Short review

RIFM fragrance ingredient safety assessment, oxacyclohexadecane-2,13-dione, CAS Registry Number 38223-29-9


Research Institute for Fragrance Materials, Inc., 50 Tice Boulevard, Woodcliff Lake, NJ 07677 USA
Columbia University Medical Center, Department of Dermatology, 161 Fort Washington Ave., New York, NY 10032, USA
Malmo University Hospital, Department of Occupational & Environmental Dermatology, Sodra Forstadsgatan 101, Entrance 47, Malmo SE-20502, Sweden
School of Natural Resources & Environment, University of Michigan, Dana Building G110, 440 Church St., Ann Arbor, MI 58109, USA
Fraunhofer Institute for Toxicology and Experimental Medicine, Nikolai-Fuchs-Straße 1, 30625 Hannover, Germany
University of Sao Paulo, School of Veterinary Medicine and Animal Science, Department of Pathology, Av. Prof. dr. Orlando Marques de Paiva, 87, Sao Paulo, CEP 05508-900, Brazil
University of Wuerzburg, Department of Toxicology, Versbacher Str. 9, 97078 Wuerzburg, Germany
Oregon Health Science University, 3181 SW Sam Jackson Park Rd., Portland, OR 97239 USA
Vanderbilt University School of Medicine, Department of Biochemistry, Center in Molecular Toxicology, 638 Robinson Research Building, 2200 Pierce Avenue, Nashville, TN 37223-0146, USA
University of Pennsylvania, Perelman School of Medicine, Center of Excellence in Environmental Toxicology, 1316 Biomedical Research Building (BBB) II/III, 421 Curie Boulevard, Philadelphia, PA 19104-3083, USA
The University of Tennessee, College of Veterinary Medicine, Department of Comparative Medicine, 2407 River Dr., Knoxville, TN 37996- 4500, USA
Department of Pharmacology, University of Arizona, College of Medicine, 1501 North Campbell Avenue, P.O. Box 245050, Tucson, AZ 85724-5050, USA
Department of Dermatology, Hamamatsu University School of Medicine, 1-20-1 Higashiyama, Higashi-ku, Hamamatsu 431-3192, Japan

Version: 091917. This version replaces any previous versions.
Name: Oxacyclohexadecane-2,13-dione
CAS Registry Number: 38223-29-9

Abbreviation 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; Safford et al., 2015; Safford et al., 2017) compared to a deterministic aggregate approach.
DEREK - Derek nexus is an in silico tool used to identify structural alerts
The Expert Panel for Fragrance Safety* concludes that this material is safe under the limits described in this safety assessment. This safety assessment is based on the RIFM Criteria Document (Api et al., 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 two-digit month/day/year), both in the RIFM database (consisting of publicly available and proprietary data) and through publicly available information sources (i.e., 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 comprised of internationally known scientists that provide RIFM guidance relevant to human health and environmental protection.

**Summary: The use of this material under current conditions is supported by existing information.**

The material (oxacyclohexadecane-2,13-dione) was evaluated for genotoxicity, repeated dose toxicity, developmental toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, skin sensitization, as well as environmental safety. Data show that oxacyclohexadecane-2,13-dione is not genotoxic nor does it have skin sensitization potential. Data provided a MOE > 100 for the repeated dose toxicity endpoint. The developmental, reproductive and local respiratory toxicity endpoints were completed using the TTC (Threshold of Toxicological Concern) for a Cramer Class III material (0.0015 mg/kg/day, 0.0015 mg/kg/day and 0.47 mg/kg/day, respectively). The phototoxicity/photoallergenicity endpoint was completed based on UV spectra along with data on oxacyclohexadecane-2,13-dione. The environmental endpoints were evaluated, oxacyclohexadecane-2,13-dione was found not to be PBT as per the IFRA Environmental Standards and its risk quotients, based on its current volume of use in Europe and North America (i.e., PEC/PNEC) are < 1.

### Human Health Safety Assessment

**Genotoxicity:** Not genotoxic. (RIFM, 1985; RIFM, 1983c; RIFM, 1989)

**Repeated Dose Toxicity**

NOAEL = 333 mg/kg/day.

