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Short Review



RIFM fragrance ingredient safety assessment, 2,6,6-trimethylcyclohex-2-ene-1,4-dione, CAS Registry Number 1125-21-9

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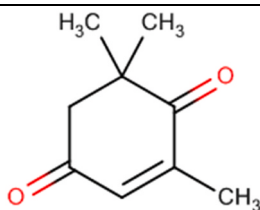
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**Abbreviation/Definition List:**

2-Box Model - A RIFM, Inc. proprietary *in silico* tool used to calculate fragrance air exposure concentration

AF - Assessment Factor

BCF - Bioconcentration Factor

Creme RIFM Model - The Creme RIFM Model uses probabilistic (Monte Carlo) simulations to allow full distributions of data sets, providing a more realistic estimate of aggregate exposure to individuals across a population (Comiskey et al., 2015, 2017; Safford et al., 2015a, 2017) compared to a deterministic aggregate approach

DEREK - Derek Nexus is an *in silico* tool used to identify structural alerts

DRF - Dose Range Finding

DST - Dermal Sensitization Threshold

ECHA - European Chemicals Agency

ECOSAR - Ecological Structure-Activity Relationships Predictive Model

EU - Europe/European Union

GLP - Good Laboratory Practice

IFRA - The International Fragrance Association

LOEL - Lowest Observable Effect Level

MOE - Margin of Exposure

MPPD - Multiple-Path Particle Dosimetry. An *in silico* model for inhaled vapors used to simulate fragrance lung deposition

NA - North America

NESIL - No Expected Sensitization Induction Level

NOAEC - No Observed Adverse Effect Concentration

NOAEL - No Observed Adverse Effect Level

NOEC - No Observed Effect Concentration

NOEL - No Observed Effect Level

OECD - Organisation for Economic Co-operation and Development

OECD TG - Organisation for Economic Co-operation and Development Testing Guidelines

PBT - Persistent, Bioaccumulative, and Toxic

PEC/PNEC - Predicted Environmental Concentration/Predicted No Effect Concentration

Perfumery - In this safety assessment, perfumery refers to fragrances made by a perfumer used in consumer products only. The exposures reported in the safety assessment include consumer product use, but do not include occupational exposures.

QRA - Quantitative Risk Assessment

QSAR - Quantitative Structure-Activity Relationship

REACH - Registration, Evaluation, Authorisation, and Restriction of Chemicals

RfD - Reference Dose

RIFM - Research Institute for Fragrance Materials

RQ - Risk Quotient

Statistically Significant - Statistically significant difference in reported results as compared to controls with a $p < 0.05$ using appropriate statistical test

TTC - Threshold of Toxicological Concern

UV/Vis spectra - Ultraviolet/Visible spectra

VCF - Volatile Compounds in Food

VoU - Volume of Use

vPvB - (very) Persistent, (very) Bioaccumulative

WoE - Weight of Evidence

The Expert Panel for Fragrance Safety* concludes that this material is safe as described in this safety assessment.

This safety assessment is based on the RIFM Criteria Document (Api, 2015), which should be referred to for clarifications.

Each endpoint discussed in this safety assessment includes the relevant data that were available at the time of writing (version number in the top box is indicative of the date of approval based on a 2-digit month/day/year), both in the RIFM Database (consisting of publicly available and proprietary data) and through publicly available information sources (e.g., SciFinder and PubMed). Studies selected for this safety assessment were based on appropriate test criteria, such as acceptable guidelines, sample size, study duration, route of exposure, relevant animal species, most relevant testing endpoints, etc. A key study for each endpoint was selected based on the most conservative endpoint value (e.g., PNEC, NOAEL, LOEL, and NESIL).

*The Expert Panel for Fragrance Safety is an independent body that selects its own members and establishes its own operating procedures. The Expert Panel is

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comprised of internationally known scientists that provide RIFM with guidance relevant to human health and environmental protection.

Summary: The existing information supports the use of this material as described in this safety assessment.

