvin 144 and Chimassorb 944. The data indicate that these hindered amines, and presumably hindered amines similar in structure, are toxic to the immune system, liver, blood, the male reproductive system, and the G.I. tract.

**Boundaries.** The boundaries of the category are not well defined. Tinuvin 144 has a molecular weight of 685, whereas Chimassorb 944 is a polymer with a number average molecular weight well in excess of 1,000. As a consequence, there is at present no molecular weight cutoff for hindered amines of concern to the new chemical program.

It is assumed that there is little or no dermal absorption of problematic hindered amines because of their high molecular weights. Consequently, hindered amines in the new chemical program are only of concern if there is significant inhalation exposure associated with their manufacture, processing, or use.

**General Testing Strategy**

For hindered amines found to pose a potentially unreasonable risk, a 90-day oral subchronic test in rats is the recommended test. We have requested that emphasis be placed on hematology, the immune system, and on the male reproductive system.

June 1990; revised March 1995

## Category: Imides

## Environmental Toxicity

**Definition.** This category includes all imides and maleimides. Substitutions may be aliphatic, aromatic, and/or halogens. The mode of toxic action of imides is unknown, but halogenated imides are used as microbial pesticides, specifically, fungicides, bactericides, slimicides, and algicides. It is assumed that these compounds need to be absorbed to be toxic; therefore, compounds with MWs > 1000 will be excluded from this category. Acute toxicity for imides which are liquids at room temperature is assumed to be limited by the octanol/water partition coefficient ( $K_{ow}$ ), and the limiting  $K_{ow}$  value for acute toxicity is assumed to be about 5.0. The limiting value for chronic toxicity is assumed to be about 8.0. Imides which are solids at room temperature may show no toxicity at saturation at  $\log K_{ow}$  values < 5.0 depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, the no-effects-at-saturation determination has to be made on a case-by-case basis.

**Hazard Concerns.** The acute toxicity for imides and maleimides have been determined through SAR Analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>]. The acute toxicity of imides towards daphnids is expected to be similar to that of fish, but their toxicity towards green algae is expected to be greater because of their use as microbial pesticides.

Polyimides may be more toxic than predicted using the general imide SAR.

The toxicity of imides towards aquatic organisms can range from low (i.e., > 100.0 mg/L) to high toxicity (i.e., < 1.0 mg/L) depending on their  $K_{ow}$  and MW. The higher the  $K_{ow}$  and the lower the MW, the higher the toxicity (or the lower the EC50 value).

**Boundaries.** There are no known lower  $\log K_{ow}$  and MW boundaries. The upper boundaries for acute toxicity will be set at a  $\log K_{ow} \leq 5.0$ ; chronic toxicity limits will be set at a  $\log K_{ow} \leq 8.0$ . MW will be < 1000 for stable compounds. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures.

### General Testing Strategy.

The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent

can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility.

Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen);

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al (1990) have demonstrated that the fish 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the fish 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test (Harmonized Test Guideline 850.4230), the earthworm acute toxicity test (Harmonized Test Guideline 850.6200), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

**References.**

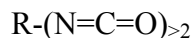
Van Leeuwen CJ, Adema DMM, and Hermens J. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. *Aquatic Toxicology* 16:321-334.

April, 1991; revised June 2010

## Category: Diisocyanates

Human Health

**Definition.** Any molecular structure containing two or more isocyanate groups is considered to be a member of the category for new chemical purposes:



Members of the class include new isocyanate monomers as well as new oligomers, polymers, prepolymers, or reaction products of existing isocyanate monomers. Most new chemical diisocyanates of concern are polymers or oligomers containing well-known diisocyanate monomers such as toluene diisocyanate (TDI) or 4,4'-methylenediphenyl diisocyanate (MDI).

**Hazard Concerns.** Diisocyanates are of concern for potential dermal and respiratory sensitization, and for pulmonary toxicity. Based on conflicting animal and human data for respiratory sensitization, the Agency has determined that there is presently not a reliable animal model for testing diisocyanates for potential respiratory sensitization. At this time, it is assumed that all diisocyanates may be potential human respiratory sensitizers.

Most members of the diisocyanate category have not been tested for carcinogenic potential. Though the aromatic diisocyanates [MDI, TDI, dianisidine diisocyanate (DADI)] tested positive and one aliphatic diisocyanate [hexamethylene diisocyanate (HDI)] tested negative in one species, it is premature to make any generalizations about the carcinogenic potential of aromatic versus aliphatic diisocyanates.

**Boundaries.** Structures with an isocyanate equivalent weight of  $\geq 5,000$  are presumed not to pose a hazard under any conditions. Typically, concerns are confined to those species with molecular weights  $< 1,000$ .

Frequently, new chemical isocyanates are manufactured with a significant excess of isocyanate monomer. Under these circumstances, the excess monomer is usually regarded as more hazardous than the "new" chemical component, and these PMN substances are ordinarily not regulated under Section 5 of TSCA. For the purposes of risk assessment within the New Chemicals Program, a PMN substance is considered "existing" if more than 50% of the free isocyanate groups in the PMN substance (new chemical component + existing chemical monomer) reside on unreacted monomer(s). This does not relieve a Company, however, of any obligations to submit a PMN for the new chemical isocyanate if indeed it is not listed on the TSCA Inventory.

**General Testing Strategy.** The following testing is recommended to address the potential for pulmonary toxicity and dermal sensitization.

- Dermal sensitization (Harmonized Test Guideline 870.2600).

- 90-day Subchronic inhalation toxicity test in rodents (Harmonized Test Guideline 870.3465).

In addition, appropriate hazard communication needs to be developed and implemented.

**Health and Safety Information.** The following information provides guidance in developing hazard communication and protective measures language to accompany new diisocyanate chemicals and formulations. It is based on the Agency's current understanding of the hazards associated with diisocyanates and the most effective means to limit exposure.

**Warnings.** Exposure to diisocyanates may cause the following human health effects: skin irritation and allergic reactions, respiratory irritation, respiratory sensitization, and lung toxicity; some diisocyanates also may cause cancer. The likelihood that these effects will occur depends on a number of factors; among them, the level of exposure, frequency of exposure, part of the body exposed, and sensitivity of the exposed individual.

Symptoms of allergic reaction and respiratory sensitization include rashes, cough, shortness of breath, asthma, chest tightness and other breathing difficulties. There is uncertainty as to the mechanism by which sensitization occurs. In sensitized individuals, exposure to even small amounts of diisocyanates (below government-recommended workplace exposure levels) may cause allergic respiratory reactions like asthma and severe breathing difficulties. It is especially important to note that contact with skin may lead to respiratory sensitization or cause other allergic reactions. In some cases, the effects of diisocyanate exposure may be immediate and life-threatening; in others, the effects may be delayed and occur hours after the exposure has ended. Repeat or prolonged exposure to diisocyanates may also cause irritation to eyes, skin, respiratory tract and lungs, as well as adverse chronic lung effects, like decreased lung capacity and function. Individuals experiencing shortness of breath, tightness in the chest or other problems breathing should seek immediate medical attention.

**Protective Measures.** In workplaces where individuals handle diisocyanates or coatings or other formulations that contain them, an industrial hygiene and safety program should be operative. Important components of this program include: hazard communication and training on safe handling practices; use of efficient and well-maintained application equipment, engineering controls and personal protective equipment; housekeeping procedures including spill prevention and cleanup practices; and, if feasible, means to measure airborne levels of polyisocyanates and diisocyanates.

During spray applications, workers should take precautions to avoid breathing vapors, mists or aerosols. Inhalation exposures should be limited to  $<0.05 \text{ mg/m}^3$  as an 8-hour time-weighted

average (TWA) for combined polyisocyanates and diisocyanates.<sup>1</sup> Engineering controls should serve as the first, most effective means of reducing airborne polyisocyanate and diisocyanate concentrations; an appropriate NIOSH/MSHA-approved respirator should be used as a secondary tool to lower exposures. Currently, downdraft spray booths and high-volume low-pressure (HVLP) spray guns appear to offer the most efficient technology to reduce inhalation exposures; a maintenance program should always be used to ensure optimal operating efficiencies. To limit dermal contact, individuals should wear impermeable gloves, protective clothing and goggles or glasses with side shields.

May 1990; revised July 1993, February 1995, and February, 1997

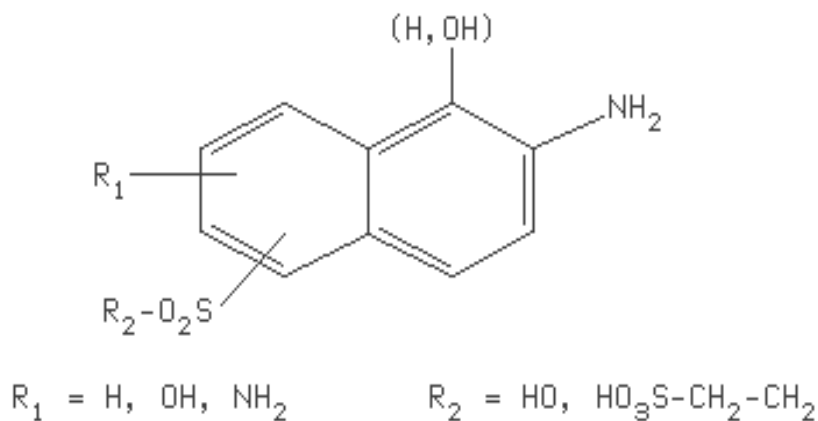
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<sup>1</sup>0.05 mg/m<sup>3</sup> or 0.005 ppm TWA is the American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for each hexamethylene diisocyanate (HMDI), toluene-2,4-diisocyanate (TDI), and methylene bisphenyl isocyanate (MDI). Also, OSHA has set 0.02 ppm as exposure ceilings for both TDI and MDI.

**Category: β-Naphthylamines, Sulfonated**

Human Health

**Definition.** Any new chemical whose structure is consistent with the following general structure is considered to be a member of the category of monosulfonated β-naphthylamines:



Included in the category are azo dyes which release a sulfonated β-naphthylamine upon reduction of azo bonds. Also included in the category are N-acetylated sulfonated β-naphthylamines.

**Hazard Concerns.** Based on analogy to β-naphthylamine *per se*, members of the class are considered potential carcinogens. A number of mono- and disulfonated β-naphthylamines are positive in the Ames assay, and some are active in the mouse lung adenoma assay. The presence of one or two sulfonate groups or the sulfatoethylsulfone group is likely to slow systemic uptake and enhance excretion, however, the extent of these mitigating effects is unknown.

**Boundaries.** Concern is restricted to sulfonated β-naphthylamines where not more than two sulfonate or sulfatoethylsulfone group(s) are on the ring distal to the β-amino group. The Agency has sufficient data to indicate that β-naphthylamines where a sulfonate group is on the proximal ring are unlikely to be carcinogenic.

**General Testing Strategy.**

The New Chemicals Program considers the following tests to be the most appropriate for mono- and di-sulfonated β-naphthylamines found to pose an unreasonable risk:

- An Ames test or, for azo dyes, an Ames test with the Prival modification, and
- An unscheduled DNA synthesis test in rat hepatocytes. For azo dyes, it is necessary that the specific sulfonated β-naphthylamine in question be isolated prior to testing.



For both tests,  $\beta$ -naphthylamine is to serve as an additional positive control.

If the results of the genotoxicity testing indicate that the new chemical is genotoxic, a two-year, two-species cancer bioassay would be required.

April 1991, updated June 1999

**Category: Lanthanides or Rare Earth Metals**

Environmental Toxicity

**Definition.** This category includes inorganic salts, complexes organic acids, and organometallic compounds or lanthanides or rare earth metals. There are 14 naturally-occurring lanthanides or rare earth metals:

Name	Symbol	MW	CASRN
Lanthanum	La	139	[7439-91-0]
Cerium	Ce	140	[7440-45-1]
Praseodymium	Pr	141	[7440-10-0]
Neodymium	Nd	144	[7440-00-8]
Samarium	Sm	150	[7440-19-9]
Europium	Eu	152	[7440-53-1]
Gadolinium	Gd	157	[7440-54-2]
Terbium	Tb	159	[7440-27-9]
Dysprosium	Dy	163	[7429-91-6]
Holmium	Ho	165	[7440-60-0]
Erbium	Er	167	[7440-52-0]
Thulium	Tm	169	[7440-30-4]
Ytterbium	Yb	173	[7440-64-4]
Lutetium	Lu	175	[7439-94-3]

The lanthanide rare earth metals are very similar to each other. Their most important oxidation state is +3 for all. None are known to be essential to biological species. Across the lanthanide series from La to Lu, there is a general or steady decrease in their (1) atomic radii, (2) covalent radii, and (3) radii of their tripositive ions due to the addition of electrons at the 4f electron shell.

This decrease in radii leads to a corresponding increase in the polarizing power of their ions and in the stability of complexes of their ions. They all have similar chemistry behaviors.

**Hazard Concerns.** The only toxicity data available for the lanthanide series are for La [7439-91-0]. Soluble salts of La are known to have high chronic toxicity towards fish, moderate chronic toxicity towards green algae, and low acute toxicity towards daphnids based on exposures in moderately hard water and in terms of mg La/L. Toxicity information is only available for La trichloride [10099-58-8] and La triacetate [917-70-4]. The toxicity profile for La based on available toxicity data, i.e., measured (M) and predicted (P), mg La/L (ppm La), and moderate hardness (i.e., <180.0 mg/L as CaCO<sub>3</sub>) is:

fish 96-h LC50	<	1.0	Predicted, ACR10
daphnid 48-h LC50	=	160.0	Measured, S, N, BK59
green algal 96-h EC50	<	1.0	Predicted, ACR4
fish chronic value(ChV)	=	0.020	Measured, SR12, M H104, B78
daphnid ChV	=	20.0	Predicted, ACR10
algal ChV	=	0.150	Measured S,N,BK59

The lanthanides are assumed to be more toxic in soft water than hard water based on data for other heavy metals.

**Boundaries.** The toxicity of the lanthanide rare earth metals depends on their physico/chemical properties and the hardness of receiving waters. The toxicity of their salts and their complexes with organic acids are expected to be related to their water solubility, their MWs, and the stability of their complexes. The toxicities of lanthanide organometallic compounds, if they exist, are expected to be related to their octanol/water partition coefficient (Kow).