**Developmental and Reproductive Toxicity:** No NOAEL available. Exposure is below the TTC.

**Skin Sensitization:** Not sensitizing.

**Phototoxicity/Photoallergenicity:** Not phototoxic/photoallergenic.

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

### Environmental Safety Assessment

**Hazard Assessment:**

**Persistence:** Critical Measured Value: 83% (OECD 301B)

**Bioaccumulation:** Critical Measured Value: BCF: 1335–2639 μg/L (OECD 305E)

**Ecotoxicity:** Screening Level: Fish LC50: 5.11 mg/L

**Conclusion:** Not PBT or vPvB as per IFRA Environmental Standards

**Risk Assessment:**

**Screening-Level:** PEC/PNEC (North America and Europe) < 1

**Critical Ecotoxicity Endpoint:** Fish LC50: 5.11 mg/L

**RIFM PNEC** is: 0.00511 μg/L

*Revised PEC/PNECs (2011 IFRA Volume of Use): North America and Europe: Not applicable; cleared at screening level
1. **Identification**

1. Chemical Name: Oxacyclohexadecane-2,13-dione
2. CAS Registry Number: 38223-29-9
3. Synonyms: 12-Ketapentadecanolide; 12-Oxo-15-pentadecanolide; 12-Oxopentadecanolide; 12-Ketapentadecanolide 1; CPD-Keton; Cetolide; Oxacyclohexadecane-2,13-dione
4. Molecular Formula: $C_{15}H_{26}O_3$
5. Molecular Weight: 254.37
6. RIFM Number: 6397

2. **Physical data**

1. Boiling Point: 397.2 °C [US EPA, 2012a], not determined up to 573 K (300 °C) [RIFM, 1990g]
2. Flash Point: 187 °C (Pensky-Martens Closed) [RIFM, 1990f]
4. Melting Point: 89.31 °C [US EPA, 2012a], 303 K (30 °C) to 305 K (32 °C) [RIFM, 1990h]
6. Specific Gravity: Not Available
7. Vapor Pressure: 0.0000011 mm Hg @ 20 °C [US EPA, 2012a], 2.34e-006 mm Hg @ 25 °C [US EPA, 2012a]
8. UV Spectra: Minor absorbance between 290 and 700 nm; molar absorption coefficient below the benchmark (1000 L mol$^{-1}$ cm$^{-1}$)


3. **Exposure**

1. Volume of Use (Worldwide Band): 0.1–1 metric tons per year (IFRA, 2011)
2. 95th Percentile Concentration in Hydroalcohols: 0.15% (RIFM, 2014)
3. Inhalation Exposure*: 0.00011 mg/kg/day or 0.0088 mg/day (RIFM, 2014)
4. Total Systemic Exposure**: 0.0014 mg/kg/day (RIFM, 2014)

*95th percentile calculated exposure derived from concentration survey data in the Creme RIFM aggregate exposure model (Comiskey et al., 2015; Safford et al., 2015, 2017; Comiskey et al., 2017).
**95th percentile calculated exposure; assumes 100% absorption unless modified by dermal absorption data as reported in Section 4. 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 et al., 2015; Safford et al., 2015, 2017; Comiskey et al., 2017).

4. **Derivation of systemic absorption**

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

5. **Computational toxicology evaluation**

1. Cramer Classification: Class III, High

<table>
<thead>
<tr>
<th>Expert Judgment</th>
<th>Toxtree v 2.6</th>
<th>OECD QSAR Toolbox v 3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>III</td>
<td>III</td>
</tr>
</tbody>
</table>

2. Analogs Selected:
   a. Genotoxicity: None
   b. Repeated Dose Toxicity: None
   c. Developmental and 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

6. **Metabolism**

No relevant data available for inclusion in this safety assessment.

7. **Natural occurrence (discrete chemical) or Composition (NCS)**

Oxacyclohexadecane-2,13-dione is not reported to occur in food by the VCF.*


8. **IFRA standard**

None.

9. **REACH dossier**

Not pre-registered as of 09/18/2017.

10. **Summary**

10.1. **Human health endpoint summaries**

10.1.1. **Genotoxicity**

Based on current existing data, oxacyclohexadecane-2,13-dione does not present a concern for genotoxicity.

10.1.1.1. **Risk assessment.** The mutagenic activity of oxacyclohexadecane-2,13-dione has been evaluated in a bacterial reverse mutation assay conducted in compliance with GLP regulations and in accordance with guidelines similar to OECD TG 471. *Salmonella typhimurium* strains TA98, TA100, TA1535 and TA1537 were treated with oxacyclohexadecane-2,13-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 dose tested in the presence or absence of S9 (RIFM,
1985). In another study, oxacyclohexadecane-2,13-dione in ethanol was tested on Salmonella typhimurium strains TA98, TA100, TA1535, TA1537 and TA1538 at concentrations up to 1000 μg/plate. No increases in the mean number of revertant colonies were observed at any dose tested in the presence or absence of S9 (RIFM, 1983c). Under the conditions of the study, oxacyclohexadecane-2,13-dione was not mutagenic in the Ames test.