2,6,6-Trimethylcyclohex-2-ene-1,4-dione was evaluated for genotoxicity, repeated dose toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, skin sensitization, and environmental safety. Data show that 2,6,6-trimethylcyclohex-2-ene-1,4-dione is not genotoxic. The repeated dose, reproductive, and local respiratory toxicity endpoints were evaluated using the threshold of toxicological concern (TTC) for a Cramer Class II material, and the exposure to 2,6,6-trimethylcyclohex-2-ene-1,4-dione is below the TTC (0.009 mg/kg/day, 0.009 mg/kg/day, and 0.47 mg/day, respectively). The skin sensitization endpoint was completed using the dermal sensitization threshold (DST) for reactive materials (64 $\mu\text{g}/\text{cm}^2$); exposure is below the DST. The phototoxicity/photoallergenicity endpoints were evaluated based on ultraviolet (UV) spectra; 2,6,6-trimethylcyclohex-2-ene-1,4-dione is not expected to be phototoxic/photoallergenic. The environmental endpoints were evaluated; 2,6,6-trimethylcyclohex-2-ene-1,4-dione was found not to be persistent, bioaccumulative, and toxic (PBT) as per the International Fragrance Association (IFRA) Environmental Standards, and its risk quotients, based on its current volume of use in Europe and North America (i.e., Predicted Environmental Concentration/Predicted No Effect Concentration [PEC/PNEC]), are < 1 .

Human Health Safety Assessment

Genotoxicity: Not genotoxic. (RIFM, 2011a; RIFM, 2011b)

Repeated Dose Toxicity: No NOAEL was determined. Material was cleared using TTC.

Reproductive Toxicity: No NOAEL was determined. Material was cleared using TTC.

Skin Sensitization: No safety concerns at current, declared use levels; Exposure is below the DST.

Phototoxicity/Photoallergenicity: Not expected to be phototoxic/photoallergenic. (UV Spectra; RIFM Database)

Local Respiratory Toxicity: No NOAEC available. Exposure is below the TTC.

Environmental Safety Assessment**Hazard Assessment:**

Persistence: Screening-level: 95% (OECD 301A) (ECHA REACH Dossier: 2,6,6-Trimethylcyclohex-2-ene-1,4-dione; ECHA, 2016)

Bioaccumulation: Screening-level: 8.084 L/kg (EPI Suite v4.11; US EPA, 2012a)

Ecotoxicity: Screening-level: Fish LC50: 261.1 mg/L (RIFM Framework; Salvito, 2002)

Conclusion: Not PBT or vPvB as per IFRA Environmental Standards

Risk Assessment:

Screening-level: PEC/PNEC (North America and Europe) < 1 (RIFM Framework; Salvito, 2002)

Critical Ecotoxicity Endpoint: Fish LC50: 261.1 mg/L (RIFM Framework; Salvito, 2002)

RIFM PNEC is: 0.2611 $\mu\text{g}/\text{L}$

• **Revised PEC/PNECs (2015 IFRA VoU):** North America and Europe: Not applicable; cleared at screening-level

1. Identification

- 1. Chemical Name:** 2,6,6-Trimethylcyclohex-2-ene-1,4-dione
- 2. CAS Registry Number:** 1125-21-9
- 3. Synonyms:** 2-Cyclohexene-1,4-dione, 2,6,6-trimethyl-; 2,6,6-トリメチル-2-シクロヘキセン-1,4-ジオン; 2,6,6-トリメチルシクロヘキサン-2-エン-1,4-ジオン; 2,6,6-Trime-thylcyclohex-2-ene-1,4-dione
- 4. Molecular Formula:** $\text{C}_9\text{H}_{12}\text{O}_2$
- 5. Molecular Weight:** 152.19
- 6. RIFM Number:** 6180

7. **Stereochemistry:** No stereocenter present and no stereoisomer possible.