The most important property determining the toxicity of chemicals derived from lanthanide rare earth metals is their water solubility. Water solubility cannot be estimated accurately and has to be measured. The water solubility of organometallic compounds is expected to decrease as Kow increases. There is no lower bound for Kow and the upper bound cannot be determined at this time since the Kow fragment-constant for any of the lanthanide rare earth metals are not known. In addition to solubility, MW is also an important boundary. Highly stable complexes and organometallics with MWs > 1000 are not expected to be absorbed by aquatic organisms even if they are water soluble. Therefore, only lanthanide rare earth metal-compounds with MWs < 1000 are expected to be toxic.

### **General Testing Strategy.**

#### **I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method; effective concentrations will be based on 100% active ingredients (ai) and mean measured concentrations; the total organic carbon (TOC) concentration of dilution water in the control must be less than 2.0 mg TOC/L; TOC must be measured in the control just prior to the start of the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>. If toxicity mitigation testing is done with humic acid, then the static method with nominal concentrations will be recommended.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with the static method; effective concentrations based on 100% ai and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with no more than 0.300 mg/L EDTA as a final concentration; the TOC of the test/growth medium should be less than 2.0 mg TOC/L; TOC should be measured just prior to the start of the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; and solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit. If toxicity mitigation testing is done with humic acid, then nominal concentrations will be recommended.

If there is no significant risk from the chemical after the results of the environmental base set have been integrated into the risk assessment, then no further testing will be recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with the flow-through method; effective concentrations based on 100% ai and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; the TOC of dilution water in the control should be less than 2.0 mg TOC/L; TOC should be measured in the controls just prior to and during the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>.

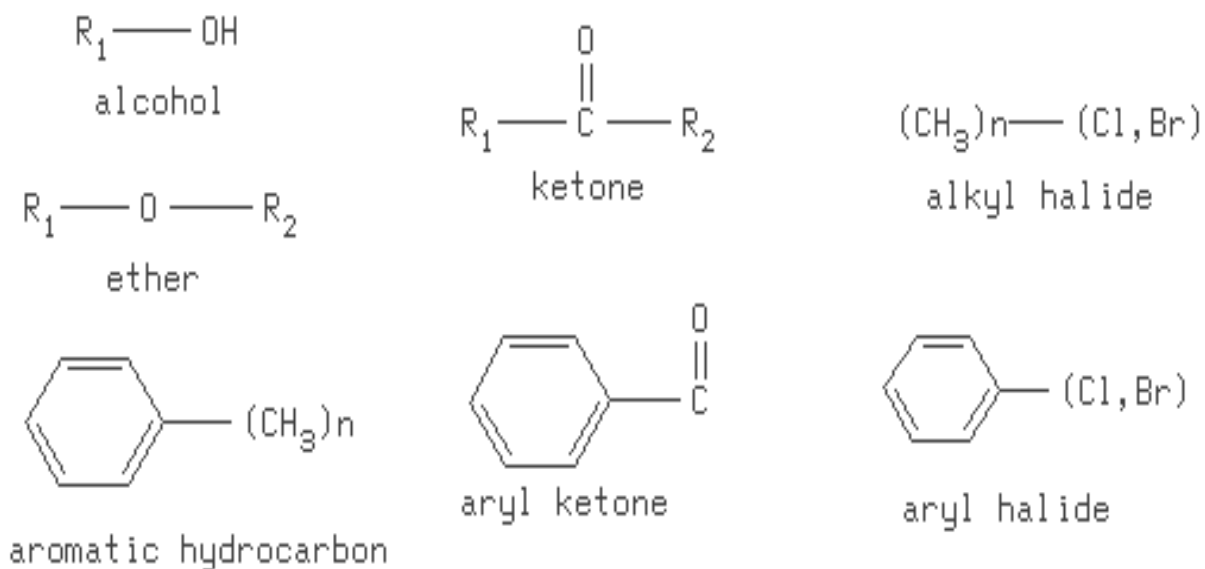
Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with the flow-through method; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; the TOC of dilution water in the control should not exceed 2.0 mg TOC/L; TOC must be measured in the controls just prior to and during the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>.

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests will be recommended for terrestrial exposures. The terrestrial base set includes: the early seeding growth test (Harmonized Test Guideline 850.4230), the earthworm toxicity test (Harmonized Test Guideline 850.6200), the soil microbial community bioassay (Harmonized Test Guideline 850.5100), and the avian acute oral toxicity test (Harmonized Test Guideline 850.2100). Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle

test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the avian reproduction test (Harmonized Test Guideline 850.2300 for bobwhite quail or for mallard duck).

February, 1998

**Definition.** This broad category includes non-reactive non-ionizable organic chemicals such as alcohols, ketones, ethers, alkyl halides, aryl halides, and aromatic hydrocarbons.



**Hazard Concerns.** Neutral organics are environmentally toxic because of their ability to produce simple narcosis in aquatic species. Toxicity is a function of the octanol-water partition coefficient. Compounds with log Kow values of <5 exhibit toxicity within 96 hours. At log Kow of 5-8, toxicity is apparent only after extended exposure. Compounds with a log Kow >8 are not toxic at water saturation even after prolonged exposure. There are a number of QSARs (quantitative structure-activity relationships) to predict the toxicity of neutral organics.

**Boundaries.** Neutral organics of concern generally have MWs less than 1,000 and Log Kow values <8. QSAR predictions of toxicity are constrained by water solubility. If a predicted toxicity level exceeds water saturation, then a longer test is needed to observe toxicity.

### General Testing Strategy

To address ecotoxicity concerns, base set acute aquatic toxicity testing (algae (Harmonized Test Guideline 850.5400): static method, daphnid (Harmonized Test Guideline 850.1010) and fish (Harmonized Test Guideline 850.1075): flow-through method, all measured concentrations).

To properly assess any human and environmental toxicity or exposure, certain environmental fate properties, such as aerobic biodegradation, need to be measured. Aerobic biodegradability can be determined using either of these two test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

The physical state and electronic charge of the PMN substance should also be reported.

For some neutral organics (e.g. ketones), Direct Photolysis (OECD 316) or Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270) AND possibly biodegradation testing is recommended.

For some neutral organics (e.g. alkyl halides) hydrolysis testing (Harmonized Test Guideline 835.2120) AND possibly biodegradation testing is recommended.

September 1988; revised October 1995; revised June 2010

**Category: Nickel Compounds**

Human Health  
Environmental Toxicity

**Definition.** Inorganic and organic compounds of nickel in which there is the potential for uptake of either  $\text{Ni}^{2+}$  or organonickel.

**Hazard Concerns.** Nickel compounds e.g., nickel refinery dust, and its major component nickel subsulfide, have been shown to be carcinogenic in humans. Some nickel compounds are known to be genotoxic. IRIS has established an oral RfD for the soluble salts of nickel of  $2 \times 10^{-2}$  mg/kg/d (1992) based on effects on organ weights in a two-year feeding study in rats. In the study, there was a statistically significant reduction in total body weight, higher heart-to-body weight ratios and lower liver-to-body weight ratios than controls. In addition to the effects on organ weights found in the critical two-year study, two other sensitive endpoints exist, neonatal mortality and dermatotoxicity. While no reproductive effects have been associated with nickel exposure to humans, several studies in laboratory animals have demonstrated fetotoxicity.

Soluble inorganic nickel compounds produce acute and chronic toxicity in freshwater and saltwater aquatic organisms over a wide range of concentrations but bioconcentrates only to a small degree. There are no known toxicity data for organonickel compounds.

**Boundaries.** Any nickel compound that will release  $\text{Ni}^{2+}$  is considered hazardous. Conversely, there are no available data to suggest that nickel compounds in which the  $\text{Ni}^{2+}$  is not released may pose a health hazard.

The boundaries for ecotoxicity of  $\text{Ni}^{2+}$  compounds depend on whether they are  $\text{Ni}^{2+}$  salts,  $\text{Ni}^{2+}$  chelates, or organonickel compounds. There is also a molecular weight boundary for strong ion pairs/complexes which is 1000.

The boundaries for organonickel compounds (e.g.,  $K_{ow}$  of the organic portion) are undefined but the molecular weight boundary is expected to be 1000.

**Occupational Exposure Controls.** Because nickel compounds have been shown to be toxic by the inhalation/ingestion route, exposure controls that maintain airborne exposures at  $0.1 \text{ mg/m}^3$  or below are needed (consistent with OSHA PEL TWA). In addition, since nickel compounds are also toxic by the dermal route, NIOSH approved protective gloves are also recommended.

**Testing.** Depending upon estimated workplace exposures and releases to water, which will be assessed on a case-by-case basis, the following testing may be recommended:

To address health effects concerns due to the toxicity of nickel and its compounds, the following tests may be recommended:



A 90-day subchronic study in rats by an appropriate route to assess systemic toxicity (Harmonized Test Guideline 870.3100 or 870.3250 or 870.3465)

Results of the 90-day study may trigger a lifetime bioassay in rats and mice by the inhalation route to assess potential carcinogenicity (Harmonized Test Guideline 870.4200)

To address ecotoxicity concerns due to toxicity of nickel and its compounds, the following base set tests may be recommended:

Acute fish toxicity test	Harmonized Test Guideline 850.1075
Acute daphnid toxicity test	Harmonized Test Guideline 850.1010
Green algae toxicity test	Harmonized Test Guideline 850.5400

All tests utilize measured concentrations.

To properly assess human and environmental toxicity or exposure, certain physico-chemical or environmental fate properties need to be measured:

Water solubility	Harmonized Test Guideline 830.7840 or 830.7860
Octanol/water partition coefficient ( $K_{ow}$ )	Harmonized Test Guideline 830.7550 or 830.7560 or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method
Vapor pressure	Harmonized Test Guideline 830.7950
Melting point-melting range	Harmonized Test Guideline 830.7200
Boiling point	Harmonized Test Guideline 830.7220

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

## References.

IRIS access. # 1271 (09/30/87) Nickel, soluble salts.

OSHA PELs (1995-1996)

September 1996; revised June 2010

**Definition.** This category includes classes of organic compounds that have either a double bond (C=C) or triple bond (C≡C) in close proximity to a nitrile (C≡N) either next to or one carbon removed. The carbon-carbon unsaturation near the nitrile results in increased metabolic reactivity in organisms which, in turn, results in excess aquatic toxicity in addition to narcosis or baseline toxicity.

Compounds included in this category include but are not limited to allylic nitriles (R-C=CCC≡N), vinyl nitriles (R-C=CC≡N), and propargyl nitriles which include alpha-alkynyl nitriles (R-C≡CC≡N), beta-alkynyl nitriles (R-C≡CCC≡N), and gamma-alkynyl nitriles (R-C≡CCCC≡N).

**Toxicity Concern.** The aquatic toxicity for allylic/vinyl nitriles have been determined by EPA through SAR Analysis using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>]. Propargyl nitriles are expected to have similar toxicity or greater toxicity. These chemicals are known to be more toxic than neutral organic chemicals, and this excess toxicity decreases with increasing Kow. Members of this category exhibit toxicity ranging from low toxicity (i.e., > 100 mg/L) to high toxicity (i.e., < 1 mg/L) depending on their Kow, MW, and melting point.

**Boundaries or Domain.** There are no known lower boundaries. The upper boundaries will be based on Kow, MW, and melting point (mp). These compounds need to be absorbed to be toxic; therefore, compounds with MWs < 1000 are expected to cause toxicity, while compounds with MWs > 1000 are expected to have low toxicity to aquatic organisms. Likewise, if the effective cross-sectional diameter is greater than 1.5 nanometers, then absorption through membranes is expected to be nil and low toxicity towards aquatic organisms is expected.

Acute toxicity for these chemicals which are liquids at room temperature is known to be limited by the octanol/water partition coefficient (Kow). Below a log Kow value of 5, these compounds are expected to show acute and chronic toxicity to aquatic organisms. Above a log Kow value of 5.0, these chemicals are expected to show low acute toxicity towards fish and aquatic invertebrates (daphnids), or no effects at saturation during 96-h exposures to fish and 48-h exposures to daphnids. Above a log Kow of 6.4, these chemicals are expected to show low toxicity towards green algae in terms of inhibition of biomass, or no obtainable EC50 during 72-h and 96-h exposures to green algae.

Allylic/vinyl nitriles which are solids at room temperature may show no acute toxicity at saturation at lower Kow values depending on the melting point, i.e., the higher the melting point at a given Kow, the greater the likelihood that no acute toxicity will be observed at saturation. For solids, the no-effects-at-saturation point for acute toxicity has to be determined on a case-by-case basis by comparing the predicted LC50/EC50 to the predicted or measured water

solubility.

These compounds should show only chronic toxicity towards fish and daphnids when log Kow values are greater than 5 and less than 8. For green algae, only chronic values should be measurable between log Kow values of 6.4 and 8.

The Kow limit for chronic toxicity is set at a log Kow = 8 for liquid compounds. All allylic/vinyl nitriles should show no toxic effects to fish, daphnids, and green algae when the log Kow is greater than 8. For solids, chronic toxicity testing will allow determination of a Kow limit.

**Environmental Fate:** Aerobic biodegradation is expected to be the dominant route of transformation in the environment.

**General Testing Strategy: I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (ai) and mean measured concentrations; dilution water hardness less than 150 mg/L as CaCO<sub>3</sub>; dilution water total organic carbon (TOC) less than 2.0 mg TOC/L; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested chemical; and solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical beyond its aqueous solubility limit.

The algal toxicity test (Harmonized Test Guideline 850.5400) should be done with the static method; measured concentrations; effective concentrations based on 100% active ingredients (ai) and mean measured concentrations; statistical analysis of effective concentrations based on (1) cells/mL, (2) area under the growth curve, and (3) growth rate at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA-Na salt as a final concentration; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the chemical; and solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical beyond its aqueous solubility limit. Control growth at 72 h should be greater than 16X and at 96 h greater than 100X. The Coefficient of Variation (CV) between control replicates at 72 h and 96 h should be less than 20 percent.