The clastogenic and aneugenic potential of oxacyclohexadecane-2,13-dione was evaluated in the bone marrow of NMRI mice in vivo using OECD 474/GLP. The test material was administered in polyethylene glycol via oral gavage, to groups of male and female NMRI mice. A dose of 5000 mg/kg was administered. Mice from each dose level were euthanized at 24, 48 and 72 h, the bone marrow was extracted and examined for polychromatic erythrocytes. The test material did not induce a significant increase in the incidence of micronucleated polychromatic erythrocytes in the bone marrow (RIFM, 1989). Under the conditions of this study, oxacyclohexadecane-2,13-dione was not considered to be clastogenic.

Based on the data available, oxacyclohexadecane-2,13-dione does not present a concern for genotoxicity.

**Additional References:** None.

**Literature Search and Risk Assessment Completed on:** 03/15/2017.

10.1.2. **Repeated dose toxicity**

The margin of exposure for oxacyclohexadecane-2,13-dione is adequate for the repeated dose toxicity endpoint at the current level of use.

10.1.2.1. **Risk assessment.** There are sufficient repeated dose toxicity data on oxacyclohexadecane-2,13-dione for the repeated dose toxicity endpoint. In an OECD/GLP 407 gavage 28-day toxicity study, groups of 5 SPF-bred Sprague-Dawley rats/sex/dose were administered via gavage test material, oxacyclohexadecane-2,13-dione, at doses of 0, 50, 200 or 1000 mg/kg/day in a 1% methyl cellulose vehicle for 28 days. No differences of toxicological significance were observed in clinical signs, body weight, food consumption, macroscopic appearance or liver weights between the treatment groups. The NOAEL was considered to be 1000 mg/kg/day, the highest dose tested (RIFM, 1999b).

A default safety factor of 3 was used when deriving a NOAEL from a 28-day 407 study. The safety factor has been approved by the Expert Panel for Fragrance Safety*.

Thus, the derived NOAEL for the repeated dose toxicity data is 1000/3 or 333 mg/kg/day.

Therefore, the oxacyclohexadecane-2,13-dione MOE for the repeated dose toxicity endpoint can be calculated by dividing the oxacyclohexadecane-2,13-dione NOAEL in mg/kg/day by the total systemic exposure to oxacyclohexadecane-2,13-dione, 333/0.0014 or 237,857.

In addition, the total systemic exposure to oxacyclohexadecane-2,13-dione (1.4 μg/kg/day) is below the TTC (1.5 μg/kg bw/day; Kroes et al., 2007) for the repeated dose toxicity endpoint of a Cramer Class III material at the current level of use.

*The Expert Panel for Fragrance Safety is composed of scientific and technical experts in their respective fields. This group provides advice and guidance.

**Additional References:** None.

**Literature Search and Risk Assessment Completed on:** 03/14/2017.

10.1.3. **Developmental and reproductive toxicity**

There are insufficient developmental and reproductive toxicity data on oxacyclohexadecane-2,13-dione or any read across materials. The total systemic exposure to oxacyclohexadecane-2,13-dione is below the TTC for the developmental and reproductive toxicity endpoints of a Cramer Class III material at the current level of use.

10.1.3.1. **Risk assessment.** There are no developmental toxicity data on oxacyclohexadecane-2,13-dione or any read across materials that can be used to support the developmental toxicity endpoint. The total systemic exposure to oxacyclohexadecane-2,13-dione (1.4 μg/kg/day) is below the TTC (1.5 μg/kg bw/day; Kroes et al., 2007; Laufersweiler et al., 2012) for the developmental toxicity endpoint of a Cramer Class III material at the current level of use.

There are no reproductive toxicity data on oxacyclohexadecane-2,13-dione or any read across materials that can be used to support the reproductive toxicity endpoint. The total systemic exposure to oxacyclohexadecane-2,13-dione (1.4 μg/kg/day) is below the TTC (1.5 μg/kg bw/day; Kroes et al., 2007; Laufersweiler et al., 2012) for the reproductive toxicity endpoint of a Cramer Class III material at the current level of use.

**Additional References:** None.

**Literature Search and Risk Assessment Completed on:** 03/14/2017.

10.1.4. **Skin sensitization**

Based on existing data, oxacyclohexadecane-2,13-dione does not present a concern for skin sensitization.

10.1.4.1. **Risk assessment.** The chemical structure indicates that this material is not expected to react with skin proteins directly (Toxtree 2.6.13, OECD toolbox v3.4). In a murine local lymph node assay, oxacyclohexadecane-2,13-dione, was found to be negative up to a maximum tested level of 30% (w/v) in acetone (RIFM, 1997b). In a guinea pig maximization test, oxacyclohexadecane-2,13-dione did not exhibit the potential to induce skin sensitization (RIFM, 1983a). In a confirmatory human repeat patch test with 20% material in white petrolatum applied under semi-occlusive covering, no reactions indicative of sensitization (0/50) were observed in any of the subjects tested (RIFM, 1982). Based on the weight of evidence from structural analysis, animal and human data, oxacyclohexadecane-2,13-dione does not present a concern for skin sensitization.