2. Physical data

1. **Boiling Point:** 253.82 °C (EPI Suite)
2. **Flash Point:** Not Available
3. **Log K_{ow}:** 1.88 (EPI Suite)
4. **Melting Point:** 56.04 °C (EPI Suite)
5. **Water Solubility:** 1839 mg/L (EPI Suite)
6. **Specific Gravity:** Not Available
7. **Vapor Pressure:** 0.0107 mm Hg at 20 °C (EPI Suite v4.0), 0.1 mm Hg at 20 °C (Fragrance Materials Association), 0.0185 mm Hg at 25 °C (EPI Suite)
8. **UV Spectra:** Minor absorbance between 290 and 700 nm; molar absorption coefficient is below the benchmark (1000 L mol⁻¹ · cm⁻¹)
9. **Appearance/Organoleptic:** Not Available

3. Volume of use (worldwide band)

1. 1–10 metric tons per year (IFRA, 2015)

4. Exposure to fragrance ingredient (Creme RIFM Aggregate Exposure Model v1.0)

1. 95th Percentile Concentration in Hydroalcohols:	0.000078%	RIFM, (2017)
2. Inhalation Exposure*:	0.0000045 mg/kg/day or 0.00031 mg/day	RIFM, (2017)
3. Total Systemic Exposure**:	0.00012 mg/kg/day	RIFM, (2017)

*95th percentile calculated exposure derived from concentration survey data in the Creme RIFM Aggregate Exposure Model (Comiskey, 2015, 2017; Safford, 2015a, 2017).

**95th percentile calculated exposure; assumes 100% absorption unless modified by dermal absorption data as reported in Section V. It is derived from concentration survey data in the Creme RIFM Aggregate Exposure Model and includes exposure via dermal, oral, and inhalation routes whenever the fragrance ingredient is used in products that include these routes of exposure (Comiskey, 2015, 2017; Safford, 2015a, 2017).

5. Derivation of systemic absorption

1. **Dermal:** Assumed 100%
2. **Oral:** Assumed 100%
3. **Inhalation:** Assumed 100%

6. Computational toxicology evaluation

1. Cramer Classification: Class II, Intermediate

Expert Judgment	Toxtree v2.6	OECD QSAR Toolbox v3.2
II	II	II

2. Analogs Selected:
 - a. **Genotoxicity:** None
 - b. **Repeated Dose Toxicity:** None
 - c. **Reproductive Toxicity:** None
 - d. **Skin Sensitization:** None
 - e. **Phototoxicity/Photoallergenicity:** None
 - f. **Local Respiratory Toxicity:** None
 - g. **Environmental Toxicity:** None
3. **Read-across Justification:** None

7. Metabolism

No relevant data available for inclusion in this safety assessment.

Additional References: None.

8. Natural occurrence (discrete chemical) or composition (NCS)

2,6,6-Trimethylcyclohex-2-ene-1,4-dione is reported to occur in the following foods by the VCF*:

Buckwheat	Rooibos tea (<i>Aspalathus linearis</i>)
Citrus fruits	Saffron (<i>Crocus sativus</i> L.)
Honey	Shrimps (prawn)
Maize (<i>Zea mays</i> L.)	Tea
Rice (<i>Oryza sativa</i> L.)	Wine

*VCF (Volatile Compounds in Food): Database/Nijssen, L.M.; Ingen-Visscher, C.A. van; Donders, J.J.H. (eds). – Version 15.1 – Zeist (The Netherlands): TNO Triskelion, 1963–2014. A continually updated database containing information on published volatile compounds that have been found in natural (processed) food products. Includes FEMA GRAS and EU-Flavis data.

9. REACH dossier

Two available; accessed 10/27/20 (ECHA, 2012b; ECHA, 2016).

10. Conclusion

The existing information supports the use of this material as described in this safety assessment.

11. Summary

11.1. Human health endpoint summaries

11.1.1. Genotoxicity

Based on the current existing data, 2,6,6-trimethylcyclohex-2-ene-1,4-dione does not present a concern for genotoxicity.

11.1.1.1. Risk assessment. 2,6,6-Trimethylcyclohex-2-ene-1,4-dione was assessed in the BlueScreen assay and found negative for both cytotoxicity (positive: <80% relative cell density) and genotoxicity, with and without metabolic activation (RIFM, 2013). BlueScreen is a human cell-based assay for measuring the genotoxicity and cytotoxicity of chemical compounds and mixtures. Additional assays were considered to fully assess the potential mutagenic or clastogenic effects of the target material.