If there is no significant risk after the results of the acute toxicity testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk after the results of the aerobic biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (ai) and mean measured concentrations; dilution water hardness less than 150 mg/L as CaCO<sub>3</sub>; dilution water total organic carbon (TOC) less than 2.0 mg TOC/L; statistical analysis of effective concentrations at days 7, 14, 21, and 28; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit for the chemical; solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen). Both anilines and allylic/vinyl/propargyl nitriles are more toxic than predicted based on narcosis alone, i.e., both classes have excess toxicity due to a more specific mode(s) of toxic action. A seven day exposure may not allow enough time for this excess toxicity to be expressed either because of not enough exposure and/or not enough time for metabolic activation.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (ai) and mean measured concentrations; dilution water hardness less than 150 mg/L as CaCO<sub>3</sub>; dilution water total organic carbon (TOC) less than 2.0 mg TOC/L; statistical analysis of effective concentrations at days 7, 14, and 21; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the chemical; solvent can be used to assist the chemical to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the chemical above its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test (Van Leeuwen et al 1990).

If there is no significant risk after the results of the chronic toxicity testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

**II. Release to Terrestrial Ecosystems:** The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm acute toxicity test [Harmonized Test Guideline 850.6200], the avian acute oral toxicity test [Harmonized Test Guideline 850.2100], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), the avian reproductive toxicity test (Harmonized Test Guideline 850.2300), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100). In addition, a fate test for biodegradability in soil (Harmonized Test Guideline 835.4100) may be recommended.

**References:**

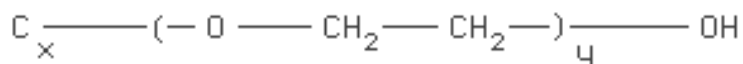
Van Leeuwen CJ, Adema DMM, and Hermens J. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. *Aquatic Toxicology* 16:321-334.

December 2007; revised June 2010

**Category:** Nonionic Surfactants

Environmental Toxicity

**Definition.** Any neutral structure having surfactant activity is considered a member of this category. Many of these surfactants have the following types of structure:



Ethoxylate groups may be mixed with or be replaced by alcohol groups. Other neutral groups e.g. propoxylates, esters, halogens, may also be present.

**Hazard Concerns.** Acute aquatic toxicity increases exponentially with increases in the hydrophobic chain length when the number of ethoxy groups or the hydrophilic component is held constant. In addition, when the number of carbons in the hydrophobe is constant, toxicity decreases with an increasing number of ethoxylate groups. The aquatic toxicity of members of the category can be predicted by structure-activity relationship (SAR).

**Boundaries.** There are no established molecular weight boundaries for this category. Limits on chain length are inherent in the SARs.

**Testing.** To address ecotoxicity concerns, base set acute aquatic toxicity testing (algae: static method, daphnid and fish: flow-through method, all measured concentrations).

Tier 1. The acute aquatic base set of environmental toxicity tests will be recommended for aquatic exposures and the terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test, the earthworm acute toxicity test and the soil microbial community bioassay) will be recommended for any terrestrial exposures.

Acute fish toxicity test	Harmonized Test Guideline 850.1075
Acute daphnid toxicity test	Harmonized Test Guideline 850.1010
Green algae toxicity test	Harmonized Test Guideline 850.5400
Early seedling growth test	Harmonized Test Guideline 850.4230
Earthworm acute toxicity test	Harmonized Test Guideline 850.6200
Soil microbial community bioassay	Harmonized Test Guideline 850.5100

Tier 2. If acute toxicity testing indicates a significant risk, then environmental fate

testing in the form of aerobic biodegradation testing is recommended. Aerobic biodegradation testing may be conducted using either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

Tier 3. In addition, if acute toxicity testing indicates a significant risk, then chronic aquatic toxicity testing with fish and aquatic invertebrates will be recommended.

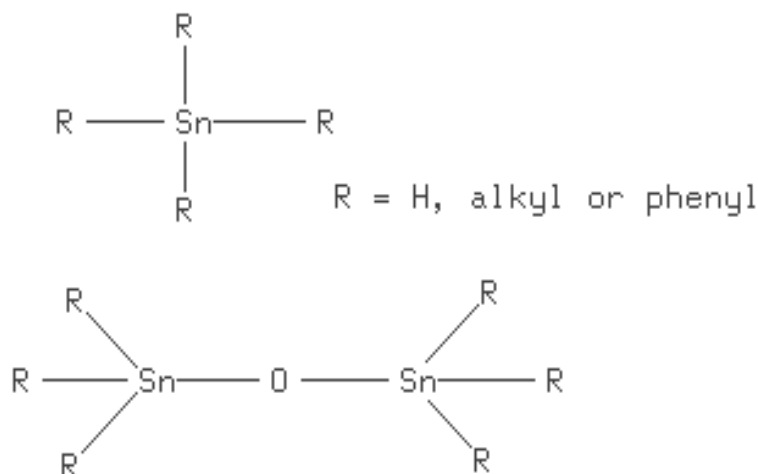
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| Fish early life stage test       | Harmonized Test Guideline 850.1400 |
| Daphnid chronic toxicity testing | Harmonized Test Guideline 850.1300 |

September 1988, revised September 1996; revised June 2010

## Category: Organotins

Human Health  
Environmental Toxicity

**Definition.** This category includes all mono-, di-, tri- and tetra-alkyl or phenyl organotin compounds, including organotin esters/oxides. The mode of toxic action of organotins in humans is unknown, but they are known to affect carbonate metabolism and other metabolic processes in the brain, liver, and muscle, as well as several enzymes and the oxidative activity of mitochondria. It has been suggested that general sulfhydryl binding may be responsible for the effects seen in mammals. It is assumed that these compounds need to be absorbed to be toxic, therefore, compounds with MWs > 1000 and which do not transform to organotin compounds with MWs < 1000 will be excluded from this category. Human health and aquatic toxicity for liquid organotins is assumed to be limited by the relative octanol/water partition coefficient (a relative  $K_{ow}$  is based on the computer program, CLOGP, with C substituted for Sn). However, the limiting relative  $K_{ow}$  value is unknown. The Agency has data for an organotin with a relative  $\log K_{ow} = 13.7$  which still showed high toxicity towards fish and daphnids. Organotins which are solids at room temperature may show no toxicity at saturation at  $\log K_{ow}$  values < 13.7 depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, the no-effects-at-saturation determination has to be made on a case-by-case basis. There are no known  $K_{ow}$  limits for acute and chronic environmental toxicity at this time, but it is higher than a  $\log K_{ow} = 13.7$ . Future testing will determine the  $K_{ow}$  limits.



**Hazard Concerns.** Tested organotins have been shown to be from moderately irritating to corrosive to the skin and eyes. Acute oral and dermal exposures can result in systemic effects, primarily neurotoxicity. Concerns for immunotoxicity are based on data on dialkyltins and trialkyltins. During a 13-week oral study in rats using dioctyltin bis (2-ethylhexylthioglycolate), effects to the thymus, spleen, lymph nodes, and bone marrow were observed. A No-Observable-Adverse-Effect-Level (NOAEL) of 1.6 mg/kg/d was derived from this study. During a 17-month feeding study in rats using bis (tri-n-butyltin)-oxide, immunoglobulin E (IgE)



titers were reduced, as well as the activity of natural killer cells in the spleen, and there was reduced macrophage function. A NOAEL of 0.025 mg/kg/d was derived from this study. Based on the immunotoxicity end-point, an oral reference dose for chronic exposure (RfD) for tributyltin oxide of  $3 \times 10^{-5}$  mg/kg/d (IRIS 01/01/89) has been derived. Organotins are well known neurotoxins, with the tri- and tetra-substituted tins being more toxic than the mono- and di-substituted compounds. Although many tri-alkyltins show clear neurotoxic effects (e.g., lesions in the hippocampus), the neurotoxic potential of di-alkyltins has not been as well defined. Available data indicate that dibutyltin and dioctyltin can produce neurotoxic effects such as reductions in brain neurotransmitter levels, alterations in spontaneous motor activity and hindlimb weakness. An effect level for neurochemical and behavioral changes following 3 days of oral administration of dibutyltin dilaurate was reported as 20 mg/kg. There are oncogenicity concerns for some of the organotins based on analogy to triphenyltin hydroxide, a group B probable human carcinogen. Therefore, the human health concerns for phenyltins will be dealt with on a case-by-case basis.

The acute aquatic toxicity for several subclasses of organotins has been determined through toxicity testing (Vighi & Calamari, 1985; Wong et al. 1982) and structure activity relationships (SAR). Organotins have been shown to be highly toxic to green algae (Wong et al. 1982). The acute toxicity of organotins is moderate to high towards daphnids (Vighi & Calamari, 1985). One datum for fish has indicated high toxicity (USEPA 1996). Organotins exhibit toxicity ranging from moderate toxicity (i.e.,  $> 10$  mg/L) to high toxicity (i.e.,  $< 1$  mg/L) depending on their  $K_{ow}$ , melting point, and MW. The higher the  $K_{ow}$ , the higher the toxicity (or the lower the  $EC_{50}$  value).

**Boundaries.** There are no known boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity expected with  $\log K_{ow} \leq 13.7$ ; chronic toxicity has no known upper bound for  $\log K_{ow}$ , but it is  $\geq 13.7$ . MW will be  $< 1000$  for stable compounds. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures.

### **General Testing Strategy.**

Tier 1. A 90-day subchronic test in rodents by the oral route with special attention to the lymphoid organs (thymus, spleen, peripheral lymph nodes) and bone marrow (Harmonized Test Guideline 870.3100).

Neurotoxicity testing to include motor activity, a functional observational battery and neuropathology with special attention to lesions in the hippocampus (Harmonized Test Guideline 870.6200). This testing can be combined with the 90-day subchronic protocol cited above.

The acute aquatic base set of environmental toxicity tests will be recommended for aquatic exposures and the terrestrial base set of environmental toxicity tests will be recommended for

terrestrial exposures. The acute toxicity tests for fish and daphnids should be done using the flow-through method with measured concentrations. Effective concentrations should be based on 100% active ingredients (AI) and mean measured concentrations. Measure TOC of dilution water in the control just prior to testing. Ideally, the highest treatment concentration on a mean measured concentration-basis should equal the aqueous solubility limit. Solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to significantly enhance the water solubility. The algal toxicity testing should be done with the static method and measured concentrations. Statistical analysis of effective concentrations at 24, 48, 72, and 96 hours should be performed. The test medium should be used with at least 0.300 mg/L EDTA as a final concentration.

#### Aquatic Base Set

Acute fish toxicity test	Harmonized Test Guideline 850.1075
Acute daphnid toxicity test	Harmonized Test Guideline 850.1010
Green algae toxicity test	Harmonized Test Guideline 850.5400

#### Terrestrial Base Set

Early seedling growth test	Harmonized Test Guideline 850.4230
Earthworm acute toxicity test	Harmonized Test Guideline 850.6200
Soil microbial community bioassay	Harmonized Test Guideline 850.5100

Tier 2. If acute aquatic toxicity testing indicates a significant risk, aerobic biodegradation testing is recommended. Aerobic biodegradability can be determined using either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

Tier 3. If acute toxicity testing and environmental fate testing continue to indicate a significant risk, then chronic aquatic toxicity testing with fish and aquatic invertebrates is recommended with flow-through methods and measured concentrations. Effective concentrations should be based on 100% active ingredients (AI) and mean measured concentrations. Conduct statistical analysis of effective concentrations at days 7, 14, 21, and 28. Measure TOC of dilution water in the control just prior to testing. Ideally, the highest treatment concentration on a mean measured concentration-basis should be equal at the aqueous solubility limit. Solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to significantly enhance the water solubility. The 7-d fish early life stage (ELS) toxicity test cannot be substituted for the 28-d ELS toxicity test and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al. (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see

Table VII in Van Leeuwen).

Chronic Aquatic Toxicity

Fish early life stage test

Daphnid chronic toxicity testing

Harmonized Test Guideline 850.1400

Harmonized Test Guideline 850.1300

**References.**

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USEPA 1996. United States Environmental Protection Agency (1996). The Office of Pollution Prevention and Toxics (OPPT) premanufacture notification (PMN) ECOTOX database: a confidential business information (CBI) collection of environmental toxicity data from new chemical submissions under Sec. 5 of the Toxic Substances Control Act (TSCA). Washington, DC: Environmental Effects Branch, Health and Environmental Review Division (7403), OPPT, USEPA. OPPT contact is V. Nabholz, 202-260-1271.

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Vighi, M., & Calamari, D. (1985). QSARs for organotin compounds on Daphnia magna. Chemosphere, 14, 1925-1932.

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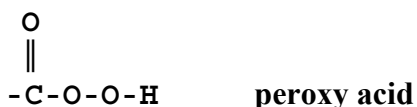
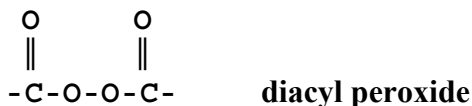
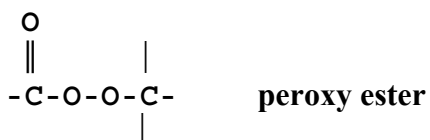
Wong, P.T.S., Chau, Y.K., Kramar, O., & Bengert, G.A. (1982). Structure-toxicity relationship of tin compounds on algae. Canadian Journal of Fisheries and Aquatic Sciences, 39, 483-488.

April 1991, revised September 1996.

**Category: Peroxides**

Human Health (case-by-case)  
Environmental Toxicity

**Definition.** Any molecular structure containing one or more of the following functional groups is considered to be a member of the class:



The "typical" peroxide in the new chemical program is a discrete (class I) chemical with a molecular weight of <500.

**Hazard Concerns.** EPA had previously identified hazard concerns for the possible carcinogenicity of new chemicals falling into the peroxide category based on available evidence. EPA has reviewed test data developed by the Society of the Plastics Industry (SPI) and others on the peroxide category of chemicals and concludes that available information does not support continued identification of peroxides as a new chemical category presenting concerns for possible carcinogenicity. EPA will continue to evaluate the potential health concerns for new chemical peroxides that are notified but, with this change, will not apply a category understanding as regards potential carcinogenicity. While the assessment of potential human health hazard concerns will be conducted on a case-by-case basis, this modification does not affect EPA's approach to environmental hazard concerns which will continue to be identified for members of this category.

**Boundaries.** There are no established boundary conditions for review of peroxides.

**General Testing Strategy.**

The New Chemicals Program considers the following tests to be appropriate to address ecotoxicity concerns for peroxides:

Base-set ecotoxicity testing to include fish (Harmonized Test Guideline 850.1075), daphnids (Harmonized Test Guideline 850.1010), and algae (Harmonized Test Guideline 850.5400).