The mutagenic activity of 2,6,6-trimethylcyclohex-2-ene-1,4-dione (purity: 99%) has been evaluated in a bacterial reverse mutation assay conducted in compliance with GLP regulations and in accordance with OECD TG 471 using the standard plate incorporation and preincubation methods. *Salmonella typhimurium* strains TA98, TA100, TA1535, TA1537, and TA102 were treated with 2,6,6-trimethylcyclohex-2-ene-1,4-dione in dimethyl sulfoxide (DMSO) at concentrations up to 5000 µg/plate. No increases in the mean number of revertant colonies were observed at any tested concentration in the presence or absence of S9 (RIFM, 2011a). Under the conditions of the study, 2,6,6-trimethylcyclohex-2-ene-1,4-dione was not mutagenic in the Ames test.

The clastogenic activity of 2,6,6-trimethylcyclohex-2-ene-1,4-dione (purity: 99%) was evaluated in an *in vitro* micronucleus test conducted in compliance with GLP regulations and in accordance with OECD TG 487. Human peripheral blood lymphocytes were treated with 2,6,6-trimethylcyclohex-2-ene-1,4-dione in DMSO at concentrations up to 1522 µg/mL in the DRF study, and micronuclei analysis was conducted up to 1522 µg/mL in the presence and absence of S9 for 3 h and the absence of S9 for 24 h. 2,6,6-Trimethylcyclohex-2-ene-1,4-dione did not induce binucleated cells with micronuclei when tested up to cytotoxic levels in the 24-hour treatment without S9 and up to the maximum concentration in 3-hour treatment with and without an S9 activation system (RIFM, 2011b). Under the conditions of the study, 2,6,

6-trimethylcyclohex-2-ene-1,4-dione was considered to be non-clastogenic in the *in vitro* micronucleus test.

Based on the data available, 2,6,6-trimethylcyclohex-2-ene-1,4-dione does not present a concern for genotoxic potential.

Additional References: None.

Literature Search and Risk Assessment Completed On: 01/02/20.

11.1.2. Repeated dose toxicity

There are insufficient repeated dose toxicity data on 2,6,6-trimethylcyclohex-2-ene-1,4-dione or any read-across materials. The total systemic exposure to 2,6,6-trimethylcyclohex-2-ene-1,4-dione is below the TTC for the repeated dose toxicity endpoint of a Cramer Class II material at the current level of use.

11.1.2.1. Risk assessment. There are no repeated dose toxicity data on 2,6,6-trimethylcyclohex-2-ene-1,4-dione or any read-across materials that can be used to support the repeated dose toxicity endpoint. The total systemic exposure to 2,6,6-trimethylcyclohex-2-ene-1,4-dione (0.12 µg/kg/day) is below the TTC for the repeated dose toxicity endpoint of a Cramer Class II material (9 µg/kg/day; Kroes, 2007) at the current level of use.

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/07/19.

11.1.3. Reproductive toxicity

There are insufficient reproductive toxicity data on 2,6,6-trimethylcyclohex-2-ene-1,4-dione or any read-across materials. The total systemic exposure to 2,6,6-trimethylcyclohex-2-ene-1,4-dione is below the TTC for the reproductive toxicity endpoint of a Cramer Class II material at the current level of use.

11.1.3.1. Risk assessment. There are no reproductive toxicity data on 2,6,6-trimethylcyclohex-2-ene-1,4-dione or any read-across materials that can be used to support the reproductive toxicity endpoint. The total systemic exposure to 2,6,6-trimethylcyclohex-2-ene-1,4-dione (0.12 µg/kg/day) is below the TTC for the reproductive toxicity endpoint of a Cramer Class II material (9 µg/kg/day; Kroes, 2007; Laufersweiler, 2012) at the current level of use.

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/11/19.