Environmental fate testing including, as appropriate, melting point (Harmonized Test Guideline 830.7200) or boiling point (Harmonized Test Guideline 830.7220), water solubility (Harmonized Test Guideline 830.7840 or 830.7860), log  $K_{ow}$  (Harmonized Test Guideline 830.7550, 830.7560, or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method), vapor pressure (Harmonized Test Guideline 830.7950), hydrolysis (Harmonized Test Guideline 835.2120), photolysis (direct Photolysis (OECD 316) or Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270)), and aerobic biodegradation.

Aerobic biodegradability can be determined using either of these two guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

September, 1988; revised June, 1994; revised April, 2001; revised June 2010

**Category: Persistent, Bioaccumulative, and Toxic (PBT) Chemicals**

Health/Environmental Toxicity  
Environmental Fate

**Definition.** PBT chemical substances possess characteristics of persistence (P) in the environment, accumulation in biological organisms (bioaccumulation (B)), and toxicity (T) that make them priority pollutants and potential risks to humans and ecosystems. Prominent examples of PBT chemical substances include the insecticide, DDT and polychlorinated biphenyls (PCBs). This PBT category includes the boundary conditions, such as fish bioconcentration/bioaccumulation factors and environmental persistence values, that would determine inclusion in (or exclusion from) the category, and standard hazard and fate tests to address P, B, and T concerns for the chemical substances fitting the category description. For background information and discussion of this PBT category, see <http://www.epa.gov/oppt/newchems/pbtpolicy.htm>, and the proposed (October 5, 1998; 63 FR 53417) and final (November 4, 1999; 64 FR 60194) “Category for Persistent, Bioaccumulative, and Toxic Chemical Substances” published in the US Federal Register.

**Hazard Concerns.** Generally, PBT chemical substances are chemical substances that partition to water, sediment or soil and are not removed at rates adequate to prevent their bioaccumulation in aquatic or terrestrial species, with the potential to pose a risk via food chain toxicity.

**Boundaries.** The following table summarizes specific identification criteria and associated process for use in evaluating new chemical PBT substances.

NEW CHEMICALS PROGRAM PBT CATEGORY CRITERIA AND PROCESS		
TSCA Section 5 Action		
	<u>5(e) Order/Significant New Use Rule (SNUR)</u> Exposure/release controls included in order; testing required	<u>Ban Pending Testing</u> Deny commercialization; testing results may justify removing chemical from “high risk concern”
Persistence (transformation half-life)	>2 months	>6 months
Bioaccumulation* (Fish BCF or BAF)	≥1000	≥5000
Toxicity	Develop toxicity data where necessary, based upon various factors, including concerns for P, B, other physical/chemical factors, and toxicity.	

\*Chemicals must also meet criteria for MW (<1000) and cross-sectional diameter (<20Å, or <20 x 10<sup>-8</sup> cm). BCF

of 1000 and 5000 are equivalent to log Kow of 4.2 and 5, respectively.

**General Testing Strategy**

***Tier 1. Based upon SAR and professional judgment, the Agency identifies a new chemical substance as a possible PBT chemical substance.***

Log Kow	Liquid chromatography (Harmonized Test Guideline 830.7570/OECD 117) or generator column (Harmonized Test Guideline 830.7560) method; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method
Ready biodegradability	Ready biodegradability (Harmonized Test Guideline 835.3110/OECD 301) 6 methods (choose one): DOC Die-Away, CO <sub>2</sub> Evolution, Modified MITI (I), Closed Bottle, Modified OECD Screening, Manometric Respirometry  <i>or</i> Sealed-vessel CO <sub>2</sub> production test (Harmonized Test Guideline 835.3140)
Hydrolysis in water (if, based upon SAR, susceptibility to hydrolysis is suspected)	Harmonized Test Guideline 835.2120 (OECD 111)
Results	If the measured log Kow is <4.2 or if the test chemical passes the ready biodegradability test (i.e., not persistent in the environment), no further PBT-related testing is required. If the measured log Kow is greater than or equal to 4.2 and the chemical does not pass the ready biodegradability test, the chemical would require tier 2 testing. If hydrolysis testing is conducted and results in a half-life of <60 days, further testing may not be needed, but the need for testing must be determined after consideration of factors specific to the case, such as physical/chemical properties, persistence and bioaccumulative qualities of hydrolysis products, and the nature of the expected releases.

**Tier 2. Biodegradability and Bioaccumulation**

Biodegradability	Shake-flask die-away test (Harmonized Test Guideline 835.3170) or Aerobic Mineralization in Surface Water – Simulation Biodegradation Test (Harmonized Test Guideline 835.3190/OECD 309)
Bioaccumulation	Fish bioconcentration test (Harmonized Test Guideline 850.1730/OECD 305), or an equivalent test). Measured BCF should be based on 100 percent active ingredient and measured concentration(s).
Results	If the measured biodegradation half-life is >60 days <u>and</u> measured BCF is >1000, tier 3 testing will be required. If only one condition is met, releases and exposure are further considered to determine if additional testing is required.

**Tier 3. Toxicity/advanced environmental fate testing.**

Human health toxicity	Combined repeated dose oral toxicity with the reproductive/developmental toxicity screening test (OECD No. 422) in rats. Other health testing will be considered where appropriate.
Environmental fate	Sediment/water microcosm biodegradation test (Harmonized test Guideline 835.3180) or Aerobic/anaerobic aquatic metabolism (Harmonized test Guideline 835.4300/835.4400)
Chronic environmental toxicity	Fish (rainbow trout) and daphnids should be tested according to Harmonized Test Guideline 850.1400 (same as OECD 210) and Harmonized Test Guideline 850.1300 (same as OECD 202), respectively. Additional testing to evaluate other biota (e.g., avian, sediment dwelling organisms) or other effects (e.g., endocrine disrupting potential) will be considered where appropriate.

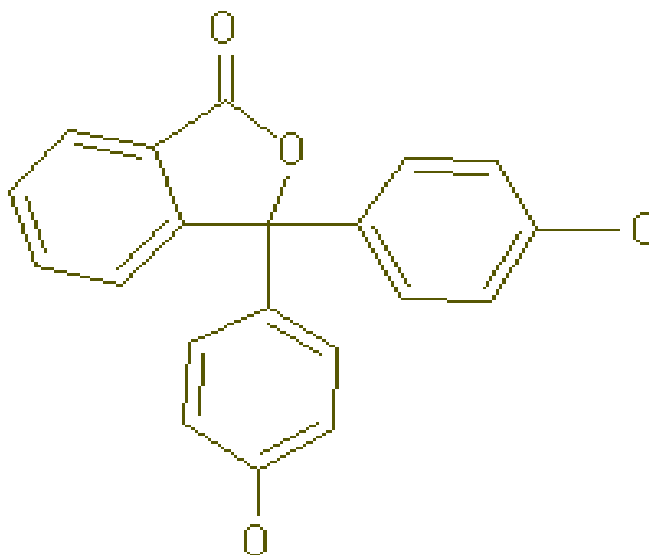
November, 1999



**Category:** Phenolphthaleins

Human Health

**Definition.** Any chemical containing the phenolphthalein structure is considered to be a member of the category.



**Hazard Concerns.** The health concern for phenolphthalein and derivatives of phenolphthalein is for cancer based on the NTP cancer study (NTP report TR-465, November 1996) for phenolphthalein with administration via the diet. There was clear evidence of carcinogenic activity in male F344/N rats based on markedly increased incidences of benign pheochromocytomas of the adrenal medulla and of renal tubule adenomas and adenomas or carcinomas (combined). There was some evidence of carcinogenic activity in female F344/N rats based on the increased incidences of benign pheochromocytomas of the adrenal medulla in the 12,000 ppm group and of benign or malignant pheochromocytomas (combined) in the 12,000 and 25,000 ppm groups. There was clear evidence of carcinogenic activity in male B6C3F<sub>1</sub> mice based on increased incidences of histiocytic sarcomas and of malignant lymphomas of thymic origin. There was clear evidence of carcinogenic activity in female B6C3F<sub>1</sub> mice based on increased incidences of histiocytic sarcomas, malignant lymphomas of all types, lymphomas of thymic origin, and benign sex-cord stromal tumors of the ovary.

**Boundaries.** No boundaries currently defined.

**Testing.** EPA considers the following tests to be the most appropriate for phenolphthalein

derivatives found to pose an unreasonable risk to human health:

Tier 1.

Comparative dermal and oral absorption study in rats (Harmonized Test Guideline, 870.7485)

In vitro Chromosome aberrations study in Chinese hamster ovary cells with phenolphthalein as an additional positive control (Harmonized Test Guideline 870.5375)

Log Kow test (Harmonized Test Guideline 830.7550, 830.7560, or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method)

Water solubility for both lactone and acid form (Harmonized Test Guideline 830.7840 or 830.7860)

Ready biodegradability (Harmonized Test Guideline 835.3110)

Tier 2.

2-year carcinogenicity study in mice (Harmonized Test Guideline 870.4200)

April, 1998

## Category: Phenols

## Environmental Toxicity

**Definition.** This category includes phenols (i.e., monophenols), polyhydroxy phenols, and polyphenols. It is assumed that these compounds need to be absorbed to be toxic; therefore, compounds with MWs > 1000 will be excluded from this category. Acute toxicity for phenols which are liquids at room temperature is known to be limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a log  $K_{ow}$  value of about 7.38, phenols are expected to show no effects at saturation during 96-h exposures (Veith and Broderius 1987). Phenols which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, no effects at saturation has to be demonstrated on a case-by-case basis. There are no known  $K_{ow}$  limits for chronic toxicity at this time, but it may not be much above a log  $K_{ow} = 9.0$  for liquid phenols. Future testing will determine this  $K_{ow}$  limit.

**Hazard Concerns.** The aquatic toxicity for phenols has been determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>]. Members of this category exhibit toxicity ranging from low toxicity (i.e., > 100 mg/L) to high toxicity (i.e., < 1 mg/L) depending on their  $K_{ow}$ , MW, and substitutions (e.g., dinitrophenols).

Dinitrophenols are known to be more toxic than predicted by these SARs (see the category for polynitroaromatics).

**Environmental Fate.** Phenols are subject to indirect photolysis under environmentally realistic conditions.

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity expected with log  $K_{ow} < 7.38$ ; no effects at saturation during 96-h exposures when log  $K_{ow} \geq 7.38$ . Chronic toxicity has no known upper bound for log  $K_{ow}$ , but it is probably near 9. MW will be < 1000. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log  $K_{ow}$  is  $\geq 7.38$ , chronic toxicity testing with fish, daphnids, and green algae will be recommended.

### General Testing Strategy

#### I. Release to Aquatic Ecosystems:

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with

measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

If there is no significant risk from the PMN after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set. For example, the most sensitive species from the environmental base set has an EC50 value = 2.0 mg PMN/L (based on 100% AI, therefore, prepare a 5.0 mg PMN per liter stock solution based on 100% AI using the standard humic-containing solution. This stock solution is exposed to sunlight for at least 6 half-lives to ensure that all of the PMN has been photolyzed, and then this stock solution is used to retest the most sensitive aquatic species to determine if the photolysis products of the PMN are more or less toxic than the PMN.

Tier 4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its

aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen);

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al (1990) have demonstrated that the fish 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the fish 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200] and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

## **References.**

Van Leeuwen CJ, Adema DMM, and Hermens J. 1990. Quantitative structure-activity relationships for fish early life stage toxicity. *Aquatic Toxicology* 16:321-334.

Veith GD and Broderius SJ. 1987. Structure-toxicity relationships for industrial chemicals causing type (II) narcosis syndrome. In Kaiser KLE (ed), *QSAR In Environmental Toxicology -II*, pp. 385-391. Reidel Publishing Company.

July, 1991; revised June 2010

**Category: Phosphates, Inorganic**

**Definition.** This category includes all inorganic soluble forms of phosphates, such as, phosphoric acid [PO<sub>4</sub>H<sub>3</sub> or OP(=O)(O)O] and its salts or phosphate salts, pyrophosphates, polyphosphates, and organic and inorganic forms of phosphorous that can be oxidized to phosphates rapidly. Inorganic forms of phosphonic acid (H<sub>2</sub>PO<sub>3</sub> or OP(=O)O) are not included in this category because monopotassium phosphonic acid [13977-65-6] has been shown not to be an algal nutrient, not to be a replacement for phosphate in algal growth medium, and not to cause exponential growth of green algae.

**Hazard Concerns.** The standard environmental toxicity profile for inorganic phosphates as P in mg P/L is:

ECOTOX: Predicted (P) and measured (M) toxicity values in mg/L (ppm) are:

fish 96-h LC50	>	100.0	P
daphnid 48-h LC50	>	100.0	P
green algal 96-h EC50 b	<	0.030	P
algal 96-h EC290 b	=	0.030	M, S,N
fish chronic value	>	10.0	P
daphnid ChV	>	10.0	P
algal ChV	=	0.010	M, Hutchinson 1957

Predictions are based on SAR-nearest analog analysis for soluble forms of inorganic phosphates (PO<sub>4</sub>); SAR chemical class = P-O<sub>4</sub>; MW of P = 31, PO<sub>4</sub> = 95, PO<sub>4</sub>H<sub>3</sub> = 98; pH7; effective concentrations based on 100% active ingredients and nominal concentrations of P; hardness <24.0 mg/L as CaCO<sub>3</sub>; and TOC <2.0 mg/L; high concern for eutrophication;

assessment factor	=	10.0
concern concentration	=	0.001

Phosphate phosphorus has the potential to stimulate the growth of green algae and cause algal blooms and eutrophication in freshwater and marine environments. The phosphate anion is a plant nutrient and is the major limiting nutrient in many freshwater environments. The USEPA OW WQC (USEPA 1976) states:

When such concentrations [of total phosphate phosphorus] exceed 25 µg/l at the time of the spring turnover on a volume-weighted basis in lakes or reservoirs, they may occasionally stimulate excessive or nuisance growths of algae and other aquatic plants. Algal growths impart undesirable tastes and odors to water, interfere with water treatment, become aesthetically unpleasant and alter the chemistry of the water supply. They contribute to the phenomenon of cultural eutrophication.

To prevent the development of biological nuisances and to control accelerated or cultural eutrophication, total phosphates as phosphorus (P) should not exceed 50 µg/l in any stream at the

point where it enters any lake or reservoir, nor 25 µg/l within the lake or reservoir. A desired goal for the prevention of plant nuisances in streams or other flowing waters not discharging directly to lakes or impoundments is 100 µg/l total P (Mackenthum, 1973). Most relatively uncontaminated lake districts are known to have surface waters that contain from 10 micrograms P/L (or 31 micrograms PO<sub>4</sub>H<sub>3</sub>/L) to 30 microg P/L (or 92 microg PO<sub>4</sub>H<sub>3</sub>/L) (Hutchinson, 1957).

Odum (1971) called phosphorus a major factor in the process of cultural eutrophication. Eutrophication results when nutrients, especially phosphates, are imported into aquatic ecosystems. This process is analogous to fertilizing an agricultural field. Phosphates act like a fertilizer and produce increases in the abundance of algae and other aquatic plants; eventually, they can result in excessive growths of algae (i.e., algal blooms). Excessive algae can block sunlight from reaching submerged macrophytes and other microalgae below the surface. When the algae die and fall to the bottom of slow-moving water or lakes, they are consumed by bacteria which use up available oxygen producing anaerobic conditions. Decaying algae cause odors and oxygen depletion of the water to occur with concomitant detriment to fish and aquatic invertebrates and, in turn, fishing and water-based recreational activities.

Phosphate concentrations as low as 0.050 mg P/L (ppm) or 50.0 micrograms P/L (ppb) will produce exponential growth of green algae in 96 hours (Miller et al. 1978), and phosphate concentrations from 10 to 60 micrograms P/L (ppb) were correlated to algal blooms and oxygen depletion (i.e., eutrophication) in Lake Washington, Seattle (Odum 1971). Phosphates have been severely limited or banned from detergents in 13 states, the District of Columbia, and several counties and municipalities (USEPA 1992). Sodium tripolyphosphate was one of the principal components of synthetic detergents. Freshwater green algae are clearly the most sensitive group of aquatic organisms to phosphate additions to water.

**Boundaries.** The boundaries for inorganic phosphate compounds depend on the release of inorganic phosphates which can be used by algae as a mineral nutrient. Any inorganic phosphate which can be used by algae as a nutrient or which transforms to release or becomes an algal nutrient is included in this category.

**Testing.** Based on a consideration of available data on inorganic phosphates and the physicochemical properties of these compounds, there is no need for further testing. However, if there is doubt about the availability of phosphate in a nutrient form from a PMN substance, then the algal toxicity test can be done with the PMN substance substituted for phosphate nutrient in the algal growth medium. If a PMN substance is capable of stimulating exponential growth green algae, it must be emphasized that inorganic phosphates should not be released to water because of their potential to cause eutrophication and their persistence.

### **Regulatory Actions.**

- (1) Phosphates have been severely limited or banned from detergents in 13 states, the District of Columbia, and several counties and municipalities (USEPA 1992).
- (2) Water Quality Criterion, 1976 (USEPA 1976): total phosphates as phosphorus (P) should

not exceed 50 micrograms p/L in any stream at the point where it enters any lake or reservoir, nor 25 micrograms P/L within the lake or reservoir.

(3) Hazard assessments of selected aqueous cleaner chemicals, USEPA (1990): OPPT recommendation to the Office of Air and Radiation: "...phosphates should never be released to water."

(4) Agency recommendation for a "nationwide elimination of the use of household laundry detergents containing phosphates." (USEPA 1992).

### **References.**

Hutchinson, G. E., 1957, A treatise on limnology. New York, NY: John Wiley & Sons.

Mackenthun, K. M., 1973, Toward a cleaner aquatic environment. Washington, DC: USEPA.

Miller, W. E., Greene, J. C., and Shiroyama T. 1978. The Selenastrum capricornutum Printz algal assay bottle test. Corvallis, OR: USEPA, Office of Research and Developmental, Environmental Research Laboratory-Corvallis, EPA-600-9-78-018.

United States Environmental Protection Agency (USEPA). 1976. Quality Criteria for Water. EPA-440/9-76-023. Washington, DC: Office of Water Planning and Standards, OW, USEPA. Available from NTIS, Springfield, VA 22161, PB-263-943.

United States Environmental Protection Agency (USEPA). 1990. (Health and environmental effects of selected aqueous cleaner chemicals. Washington, DC: Health and Environmental Review Division, Office of Pollution Prevention and Toxics, USEPA.

United States Environmental Protection Agency (USEPA). 1992. (DRAFT Phosphate detergents: An evaluation of the benefits and costs of eliminating their use in the United States. Washington, DC: Environmental Results Branch, Office of Policy, Planning, & Evaluation, USEPA.

March 2000



**Category: Phosphinate Esters**

Environmental Toxicity

**Definition.** Phosphinate esters are a class of organic compounds characterized by the functional group R-O-P(=O)(R)R. Phosphinate esters are metabolically active and exhibit excess aquatic toxicity in addition to narcosis. Phosphinate esters exhibit excess toxicity relative to simple esters (-C(=O)O-) and phosphate esters (-OP(=O)(O-)O-).

It is assumed that phosphinate esters need to be absorbed to be toxic, therefore, phosphinate esters with MW >1000 will be excluded from this category. Acute toxicity for phosphinate esters is known to be correlated and limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a log  $K_{ow}$  value of >5.0, phosphinate esters show no effects at saturation during 96-hr exposures to fish. Phosphinate esters which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, the no effects at saturation has to be determined on a case-by-case basis.

There are no measured upper  $K_{ow}$  limits for chronic toxicity at this time, but it may not be much above a log  $K_{ow}$  = 8.

**Hazard Concerns.** The aquatic toxicity for phosphonate esters has been determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>].

**Environmental Fate.** Phosphinate esters hydrolyze in water and their rate of hydrolysis is correlated with pH. The more alkaline, the faster the hydrolysis. The SAR for hydrolysis is:

Log hydrolysis  $t_{1/2}$  (d) = 4.325 - 0.497 pH  
where n=2,  $R^2=1.0$ .

At pH 7.1, the hydrolysis  $t_{1/2}$  = 6.3 days or 150 hours.

**Boundaries.** MW <1000. Log  $K_{ow}$  <5.0 for acute toxicity to fish and aquatic invertebrates; log  $K_{ow}$  <6.4 for toxicity to green algae as a 96-h  $EC_{50}$ ; and log  $K_{ow}$  assumed to be <8.0 for chronic toxicity to aquatic organisms, but could be higher.

**General Testing Strategy.****I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (ai) and mean measured concentrations; measured TOC of dilution water in the control; ideally,

mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the aldehyde to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical significantly above its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (ai) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; ideally, mean measured concentrations in the highest treatment concentration should be equal the aqueous solubility limit; and solvent can be used to assist the aldehyde to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the test chemical significantly above its aqueous solubility limit.

If there is no significant risk from the PMN chemical after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the PMN chemical after the results of biodegradation testing have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; ideally, mean measured concentrations in the highest treatment concentration should be equal to the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN significantly above its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because the 7-d ELS toxicity test may underestimate chronic toxicity measured by the 28-d ELS toxicity test when the Chronic Values are compared.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; ideally, mean measured

concentrations in the highest treatment concentration should be equal to the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN significantly above its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because the daphnid 7-d short-term chronic toxicity test may underestimate chronic toxicity measured by the daphnid 21-d chronic toxicity test when the chronic values are compared.

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test Harmonized Test Guideline 850.4150), the plant uptake test Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

September 1996; revised June 2010.

**Category:** Polyanionic Polymers (& Monomers Environmental Toxicity

**Definition.** There are two subcategories of polymers that are of concern:

- Polyaromatic sulfonates - condensation products of sulfonated aromatics with formaldehyde, and
- Polyacrylates with free carboxyl groups

This category includes monomers with two or more acid groups and which act like organic acid chelators. The acid groups may include carboxylic acids, silicic acids, phosphoric acid, and sulfuric acids. These acids may also contain thiol substitutions. The acid groups on a monomer may be all of the same type of acid or may be a mixture of acids. The monomeric nucleus may include carbon, silica, oxygen, sulfur, and nitrogen, or mixtures of these elements. Members of this category must be water soluble or water self-dispersing. Molecular weights can be > 1000.

**Hazard Concerns.** Polyaromatic sulfonates are moderately toxic to fish, daphnids, and algae. The polyacrylates are toxic to algae only. Polyanionic monomers (as salts, e.g., Na or K salts) are moderately toxic to green algae, but show low toxicity to fish and daphnids. It is assumed that the toxicity of these compounds is due to over-chelation of nutrient elements needed for algal growth and that this toxicity will be mitigated in the presence of  $\text{Ca}^{++}$  either added to the compound before testing or present in the growth/test medium at a hardness of about 150 mg/L as  $\text{CaCO}_3$ .

**Boundaries.** Polymers must be water-soluble. Molecular weights are generally >1,000.

### General Testing Strategy

To address ecotoxicity concerns, for polycarboxylic acids (polyacrylates) and polyanionic monomers, algal testing (static methods, nominal concentrations) is recommended, in 3 separate tests: 1) the test substance as is, 2) with equivalent of calcium ion, and 3) with growth medium at 150 mg/L hardness, as  $\text{CaCO}_3$ ). For polyaromatic sulfonates, base set aquatic toxicity testing (flow through methods, measured concentrations) in algae, daphnids, and fish is recommended.

September, 1988; revised April, 1991

**Category: Polycationic Polymers**

Environmental Toxicity

**Definition.** Any polymer that exists in the environment with multiple positive charges is a member of this class. Such structures include polyamines, polyquaternary ammonium, polysulfonium, and polyphosphonium compounds.

**Hazard Concerns.** Members of the category are toxic to fish, invertebrates, and algae. Algae are six-fold more sensitive than fish and daphnids. It is presumed that these compounds act on the surface of organisms and need not be absorbed. Toxicity increases exponentially with increasing charge density at cationic equivalent weights of >400. At lower charge equivalent weights, toxicity does not increase. A number of QSARs (quantitative structure-activity relationships) have been developed to predict the toxicity of polycationic polymers.

**Boundaries.** Polymers must be water-soluble or water-dispersible. Molecular weights are >300 although the typical new chemical polycationic polymer has a molecular weight in excess of 1000. EPA has been engaged in discussions with the Cationic Flocculant Producers Association in an attempt to identify and develop a set of tests on representative polycationic polymers which could better define the limits of the category.

**General Testing Strategy**

To address ecotoxicity concerns, for polymers with % amine nitrogen <0.7% and >0.1%: base set acute aquatic toxicity testing in algae, daphnids, and fish, plus humic acid testing in fish (20 mg/L humic acid in dilution water and 10 mg/L) is recommended. All testing uses static method, nominal concentrations. For some members of the class, a test of sorbed chemical using a benthic organism may also be recommended.

September, 1988; periodically revised.

**Definition.** This category includes all dinitroaromatics and trinitroaromatic compounds, for example, dinitrobenzenes, dinitroanilines, dinitrophenols, and dinitropyridines. Polynitroaromatics probably act by uncoupling of oxidative phosphorylation (Doull et al 1980). It is assumed that these compounds need to be absorbed to be toxic; therefore, compounds with MWs > 1000 will be excluded from this category. Acute toxicity for polynitroaromatics which are liquids at room temperature is assumed to be limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a log  $K_{ow}$  value of  $\geq 7.00$  (based on test data for anilines reported Veith and Broderius 1987), polynitroaromatics are not expected to show toxic effects at saturation during 96-h exposures. Polynitroaromatics which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, the no effects at saturation has to be determined on a case-by-case basis. There are no known  $K_{ow}$  limits for chronic toxicity at this time, but it may not be much above a log  $K_{ow} = 10$  for liquid polynitroaromatics.

**Hazard Concerns.** The aquatic toxicity for several classes of polynitroaromatics have been determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>]. Members of this category exhibit toxicity ranging from low toxicity (i.e., > 100 mg/L) to high toxicity (i.e., < 1 mg/L) depending on their  $K_{ow}$  and MW.

**Environmental Fate.** Polynitroaromatics are expected to be subject to rapid direct and indirect photolysis under environmentally realistic conditions.

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity expected with log  $K_{ow} < 7.0$ ; no effects at saturation during 96-h exposures when log  $K_{ow} \geq 7.0$ . Chronic toxicity has no known upper bound for log  $K_{ow}$ , but it is probably near 10. MW will be < 1000. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log  $K_{ow}$  is  $\geq 7.0$ , chronic toxicity testing with fish and daphnids will be recommended.

### **General Testing Strategy.**

#### **I. Release to Aquatic Ecosystems:**

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest

treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

If there is no significant risk from the PMN after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set. For example, if the most sensitive species from the environmental base set has an EC50 value = 2.0 mg PMN/L (based on 100% active ingredients [AI]), then prepare a 5.0 mg PMN per liter stock solution based on 100% AI using the standard humic-containing solution. This stock solution is exposed to sunlight for at least 6 half-lives to ensure that all of the PMN has been photolyzed, and then this stock solution is used to retest the most sensitive aquatic species to determine if the photolysis products of the PMN are more or less toxic than the PMN.

Tier 4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van

Leeuwen);

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al (1990) have demonstrated that the fish 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the fish 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test [Harmonized Test Guideline 850.4230], the earthworm toxicity test [Harmonized Test Guideline 850.6200], and the soil microbial community bioassay [Harmonized Test Guideline 850.5100]) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test Harmonized Test Guideline 850.4150), the plant uptake test Harmonized Test Guideline 850.4800), and the soil microbial community bioassay (Harmonized Test Guideline 850.5100).

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May, 1991; revised June 2010



## Category: Respirable, Poorly Soluble Particulates

Health Only

**Definition.** This category includes a variety of inorganic, poorly soluble (as designated in ILSI 2000) particulates. Typically, they are oxides of various metals or nonmetals (i.e., silicon)

**Boundaries.** There is a potential for respirability if there are any particles  $\leq 10 \mu$  in diameter in the material being handled by workers. Summarized below are currently available test data on five different poorly soluble particulates: silica, talc, titanium dioxide, PMN 96-175 (lithium manganese oxide), and carbon black. The suitability of one or more of these analogues for a particular PMN particulate must be determined on a case-by-case basis. Risk is to be assessed by the margin of exposure method for the reason stated in the next paragraph.