11.1.4. Skin sensitization

Based on existing data, 2,6,6-trimethylcyclohex-2-ene-1,4-dione is a sensitizer. However, the existing data is insufficient to define a No Expected Sensitization Induction Level (NESIL). Therefore, the DST for reactive materials was applied and 2,6,6-trimethylcyclohex-2-ene-1,4-dione does not present a concern for skin sensitization under the current, declared levels of use.

11.1.4.1. Risk assessment. The chemical structure of this material indicates that it would be expected to react with skin proteins (Roberts, 2007; Toxtree v3.1.0; OECD Toolbox v4.2). In a guinea pig maximization test, 2,6,6-trimethylcyclohex-2-ene-1,4-dione (purity: 98.8%) had shown positive skin sensitization reactions at 25% (ECHA, 2012b). While the reactions in the guinea pig maximization test demonstrate that 2,6,6-trimethylcyclohex-2-ene-1,4-dione is a sensitizer, insufficient data are available to define a NESIL. Acting conservatively due to the limited data, the reported exposure was benchmarked utilizing the reactive DST of 64 µg/cm² (Safford, 2008, 2011, 2015b; Roberts, 2015). The current exposure from the 95th percentile concentration is below the DST for reactive materials when evaluated in all QRA categories. Table 1 provides the maximum acceptable concentrations for 2,6,

Table 1

Maximum acceptable concentrations for 2,6,6-trimethylcyclohex-2-ene-1,4-dione that present no appreciable risk for skin sensitization based on reactive DST.

IFRA Category ^a	Description of Product Type	Maximum Acceptable Concentrations in Finished Products Based on Reactive DST	Reported 95th Percentile Use Concentrations in Finished Products
1	Products applied to the lips	0.0049%	$9.5 \times 10^{-4}\%$
2	Products applied to the axillae	0.0015%	$3.4 \times 10^{-5}\%$
3	Products applied to the face using fingertips	0.029%	$3 \times 10^{-4}\%$
4	Fine fragrance products	0.027%	$4.1 \times 10^{-4}\%$
5	Products applied to the face and body using the hands (palms), primarily leave-on	0.0070%	$5.1 \times 10^{-6}\%$
6	Products with oral and lip exposure	0.016%	0.01%
7	Products applied to the hair with some hand contact	0.056%	$1.9 \times 10^{-5}\%$
8	Products with significant anogenital exposure	0.0029%	No Data ^c
9	Products with body and hand exposure, primarily rinse-off	0.054%	$8.1 \times 10^{-4}\%$
10	Household care products with mostly hand contact	0.19%	0.0033%
11	Products with intended skin contact but minimal transfer of fragrance to skin from inert substrate	0.11%	No Data ^c
12	Products not intended for direct skin contact, minimal or insignificant transfer to skin	Not restricted	0.024%

Note.

^b No reported use.

^a For a description of the categories, refer to the IFRA/RIFM Information Booklet.

^c Fragrance exposure from these products is very low. These products are not currently in the Creme RIFM Aggregate Exposure Model.

6-trimethylcyclohex-2-ene-1,4-dione that present no appreciable risk for skin sensitization based on the reactive DST. These levels represent maximum acceptable concentrations based on the DST approach. However, additional studies may show it could be used at higher levels.

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/13/19.

11.1.5. Phototoxicity/photoallergenicity

Based on the available UV/Vis spectra, 2,6,6-trimethylcyclohex-2-ene-1,4-dione would not be expected to present a concern for phototoxicity or photoallergenicity.

11.1.5.1. Risk assessment. There are no phototoxicity studies available for 2,6,6-trimethylcyclohex-2-ene-1,4-dione in experimental models. UV/Vis absorption spectra indicate minor absorption between 290 and 700 nm. The corresponding molar absorption coefficient is well below

the benchmark of concern for phototoxicity and photoallergenicity (Henry, 2009). Based on the lack of absorbance, 2,6,6-trimethylcyclohex-2-ene-1,4-dione does not present a concern for phototoxicity or photoallergenicity.