**Hazard Concerns.** The category concerns discussed here are limited to effects on the lung as a result of inhaling the particles. Broadly, as shown in rat inhalation studies, these effects range from inflammation to fibrosis to, potentially, cancer. Because it is still not known with certainty whether high lung burdens of poorly soluble particulates can lead to lung cancer in humans via mechanisms similar to those of the rat, in the absence of mechanistic data to the contrary, it must be assumed that the rat model can identify potential carcinogenic hazards to humans. Since the apparent responsiveness of the rat model at overload is dependent on coexistent chronic active inflammation and cell proliferation, at lower lung doses in which chronic active inflammation and cell proliferation are not present, no lung cancer hazard is anticipated (ILSI 2000).

Some of the particulates may contain metals, for example, chromium, that may present other and more imminent toxicities, depending on the bioavailability of the metal ions. Thus, the toxicities of the metal components of the particulates must also be assessed, and on a case-by-case basis.

### Lung Toxicity of Five Poorly Soluble Particulates

#### 1. Fibrogenicity/Carcinogenicity of Crystalline Silica

Humans. Based on sufficient evidence for the carcinogenicity of inhaled crystalline silica from occupational sources, the International Agency for Research on Cancer (IARC, 1997) has classified crystalline silica as a Group 1 carcinogen in humans. According to IARC, studies of the following populations provided the least-confounded examinations of an association between silica exposure and cancer risk: gold miners, stone industry workers, granite shed and quarry workers, crushed stone industry workers, diatomaceous earth industry workers, refractory brick workers, pottery workers, and cohorts of registered silicotics. Not all of these studies demonstrated excess cancer risks; but, in view of the large number of epidemiological studies undertaken and the wide range of populations and exposure circumstances, some nonuniformity of results would be expected. In some studies, increasing risk gradients have been observed in relation to dose surrogates--cumulative exposure, duration of exposure, or the presence of radiographically defined silicosis--and, in one instance, to peak intensity exposure. For these

reasons, the IARC Working Group concluded that overall, the epidemiological findings support increased lung cancer risks from inhaled crystalline silica resulting from occupational exposure.

Animals. IARC (1997) has concluded that there is “sufficient evidence in experimental animals for the carcinogenicity of crystalline silica. A number of studies (*rev. in:* IARC, 1997; Woo *et al.*, 1988; Holland, 1990) have demonstrated that, in addition to silicosis/fibrosis, pulmonary tumors are induced in rats exposed to quartz (Mini-U-Sil; a common form of crystalline silica) by inhalation, single intrapleural, intraperitoneal, and/or intratracheal administration. In a 24-month inhalation study in rats, the lowest tested dose of respirable crystalline silica particles to induce lung tumors (Lowest Observed Adverse Effect Level, or LOAEL) was 0.74 mg/m<sup>3</sup>.

**\* Note for Cases Using Silica as Primary Analogue:** For LOAEL doses, the Agency considers a margin of exposure (MOE) of 1,000 or greater as representing a low order of toxicity for health endpoints for which a threshold dose is deemed appropriate. In this instance, exposures would have to be reduced to 0.0007 mg/m<sup>3</sup> to achieve a MOE of 1,000, a concentration that is practically impossible to achieve. Because the LOAEL of 0.74 mg/m<sup>3</sup> is based on test data on pure silica and because silica is considered to be a much more potent lung toxicant than crystalline particulates containing silica, **the Agency has adopted the NIOSH REL (Recommended Exposure Limit) for silica, 0.05 mg/m<sup>3</sup>, as a NCEL (New Chemical Exposure Limit) - see <http://www.epa.gov/opptintr/newchems/pubs/ncelmain.htm> for more information) concentration that would adequately protect workers from crystalline particulates containing silica.** This NCEL replaces the former one based on the OSHA Permissible Exposure Limit (PEL) for silica, 0.1 mg/m<sup>3</sup>.

## 2. Fibrogenicity/Carcinogenicity of Talc

Humans. Epidemiology studies suggest an association between nonfibrous talc (a finely powdered hydrous magnesium silicate) and lung cancer risk. The OSHA PEL for talc is 20 mppcf (million particles per cubic foot), and the NIOSH-recommended 8-hr TWA concentration is 2 mg/m<sup>3</sup>.

Animals. In an NTP inhalation study (NTP TR 421, 1993), male and female F344 rats were exposed to 0, 6, or 18 mg/m<sup>3</sup> talc for 113 and 122 weeks, respectively. There was clear evidence of the carcinogenicity of talc in female rats based on the increased incidence of alveolar/bronchiolar adenomas and carcinomas of the lung in the 18-mg/m<sup>3</sup> group (LOAEL). The No Observed Adverse Effect Level (NOAEL) from this study is 6 mg/m<sup>3</sup>. The NCEL for analogous particulates would be 0.06 mg/m<sup>3</sup>.

## 3. Fibrogenicity/Carcinogenicity of Titanium Dioxide (TI)

Humans. According to IARC (ACGIH 1993), there is inadequate evidence for the carcinogenicity of TI in humans. [There is limited evidence for the carcinogenicity of TI in experimental animals.] Overall evaluation: TI is not classifiable as to its carcinogenicity to humans. The OSHA PEL's for nuisance dust (in which TI is included) are 15 mg/m<sup>3</sup> total particulates and 5 mg/m<sup>3</sup> respirable fraction. The ACGIH TLV-TWA is 10 mg/m<sup>3</sup> of total dust

containing no asbestos and <1% crystalline silica.

The various literature case reports of lung toxicity in TI-exposed workers are generally inconclusive because of several factors--smoking; other conditions, such as tuberculosis; or incomplete data on TI exposure histories.

In one fairly comprehensive cohort study, Chen and Fayerweather (1988, as summarized in ACGIH 1993) analyzed lung cancer mortality and incidence of chronic respiratory disease, chest x-ray abnormality, and pulmonary fibrosis among 1,576 workers exposed to TI for at least 1 yr at two production facilities between 1935 and 1984. Of the 211 deaths, 14 were attributed to respiratory cancer and 11 to nonmalignant respiratory disease compared with 18.3 and 13.8 cases expected, respectively, based on US mortality data. Expected deaths based on company mortality data since 1957 were 16.6 from respiratory cancer and 8.3 from nonmalignant respiratory disease. The authors concluded that the increase in deaths from nonmalignant respiratory disease compared with company data was not statistically significant. They further concluded that there was no significant association between exposure to TI and the respiratory diseases studied.

Animals. There is limited evidence for the carcinogenicity of TI in experimental animals. Two-year inhalation studies in animals are summarized below.

(1) Lee et al. (1986, as cited in ACGIH 1993 and in USEPA 1983) exposed Charles River-CD rats to 0, 10, 50, or 250 mg/m<sup>3</sup> for 6 hr/day 5 days/wk for 2 yr. The mean respirable fractions were 93.7% or greater. Squamous cell carcinomas developed after exposure to the highest dose for the full 2 yr. The authors considered the carcinomas to be unique, experimentally induced tumors in rats and to be of questionable relevance to humans. Given the amount of dust in the rat lungs, the tumors were postulated to be the result of saturation of normal pulmonary clearance mechanisms. There were minute areas of lung fibrosis at the two higher exposure levels.

At 50 mg/m<sup>3</sup>, massive accumulations of dust-laden macrophages, foamy dust cells, and free particles were considered indicative of such an overload. At 10 mg/m<sup>3</sup>, the architecture of the air spaces remained intact and there was no significant formation of scar tissue. The NOAEL is 10 mg/m<sup>3</sup>.

(2) Heinrich et al. (1995, abstract only) exposed Wistar rats to diesel engine exhaust, carbon black, or ultrafine TI for 2 yr. Particle exposure concentrations were increased during the course of the experiment. The average particle concentration of TI was 10 mg/m<sup>3</sup>. Lung tumor rates (not given) increased with increasing cumulative particle exposure times, independent of the type of particle.

(3) Trochimowicz et al. (1988, abstract only) exposed Charles River-CD rats to 10, 50, or 250 mg/m<sup>3</sup> TI for 6 hr/day, 5 days/wk for 104 wk. Microscopic findings included alveolar cell hyperplasia, dust deposition, and minute areas of collagen fiber deposition associated with cholesterol giant cell granulomas. The earliest indicator of TI exposure was alveolar cell

hyperplasia. Lung tumors were only found in rats exposed to 250 mg/m<sup>3</sup>. The NOAEL from this study is 10 mg/m<sup>3</sup>.

On the basis of the NOAELs from the above studies, the NCEL for analogous particulates would be 0.1 mg/m<sup>3</sup>. However, this would make the NCEL for TI analogues identical to the OSHA PEL for silica, a highly potent lung toxicant that IARC (1997) has classified as a Group 1 carcinogen in humans (see section 1, above). Therefore, it was decided to use the OSHA PEL for TI, which is 5 mg/m<sup>3</sup> (respirable fraction), as the NCEL for TI analogues.

#### 4. Lung Toxicity of PMN 96-175, Lithium Manganese Oxide

Animal Data Only. Rats were exposed by inhalation to 0 (air controls), 1, 4, or 16 mg/m<sup>3</sup> of the PMN substance 6 hr/day, 5 days/wk for 90 days. At the highest concentration, rats developed inflammation of the lung and larynx. Similar results were seen in the 14-day range-finding study at concentrations ranging from 10 to 100 mg/m<sup>3</sup>. The **NOAEL from this study is 4 mg/m<sup>3</sup>**. The NCEL for analogous particulates would be 0.04 mg/m<sup>3</sup>.

#### 5. Fibrogenicity/Carcinogenicity of Carbon Black

Chronic inhalation of carbon black produced pulmonary inflammation, fibrosis, and lung tumors in rats (Nikula et al. 1995, Heinrich et al. 1995). These effects were observed at dust concentrations of 2.5, 6.6, and approximately 10 mg/m<sup>3</sup> carbon black. The LOAEL from these studies is 2.5 mg/m<sup>3</sup>. The NCEL for analogous particulates would be 0.0025 mg/m<sup>3</sup>. [The OSHA PEL for carbon black is 3.5 mg/m<sup>3</sup>.]

### **General Testing Strategy**

A 90-day inhalation toxicity test (Harmonized Test Guideline 870.3465) in rats with special attention to histopathology (inflammation and cell proliferation) of the lung tissues and to various parameters of the bronchoalveolar lavage fluid (BALF), e.g., marker enzyme activities, total protein content, total cell count, cell differential, and cell viability. It is not necessary to look at internal organs. It is recommended that a recovery period of 60 days be included to assess the progression or regression of any lesions. If the results of the subchronic study indicate that the PMN particles have carcinogenic potential, a 2-year inhalation bioassay in rats may be warranted.

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October, 2002

**Category: Rosin**

## Environmental Toxicity

**Definition.** This category includes rosin, abietic acid, abietinic acid, sylvic acid, their salts, and polymeric forms whose MW < 1000. The mode of toxic action of rosin is unknown. It is assumed that these compounds need to be absorbed to be toxic, therefore, compounds with MWs > 1000 will be excluded from this category. It is also assumed that these compounds need to be water soluble to be toxic, therefore, compounds with water solubilities (WS) < 0.001 mg/L (ppm) will also be excluded from this category.

**Hazard Concerns.** The acute toxicity for rosin towards fish has been measured to be between 0.410 to 0.700 mg/L by Leach and Thakore (1976 and 1978). Toxicity to aquatic invertebrates and green algae have no been reported. Based on these data, rosin presents a high concern for toxicity towards the aquatic environment.

**Boundaries.** The only lower boundary is water solubility which is set at 0.001 mg/L (ppm). The only upper boundary will be set at a MW  $\geq$  1000 for stable compounds. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures.

**General Testing Strategy.**

The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility.

Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility; and the

7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test because Van Leeuwen et al (1990) have demonstrated that the 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen);

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test because Van Leeuwen et al (1990) have demonstrated that the fish 7-d ELS toxicity test underestimated the chronic toxicity of anilines measured by the fish 28-d ELS toxicity test by >5.3 times when the NOECs were compared (see Table VII in Van Leeuwen).

The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, Harmonized Test Guideline 850.4230), the earthworm acute toxicity test (Harmonized Test Guideline 850.6200), and the soil microbial community bioassay (Test Guideline 850.5100) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Test Guideline 850.4150), the plant uptake test (Test Guideline 850.4800), and the soil microbial community bioassay (Test Guideline 850.5100).

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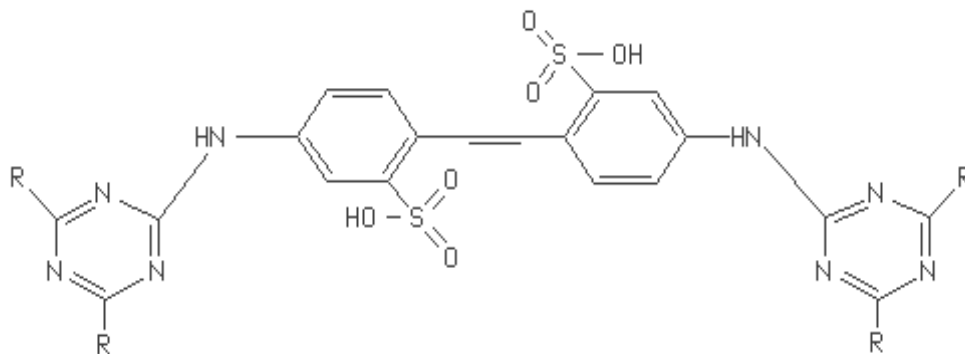
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January, 1994; revised June 2010

**Category:** Stilbene, derivatives of 4,4-bis(triazin-2-ylamino)-

Human Health (case-by-case)

**Definition.** Any water soluble (sulfonated) derivative of 4,4-bis(triazin-2-ylamino) stilbene is considered to be a member of this category.



**Hazard Concerns.** EPA previously identified hazard concerns for the possible developmental/reproductive toxicity of new chemicals falling into this stilbene, derivatives of 4,4-bis(triazin-2-ylamino)- category based on published test results for a member of the category. EPA has reviewed test data developed by the Stilbene Whitening Agent Task Force of the Ecological and Toxicological Association of Dyes and Organic Pigments Manufacturers (ETAD). These studies consisted of a range-finding and definitive 2-generation rat study (gavage) and range-finding and definitive developmental toxicity studies in rats and rabbits (gavage) for C.I. Fluorescent Brightener 220 (CAS No. 16470-24-9). Based on the results from these studies, EPA has concluded that available information does not support continued identification of stilbenes as a new chemical category presenting concerns for possible developmental/reproductive toxicity. EPA will continue to evaluate the potential health concerns for new chemical stilbenes that are notified but, with this change, will not apply a category understanding as regards potential developmental/reproductive toxicity.