11.1.5.2. UV spectra analysis. UV/Vis absorption spectra (OECD TG 101) were obtained. The spectra indicate minor absorbance in the range of 290–700 nm. The molar absorption coefficient is below the benchmark of concern for phototoxic effects, 1000 L mol⁻¹ · cm⁻¹ (Henry, 2009).

Additional References: None.

Literature Search and Risk Assessment Completed On: 11/22/19.

11.1.6. Local respiratory toxicity

The MOE could not be calculated due to a lack of appropriate data. The exposure level for 2,6,6-trimethylcyclohex-2-ene-1,4-dione is below the Cramer Class III* TTC value for inhalation exposure local effects.

11.1.6.1. Risk assessment. There are no inhalation data available on 2,6,6-Trimethylcyclohex-2-ene-1,4-dione. Based on the Creme RIFM Model, the inhalation exposure is 0.00031 mg/day. This exposure is 1516 times lower than the Cramer Class III* TTC value of 0.47 mg/day (based on human lung weight of 650 g; Carthew, 2009); therefore, the exposure at the current level of use is deemed safe.

*As per Carthew et al. (2009), Cramer Class II materials default to Cramer Class III for the local respiratory toxicity endpoint.

Additional References: None.

Literature Search and Risk Assessment Completed On: 12/13/19.

11.2. Environmental endpoint summary

11.2.1. Screening-level assessment

A screening-level risk assessment of 2,6,6-trimethylcyclohex-2-ene-1,4-dione was performed following the RIFM Environmental Framework (Salvito, 2002), which provides 3 tiered levels of screening for aquatic risk. In Tier 1, only the material's regional VoU, its log K_{OW}, and its molecular weight are needed to estimate a conservative risk quotient (RQ), expressed as the ratio Predicted Environmental Concentration/Predicted No Effect Concentration (PEC/PNEC). A general QSAR with a high uncertainty factor applied is used to predict fish toxicity, as discussed in Salvito et al. (2002). In Tier 2, the RQ is refined by applying a lower uncertainty factor to the PNEC using the ECOSAR model (US EPA, 2012b), which provides chemical class-specific ecotoxicity estimates. Finally, if necessary, Tier 3 is conducted using measured biodegradation and ecotoxicity data to refine the RQ, thus allowing for lower PNEC uncertainty factors. The data for calculating the PEC and PNEC for this safety assessment are provided in the table below. For the PEC, the range from the most recent IFRA Volume of Use Survey is reviewed. The PEC is then calculated using the actual regional tonnage, not the extremes of

the range. Following the RIFM Environmental Framework, 2,6,6-trimethylcyclohex-2-ene-1,4-dione was identified as a fragrance material with no potential to present a possible risk to the aquatic environment (i.e., its screening-level PEC/PNEC <1).

A screening-level hazard assessment using EPI Suite v4.11 (US EPA, 2012a) identified 2,6,6-trimethylcyclohex-2-ene-1,4-dione as possibly persistent but not bioaccumulative based on its structure and physical-chemical properties. This screening-level hazard assessment considers the potential for a material to be persistent *and* bioaccumulative *and* toxic, or very persistent *and* very bioaccumulative as defined in the Criteria Document (Api, 2015). As noted in the Criteria Document, the screening criteria applied are the same as those used in the EU for REACH (ECHA, 2012a). For persistence, if the EPI Suite model BIOWIN 3 predicts a value < 2.2 and either BIOWIN 2 or BIOWIN 6 predicts a value < 0.5, then the material is considered potentially persistent. A material would be considered potentially bioaccumulative if the EPI Suite model BCFBAF predicts a fish BCF ≥2000 L/kg. Ecotoxicity is determined in the above screening-level risk assessment. If, based on these model outputs (Step 1), additional assessment is required, a WoE-based review is then performed (Step 2). This review considers available data on the material's physical-chemical properties, environmental fate (e.g., OECD Guideline biodegradation studies or die-away studies), fish bioaccumulation, and higher-tier model outputs (e.g., US EPA's BIOWIN and BCFBAF found in EPI Suite v4.11).