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January, 1992; revised December, 1994; revised August, 2002.

## Category: Thiols

## Environmental Toxicity

**Definition.** This category includes all thiols or mercaptans. It is assumed that thiols have to be absorbed to be toxic, therefore, compounds with MWs > 1000 will be excluded from this category. Acute toxicity for thiols which are liquids at room temperature is known to be limited by the octanol/water partition coefficient ( $K_{ow}$ ). Above a log  $K_{ow}$  value  $\geq 6.5$ , thiols show no effects at saturation during 96-h exposures for fish. The log  $K_{ow}$  cut-offs for other organisms for acute effects are generally lower. Thiols which are solids at room temperature may show no toxicity at saturation at lower  $K_{ow}$  values depending on the melting point, i.e., the higher the melting point at a given  $K_{ow}$ , the greater the likelihood that no toxicity will be observed at saturation. For solids, the no effects at saturation has to be determined on a case-by-case basis. There are no known  $K_{ow}$  limits for chronic toxicity at this time, but it may not be much above a log  $K_{ow}$  of 8 to 9 for liquid thiols.

**Hazard Concerns.** The aquatic toxicity for thiols and mercaptans has been determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>].

Thiols which are substituted with a carboxylic acid will be about 10 times less toxic than predicted by this SAR at pH 7. Use the  $K_{ow}$  for the free acid.

Members of this category exhibit toxicity ranging from low toxicity (i.e., > 100 mg/L) to high toxicity (i.e., < 1 mg/L) depending on their  $K_{ow}$ , MW and substitutions.

**Boundaries.** There are no known lower boundaries. The upper boundaries will be based on  $K_{ow}$  and MW. Acute toxicity expected with log  $K_{ow}$  < 6.5 for fish; no effects at saturation during 96-h exposures when log  $K_{ow}$   $\geq 6.5$  for fish. Chronic toxicity has no known upper bound for log  $K_{ow}$ , but it is probably near 9. MW will be < 1000. The environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log  $K_{ow}$  is  $\geq 6.5$ , chronic toxicity testing will be recommended.

### General Testing Strategy

#### I. Release to Aquatic Ecosystems

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should equal the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with

static methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with at least 0.300 mg/L EDTA as a final concentration; the highest treatment concentration on a nominal-basis equal to the aqueous solubility limit; and solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit.

If there is no significant risk from the PMN after the results of the environmental base set have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

If there is no significant risk from the PMN after the results of the aerobic biodegradation have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 3.

Tier 3. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d ELS stage toxicity test cannot be substituted for the 28-d ELS toxicity test.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; measured TOC of dilution water in the control; the highest treatment concentration on a nominal-basis should be set at the aqueous solubility limit; solvent can be used to assist the PMN to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the PMN beyond its aqueous solubility limit; and the 7-d daphnid chronic toxicity test cannot be substituted for the 21-d toxicity test.

## II. Release to Terrestrial Ecosystems

The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, Harmonized Test Guideline 850.4230), the earthworm acute toxicity test (Harmonized Test

Guideline 850.6200), and the soil microbial community bioassay (Test Guideline 850.5100) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Test Guideline 850.4150), the plant uptake test (Test Guideline 850.4800), and the soil microbial community bioassay (Test Guideline 850.5100).

December, 1994; revised June 2010

**Definition.** This category includes substituted triazines which can be aromatic, partially aromatic (or partially saturated) and unsaturated. The nitrogens in the triazine ring may be symmetrical or asymmetrical. Substitutions on the carbons may include but not be limited to: aliphatic alcohols; ketones; benzene and substituted benzenes; aliphatic hydrocarbons, alkyenes and alkynes; free amines and substituted amines; cyclic aliphatic hydrocarbons; halogens; amides; cyanides; ethers; methoxy groups; sulfides; azido groups; and carboxylic acid esters. Substitutions on the nitrogens may include but not be limited to: free amines and substituted amines; -N=CH; aliphatic hydrocarbons, alkyenes and alkynes; and benzene and substituted benzenes.

**Hazard Concerns.** Many members of this category are commercial herbicides which are used to control both aquatic plants and terrestrial plants. Their mode of toxic action is generally considered to be inhibition of photosynthesis. Many members of this class are toxic to algae at < 1 mg/L and toxic to terrestrial vascular plants at < 1 mg/kg. Members of this group can also be highly toxic to fish and aquatic invertebrates. Toxicity is expected to be related to the octanol/water partition coefficient with respect to fish and aquatic invertebrates, but toxicity to plants may not be related to Kow when log Kow < 5. When the log Kow is < 5, algae and terrestrial plants are expected to be the most sensitive species. As log Kow increases, species differences are expected to diminish. The aquatic toxicity substituted triazines has been determined through SAR analysis by EPA using ECOSAR – a hazard estimation tool that uses chemical structure descriptors to estimate the acute and chronic toxicity of a substance to aquatic organisms. [Link for ECOSAR: <http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm>].

**Boundaries.** There are no known lower boundaries. The upper boundaries are based on Kow and MW. When the log Kow value is < 5 mg/L, the environmental base set of tests will be requested for aquatic releases and the terrestrial base set of tests will be recommended for terrestrial exposures. When the log Kow is between 5 and 8, only chronic toxicity testing will be recommended. When the log Kow is > 8, no testing will be requested because no toxic effects at saturation will be expected. Generally, members of this category will have MWs of less than 1000.

### **General Testing Strategy**

The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures and the terrestrial base set of environmental toxicity tests (i.e., the early seedling growth test, the earthworm acute toxicity test and the soil microbial community bioassay) will be recommended for terrestrial exposures.

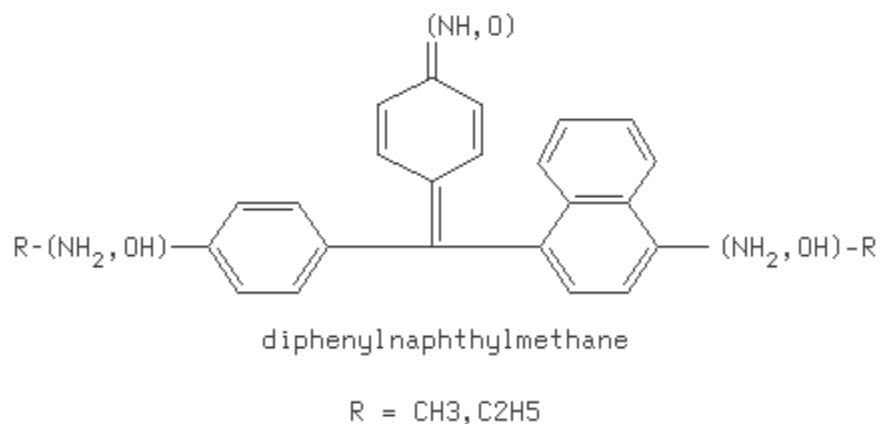
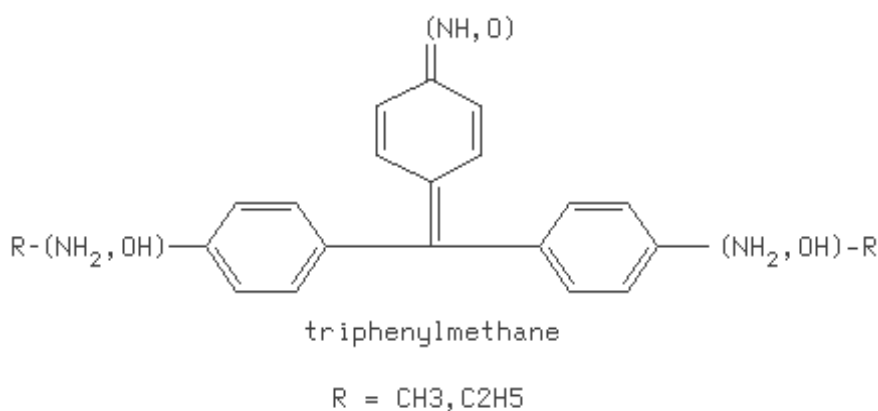
August, 1989; revised June 2010

**Category: Triarylmethane Pigments/Dyes  
with Non-solubilizing Groups**

Human Health  
Environmental Toxicity

**Other Names:** Triphenylmethane Pigments/Dyes, Diphenylnaphthyl-methane Pigments/Dyes

**Definition.** Structurally, triarylmethane pigments/dyes are derivatives of triphenylmethane or diphenylnaphthylmethane. In order to achieve the required spectral absorption properties that characterize these dyes, amine groups (primary, secondary, or tertiary) or hydroxyl groups must be present on the aromatic ring positions para to the methane carbon. Amine substitutions are more prevalent than hydroxy substitutions (C.I. 42000-42175 for diamino derivatives, C.I. 42500-42800 for triamino derivatives, C.I. 43800-43875 for hydroxy derivatives, and 43500-43570 for aminohydroxy derivatives).



**Hazard Concerns.** There are oncogenicity concerns for the triarylmethane pigments/dyes based on analogy to Gentian Violet and C.I. Basic Red 9. In addition, there are developmental and reproductive toxicity concerns for these compounds based on analogy to Gentian Violet and Malachite Green. Ecotoxicity concerns are based on QSAR predictions for delocalized cationic dyes. Cationic dyes are an established ecotoxicity category.

**Boundaries.** Pigments/Dyes included in this category are the di- and tri-amino substituted triphenylmethane and diphenylnaphthyl-methane derivatives. Dyes substituted with solubilizing groups such as carboxylic acid, sulfonic acid, or halogens, are not included. Pigments that have essentially negligible water solubility (<1ppb) and therefore, little or no bioavailability, are also not included.

### **General Testing Strategy**

The New Chemicals Program considers the following tests to be appropriate to address the potential for triarylmethane pigments/dyes to pose a significant risk.

#### I. Health

- Developmental toxicity study in two species of rodents by the oral route (Harmonized Test Guideline 870.3700).
- Two-generation reproductive toxicity study in rodents by the oral route (Harmonized Test Guideline 870.3800).
- Salmonella typhimurium/Ames assay with the Chinese hamster liver S9 activation system (Harmonized Test Guideline 870.5100).
- In vivo mouse micronucleus assay i.p. (Harmonized Test Guideline 870.5395).

Tests 3. and 4. would trigger a lifetime rodent bioassay if positive.

#### II. Environmental Toxicity and Fate

Prior to Tier 1, first the following physical-chemical properties need to be established:

- Melting point (Harmonized Test Guideline 830.7200) or boiling point (Harmonized Test Guideline 830.7220)
- Water solubility (Harmonized Test Guideline 830.7840 or 830.7860)
- Log K<sub>ow</sub> (Harmonized Test Guideline 830.7550, 830.7560, or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method)
- Vapor pressure (Harmonized Test Guideline 830.7950).

Tier 1. The fish, daphnid, and algal (Harmonized Test Guideline 850.5400) acute toxicity tests from the aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method with measured concentrations, and effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations.



If there is no significant risk from the PMN after the results of the fish and daphnid acute toxicity tests have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 3; if  $t_{1/2} > 2$  days, then integrate the results into the risk assessment. If there is no significant risk from the PMN, then no further testing is recommended. However, if there remains a significant risk, then go to Tier 4.

Tier 3a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental risk. If there is no significant risk from the photolysis products from the PMN, then no further testing is recommended. However, if there remains a significant risk, then go to Tier 4.

Tier 3b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of PMN using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with most sensitive species from environmental base set. For example, if the most sensitive species from the environmental base set has an EC50 value = 2.0 mg/L (based on 100% active ingredients [AI]), then prepare a 5.0 mg PMN per liter stock solution based on 100% AI using the standard humic-containing solution. This stock solution is exposed to sunlight for at least 6 half-lives to ensure that all of the PMN has been photolyzed, and then this stock solution is used to retest the most sensitive aquatic species to determine if the photolysis products of the PMN are more or less toxic than the PMN. Integrate these toxicity results into the risk assessment. If there is no significant risk from the PMN, then no further testing is recommended. However, if there remains a significant risk, then go to Tier 4.

Tier 4. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability—CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

Integrate the results for aerobic biodegradability into the risk assessment. If there is no significant risk from the PMN, then no further testing is recommended. However, if there remains a significant risk, then do chronic toxicity testing for fish and daphnids:

Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; and statistical analysis of effective concentrations at days 7, 14, 21, and 28.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through

methods; measured concentrations; effective concentrations based on 100% active ingredients (AI) and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21.

For Terrestrial ecosystems-

The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, Harmonized Test Guideline 850.4230), the earthworm acute toxicity test (Harmonized Test Guideline 850.6200), and the soil microbial community bioassay (Test Guideline 850.5100) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Test Guideline 850.4150), the plant uptake test (Test Guideline 850.4800), and the soil microbial community bioassay (Test Guideline 850.5100).

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July, 1994; revised June 2010.

**Category: Vinyl Esters**

Human Health  
Environmental Toxicity  
(See "Esters")

**Definition:** A carboxylic acid ester with at least one vinyl group (CH<sub>2</sub>=CH-) attached to an organic acid radical (RCOO-). A simple vinyl ester is vinyl acetate:



Note: Certain carboxylic acid moieties themselves may exert toxicity such that there are concerns for effects **in addition** to those identified for the vinyl ester class.

**Hazard Concerns:** Oncogenicity based on data from two bioassays: a 2-yr drinking water study of vinyl acetate in rats [significantly increased incidences of adenocarcinomas of the uterus and combined C-cell adenomas and carcinomas in high-dose (2,500 mg/l) female rats] and a chronic inhalation study of vinyl acetate in rats and mice (laryngeal/nasal tumors in rats, bronchiolar/alveolar adenomas in lungs of mice). There are supporting data from 27-mo and 81-wk inhalation studies of acetaldehyde in rats and hamsters, respectively. Furthermore, mutagenicity data on these analogues support a cancer concern. Neurotoxicity based on data on an analogous PMN compound in rats plus suggestive data on vinyl acetate. Reproductive toxicity based on a two-generation study of vinyl acetate in rats. Environmental toxicity (see "Esters" category).

**Boundaries.** Other than a requirement for a vinyl group and an acid group, none.

**General Testing Strategy**

(1) Up-front glove permeation study if there is a risk of any toxicity through dermal exposure.

(2) Hydrolysis test (both acid- and enzyme-catalyzed) to determine the rate at which acetaldehyde, a potentially toxic metabolite, is released. [The requirement to measure acetaldehyde release is based on the assumption that acetaldehyde is the presumed "ultimate carcinogen" of vinyl esters. This requirement will be revisited as more decisive data become available. The hydrolysis data should be helpful in determining the most appropriate route of administration in the following tests.]

(3) A 90-day neurotoxicity test in rats that includes a functional observational battery, motor activity tests, and neuropathology examinations. Also to be included, to address reproductive toxicity concerns, are the following adjuncts to the subchronic test:

(a) Weights of the testes, epididymides (total and cauda), pituitary, seminal vesicles (with coagulating glands), prostate, ovary, and uterus are to be recorded at the time of sacrifice.

(b) Histopathology of the testes is to be done on the males at the time of sacrifice. Particular attention is to be directed toward achieving satisfactory quality from fixation and embedding, and preparations are to follow the recommendations of Russell et al. (1990). Histologic analyses are to include evaluations of the spermatogenic cycle; i.e., the presence and integrity of the 14 cell states. These evaluations would follow the guidance provided by Russell et al.

(4) A standard developmental toxicity study in rabbits and rats.

(5) A 2-yr bioassay in rats and mice to address cancer concerns.

(6) Environmental toxicity testing: see "Esters" category.

### **References.**

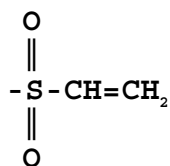
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August, 1992

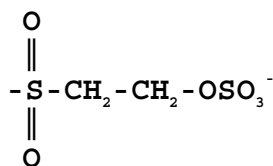
**Category:** Vinyl Sulfones

Human Health  
Environmental Toxicity

**Definition.** Any molecular structure with a vinyl sulfone group is considered to be a member of the class:



In addition the following is an example of a functional group that generates a vinyl sulfone under certain conditions.  $\beta$ -Sulfatoethyl-sulfonyl groups are typical vinyl sulfone precursors. Structures bearing this group are also members of the class:



Typically, the new chemical of concern is a fiber-reactive dye bearing one or more vinyl sulfones, or vinyl sulfone precursors. Occupational exposure to workers via inhalation/ingestion of the powdered dye may pose a potential health risk. Under the conditions in a dye bath a vinyl sulfone precursor-containing dye generates the vinyl sulfone. In this scenario the only potential risk is to those who drink contaminated drinking water. However, following covalent binding of vinyl sulfone to textile fibers, survival of unbound vinyl sulfone substituents in the dye bath is low (< 10%). The majority of unbound vinyl sulfone is hydrolyzed to  $\beta$ -hydroxyethylsulfone. Unless releases to water are extremely high, vinyl sulfones are not expected to pose a significant risk to human health. Presently, there are no human health concerns for  $\beta$ -hydroxyethylsulfone.

**Hazard Concerns.** For those who inhale or ingest a vinyl sulfone, there is an oncogenicity concern and mutagenicity concerns based on the potent mutagenicity of vinyl sulfone (VS) and methylvinyl sulfone (MVS). VS and MVS are mutagenic in the L5178Y TK<sup>+/−</sup> mouse lymphoma gene mutation assay in vitro. Evaluation of small colonies indicates that genotoxicity is due to a clastogenic mechanism. This is confirmed by evaluating the lymphoma cells for chromosome aberrations and micronuclei. MVS also induces effects upon the spindle apparatus in Chinese hamster lung cells in vitro, indicating an aneugenic (aneuploidy-inducing) activity. A direct-acting Michael addition-type reaction may be the mechanism of action. Although MVS and divinyl sulfone (DVS) are both reported as negative in vivo in the mouse micronucleus assay (inconclusive, only males tested), and in the dominant lethal assay, the Agency has determined that these negatives are not sufficient to remove concern for vinyl sulfone-containing new chemicals as potential mutagens and carcinogens.

There are ecotoxicity concerns for VS only, based on concerns for electrophiles.

**Boundaries.** There are at present no boundary conditions, related to health effects, for structures containing vinyl sulfones. Nearly all new chemicals in the category have been water-soluble, fiber-reactive dyes with molecular weights <1,000. The boundary conditions for ecotoxicity effects are molecular weights < 1000 and  $\log K_{ow} < 8$ .

### **General Testing Strategy**

The New Chemicals Program considers the following tests to be appropriate to address health and ecotoxicity concerns:

1. Mouse lymphoma assay with evaluation of small colonies (Harmonized Test Guideline 870.5300). The test would trigger a lifetime rodent bioassay if positive.
2. Base-set ecotoxicity testing to include fish (Harmonized Test Guideline 850.1075), daphnids (Harmonized Test Guideline 850.1010) and algae (Harmonized Test Guideline 850.5400). The acute toxicity tests for fish and daphnids will be done using the flow-through method with measured concentrations, and effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations. If there is insufficient knowledge about the water solubility of the dye, then it should also be measured (Harmonized Test Guideline 830.7840 or Harmonized Test Guideline 830.7860).

If there is no significant risk from the PMN after the results of the fish and daphnid acute toxicity and algal toxicity tests have been integrated into the risk assessment, then no further testing is recommended. However, if there is a significant risk, then do environmental fate testing as outlined in 3.

3. Environmental fate testing for releases to water:

Tier 1. Phototransformation of Chemicals in Water— Indirect Photolysis Screening Test (Harmonized Test Guideline 835.5270). If  $t_{1/2} \leq 2$  days, go to Tier 2; if  $t_{1/2} > 2$  days, go to Tier 3.

Tier 2a. If  $t_{1/2} \leq 2$  days and photolysis products are known and/or identified, then assess photolysis products for environmental hazards.

Tier 2b. If  $t_{1/2} \leq 2$  days and photolysis products are not known and/or identifiable, then prepare a stock solution of the PMN chemical using the standard humic-containing solution described in the photolysis test, expose to sunlight for at least 6 half-lives ( $t_{1/2}$ ), and test photolysis products for toxicity with the most sensitive species from the environmental base set.

Tier 3. Aerobic biodegradability according to either of the following test guidelines:

- Ready Biodegradability (six methods; choose any one) (Harmonized Test Guideline 835.3110)
- Ready Biodegradability–CO<sub>2</sub> in Sealed Vessels (Headspace Test) (Harmonized Test Guideline 835.3140)

In addition, if appropriate, physical/chemical properties including:

- Log K<sub>ow</sub> (Harmonized Test Guideline 830.7550, 830.7560, or 830.7570; or OECD 123, Partition Coefficient (1-Octanol/Water): Slow-Stirring Method)
- Vapor pressure (Harmonized Test Guideline 830.7950)
- Boiling point (Harmonized Test Guideline 830.7220)
- Melting point range (Harmonized Test Guideline 830.7200)

If the PMN chemical passes the aerobic biodegradability test according to the criteria set forth in the guidelines, no further testing may be recommended. A new risk assessment is conducted to determine if chronic ecotoxicity testing is warranted.

4. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with flow-through methods; measured concentrations; effective concentrations based on 100% AI and mean measured concentrations; and statistical analysis of effective concentrations at days 7, 14, 21, and 28.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with flow-through methods; measured concentrations; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21.

5. Ecotoxicity testing for release to terrestrial ecosystems.

The terrestrial base set of environmental toxicity tests (i.e., the early seeding growth test, Harmonized Test Guideline 850.4230), the earthworm acute toxicity test (Harmonized Test Guideline 850.6200), and the soil microbial community bioassay (Test Guideline 850.5100) will be recommended for terrestrial exposures. Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Test Guideline 850.4150), the plant uptake test (Test Guideline 850.4800), and the soil microbial community bioassay (Test Guideline 850.5100).

### References:

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September, 1988; revised June, 1994; revised June 2010

**Category: Soluble complexes of Zinc**

Environmental Toxicity

**Definition.** This category includes all organic and inorganic soluble complexes of zinc, for example, zincates, organozincs, such as, dimethylzinc. Not included in this category are zinc-complexed acid dyes and strong ion pairs between zinc and anionic surfactants. There are no toxicity data for soluble complexes of zinc, therefore, the toxicity data for the free  $Zn^{++}$  ion will be used to predict aquatic toxicity.

**Hazard Concerns.** Zinc produces acute toxicity to freshwater aquatic organisms over a range of concentrations from 90 to 58,100 ug/L and produces chronic toxicity over a range from 47 to 852 ug/L. The acute to chronic ratio (ACR) for Zn has been set at 3 in the water quality criteria (WQC) document. Zinc concentrations from 30 to 21,600 ug/L have been shown to reduce the growth of various aquatic plants and algae appear to be the most sensitive group. Bioconcentration factors (as logarithms) for freshwater fish ranged from 1.7 to 2.6, and from 2.0 to 3.1 for freshwater invertebrates. Zinc is an essential nutrient trace element which can be toxic at higher concentrations. While acute toxicity is affected by hardness, chronic toxicity is not affected. The freshwater criteria at an average hardness of 100 mg/L are 0.120 ug/L for acute exposures and 0.110 ug/L for chronic exposures; the saltwater criteria are 0.095 ug/L for acute exposures and 0.086 ug/L for chronic exposures. These criteria are based on toxicity information for the following Zn salts: sulfate, chloride, phosphate, and nitrate.

**General Testing Strategy**

To address ecotoxicity concerns, base set acute aquatic toxicity testing (algae: static method, daphnid and fish: flow-through method, all measured concentrations).

April, 1990

**Category: Zirconium Compounds**

Environmental Toxicity

**Definition.** This category includes inorganic salts of zirconium (Zr), complexes between Zr and organic acids, and organoZr compounds, i.e., Zr covalently-bonded with carbon. For example, some inorganic Zr salts include: Zr sulfate, Zr oxychloride, and Zr tetrachloride. Not included in this category are dyes complexed with Zr.

**Hazard Concerns.** Soluble salts of Zr are known to be moderately toxic to green algae and fish based on exposures in soft water and in terms of mg Zr/L. Toxicity information is only available for Zr sulfate, Zr tetrachloride, and Zr oxychloride. The toxicity profile for Zr based on available toxicity data, mg Zr/L (ppm Zr), and moderate hardness (i.e., 150.0 mg/L as CaCO<sub>3</sub>) is:

Fish 96-h LC50	=	58.0 (n=3)
Green algal 96-h EC50	=	2.6

Zirconium is more toxic in soft water than hard water. Acute toxicity to fish has been shown to increase 13 times as hardness decreases from 400.0 to 20 mg/L.

**Boundaries.** The toxicity of Zr compounds depends on their physical/chemical properties and the hardness of receiving waters. The toxicity of Zr salts and Zr complexes with organic acids are expected to be related to their water solubility and MW. The toxicity of organoZr compounds are also expected to be related to their octanol/water partition coefficient (Kow).

The most important property determining the toxicity of Zr compounds is water solubility. Water solubility cannot be estimated accurately and has to be measured. The water solubility of organoZr compounds is expected to decrease as Kow increases. There is no lower bound for Kow and the upper bound cannot be determined at this time since the Kow fragment-constant for Zr is not known. In addition to solubility, MW is also an important boundary. Compounds with MWs > 1000 are not expected to be absorbed by aquatic organisms even if they are water soluble. Therefore, only Zr compounds with MWs < 1000 are expected to be toxic.

**General Testing Strategy**

I. Release to Aquatic Ecosystems

Tier 1. The aquatic base set of environmental toxicity tests will be recommended for aquatic exposures. The acute toxicity tests for fish (Harmonized Test Guideline 850.1075) and daphnids (Harmonized Test Guideline 850.1010) will be done using the flow-through method; effective concentrations will be based on 100% active ingredients (AI) and mean measured concentrations; the total organic carbon (TOC) concentration of dilution water in the control must be less than 2.0 mg TOC/L; TOC must be measured in the control just prior to the start of the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can be used to assist the compound to reach its

aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>. If toxicity mitigation testing is done with humic acid, then the static method with nominal concentrations will be recommended.

The algal toxicity testing (Harmonized Test Guideline 850.5400), should be done with the static method; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at 24, 48, 72, and 96 hours; test medium with no more than 0.300 mg/L EDTA as a final concentration; the TOC of the test/growth medium should be less than 2.0 mg TOC/L; TOC should be measured just prior to the start of the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; and solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit. If toxicity mitigation testing is done with humic acid, then nominal concentrations will be recommended.

If there is no significant risk from the Zr compound after the results of the environmental base set have been integrated into the risk assessment, then no further testing will be recommended. However, if there is a significant risk, then go to Tier 2.

Tier 2. Fish chronic toxicity testing, i.e., fish early life stage (ELS) toxicity testing (Harmonized Test Guideline 850.1400), with the flow-through method; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, 21, and 28; the TOC of dilution water in the control should be less than 2.0 mg TOC/L; TOC should be measured in the controls just prior to and during the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>.

Daphnid chronic toxicity testing (Harmonized Test Guideline 850.1300), with the flow-through method; effective concentrations based on 100% AI and mean measured concentrations; statistical analysis of effective concentrations at days 7, 14, and 21; the TOC of dilution water in the control should not exceed 2.0 mg TOC/L; TOC must be measured in the controls just prior to and during the test; the highest treatment concentration on a nominal-basis should not exceed the aqueous solubility limit of the tested compound; solvent can be used to assist the compound to reach its aqueous solubility limit quicker, but cannot be used to artificially enhance the water solubility of the compound beyond its aqueous solubility limit; and hardness of dilution water has to be less than 180.0 mg/L as CaCO<sub>3</sub>.

II. Release to Terrestrial Ecosystems: The terrestrial base set of environmental toxicity tests will be recommended for terrestrial exposures. The terrestrial base set includes: the early seeding growth test (Harmonized Test Guideline 850.4230), the earthworm toxicity test (Harmonized Test Guideline 850.6200), the soil microbial community bioassay (Harmonized Test Guideline 850.5100), and the avian acute oral toxicity test (Harmonized Test Guideline 850.2100). Chronic toxicity testing for terrestrial organisms include: the plant whole life cycle test (Harmonized Test Guideline 850.4150), the plant uptake test (Harmonized Test Guideline

850.4800) and the avian reproduction test (Harmonized Test Guideline 850.2300).

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