11.2.2. Risk assessment

Based on the current Volume of Use (2015), 2,6,6-trimethylcyclohex-2-ene-1,4-dione presents no risk to the aquatic compartment in the screening-level assessment.

11.2.3. Key studies

11.2.3.1. Biodegradation. No data available.

11.2.4. Ecotoxicity

No data available.

11.3. Other available data

2,6,6-Trimethylcyclohex-2-ene-1,4-dione has been registered for REACH with the following additional data available at this time (ECHA, 2012b):

The ready biodegradability of the test material (purity: >98%) was evaluated using the DOC die-away test according to the OECD 301A guideline. Biodegradation of 95% after 18 days.

The acute fish (*Danio rerio*) toxicity test was conducted using the test material (purity: 98.87%) according to the OECD 203 guidelines under static conditions. The 96-hour LC50 value based on the nominal test concentration was reported to be 315.85 mg/L.

	LC50 (Fish) (mg/L)	EC50 (<i>Daphnia</i>) (mg/L)	EC50 (Algae) (mg/L)	AF	PNEC (µg/L)	Chemical Class
RIFM Framework Screening-level (Tier 1)	<u>261.1</u>			1000000	0.2611	

11.4. Risk assessment refinement

Ecotoxicological data and PNEC derivation (all endpoints reported in mg/L; PNECs in µg/L).

Endpoints used to calculate PNEC are underlined>.

Exposure information and PEC calculation (following RIFM Environmental Framework; [Salvito, 2002](#)).

Exposure	Europe (EU)	North America (NA)
Log K _{OW} Used	1.88	1.88
Biodegradation Factor Used	0	0
Dilution Factor	3	3
Regional Volume of Use Tonnage Band	<1	<1
Risk Characterization: PEC/PNEC	<1	<1

Based on available data, the RQ for this material is < 1. No further assessment is necessary.

The RIFM PNEC is 0.2611 µg/L. The revised PEC/PNECs for EU and NA are not applicable. The material was cleared at the screening-level; therefore, it does not present a risk to the aquatic environment at the current reported volumes of use.

Literature Search and Risk Assessment Completed On: 11/20/19.

12. Literature Search*

- **RIFM Database:** Target, Fragrance Structure-Activity Group materials, other references, JECFA, CIR, SIDS
- **ECHA:** <https://echa.europa.eu/>
- **NTP:** <https://ntp.niehs.nih.gov/>
- **OECD Toolbox:** <https://www.oecd.org/chemicalsafety/risk-assessment/oecd-qsar-toolbox.htm>
- **SciFinder:** <https://scifinder.cas.org/scifinder/view/scifinder/scifinderExplore.jsf>
- **PubMed:** <https://www.ncbi.nlm.nih.gov/pubmed>
- **National Library of Medicine's Toxicology Information Services:** <https://toxnet.nlm.nih.gov/>
- **IARC:** <https://monographs.iarc.fr>
- **OECD SIDS:** <https://hvpchemicals.oecd.org/ui/Default.aspx>
- **EPA ACToR:** <https://actor.epa.gov/actor/home.xhtml>
- **US EPA HPVIS:** https://ofmpub.epa.gov/opthpv/public_search_publicdetails?submission_id=24959241&ShowComments=Yes&sqlstr=null&recordcount=0&User_title=DetailQuery%20Results&EndPointRpt=Y#submission
- **Japanese NITE:** https://www.nite.go.jp/en/chem/chrip/chrip_search/systemTop
- **Japan Existing Chemical Data Base (JECDB):** http://dra4.nihs.go.jp/mhlw_data/jsp/SearchPageENG.jsp
- **Google:** <https://www.google.com>
- **ChemIDplus:** <https://chem.nlm.nih.gov/chemidplus/>

Search keywords: CAS number and/or material names.

*Information sources outside of RIFM's database are noted as appropriate in the safety assessment. This is not an exhaustive list. The links listed above were active as of 09/22/20.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. RIFM staff are employees of the Research Institute for Fragrance Materials, Inc. (RIFM). The Expert Panel receives

a small honorarium for time spent reviewing the subject work.

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