**Additional References:** None.

**Literature Search and Risk Assessment Completed on:** 05/08/2015.

10.1.5. **Photoxicity/photoallergenicity**

Based on available UV/Vis spectra along with existing data, oxacyclohexadecane-2,13-dione would not be expected to present a concern for phototoxicity or photoallergenicity.

10.1.5.1. **Risk assessment.** UV/Vis absorption spectra indicate minor absorbance between 290 and 700 nm. Corresponding molar absorption coefficient is below the benchmark of concern for phototoxicity and photoallergenicity, 1000 L mol⁻¹ cm⁻¹ (Henry et al., 2009). In a phototoxicity and photoallergenicity study conducted in Dunkin-Hartley guinea pigs, topical application of 50% oxacyclohexadecane-2,13-dione in arachis oil followed by UV exposure did not result in phototoxic or photoallergenic reactions (RIFM, 1983b). Likewise, in a human photoxicity/photoallergenicity study, topical application of 20% oxacyclohexadecane-2,13-dione followed by exposure to UV radiation did not result in phototoxic or photoallergenic reactions (RIFM, 1982). Based on the lack of significant absorbance in the critical range, and findings in a guinea pig phototoxicity/photoallergenicity study as well as data from a human phototoxicity/photoallergenicity study, oxacyclohexadecane-2,13-dione does not present a concern for phototoxicity or photoallergenicity.

**Additional References:** None.

**Literature Search and Risk Assessment Completed on:** 03/17/2017.

10.1.6. **Local respiratory toxicity**

The margin of exposure could not be calculated due to the lack of
appropriate data. The material, oxacyclohexadecane-2,13-dione, exposure level is below the Cramer Class III TTC value for inhalation exposure local effects.

10.1.6.1. Risk assessment. There are no inhalation data available on oxacyclohexadecane-2,13-dione. Based on the Creme RIFM model, the inhalation exposure is 0.0088 mg/day. This exposure is 53.4 times lower than the Cramer Class III TTC value of 0.47 mg/day (based on human lung weight of 650 g; Carthew et al., 2009); therefore, the exposure at the current level of use is deemed safe.

Additional References: Pinching and Doving, 1974; Gilbert and Kemp, 1996.

Literature Search and Risk Assessment Completed on: 03/21/2017.

10.2. Environmental endpoint summary

10.2.1. Screening-level assessment

A screening level risk assessment of oxacyclohexadecane-2,13-dione was performed following the RIFM Environmental Framework (Salvito et al., 2002) which provides for 3 levels of screening for aquatic risk. In Tier 1, only the material’s volume of use in a region, its log Kow and molecular weight are needed to estimate a conservative risk quotient (RQ; Predicted Environmental Concentration/Predicted No Effect Concentration or PEC/PNEC). In Tier 1, a general QSAR for fish toxicity is used with a high uncertainty factor as discussed in Salvito et al. (2002). At Tier 2, the model ECOSAR (US EPA, 2012b; providing chemical class specific ecotoxicity estimates) is used and a lower uncertainty factor is applied. Finally, if needed, at Tier 3, measured biodegradation and ecotoxicity data are used to refine the RQ (again, with lower uncertainty factors applied to calculate the PNEC). Provided in the table below are the data necessary to calculate both the PEC and the PNEC determined within this safety assessment. For the PEC, while the actual regional tonnage, which is considered proprietary information, is not provided, the range from the most recent IFRA Volume of Use Survey is reported. The PEC is calculated based on the actual tonnage and not the extremes noted for the range. Following the RIFM Environmental Framework, oxacyclohexadecane-2,13-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) did not identify oxacyclohexadecane-2,13-dione as either possibly persistent or bioaccumulative based on its structure and physical-chemical properties. This screening level hazard assessment is a weight of evidence review of a material’s physical-chemical properties, available data on environmental fate (e.g., OECD Guideline biodegradation studies or die-away studies) and fish bioaccumulation, and review of model outputs (e.g., USEPA’s BIOWIN and BCDFABF found in EPI Suite v4.11). Specific key data on biodegradation and fate and bioaccumulation are reported below and summarized in the Environmental Safety Assessment section prior to Section 1.

10.2.1.1. Risk assessment. Based on the current Volume of Use (2011), oxacyclohexadecane-2,13-dione does not present a risk to the aquatic compartment in the screening level assessment.

10.2.2. Biodegradation

RIFM, 1990c: Ready biodegradability of the test material was determined in the modified Sturm test according to the OECD 301B method. Under the conditions of the study, 10 mg/L and 20 mg/L of the test material was degraded significantly, 83% and 79%, respectively.

10.2.3. Bioaccumulation

RIFM, 1997a: The bioaccumulation and depuration of 14C oxacyclohexadecane-2,13-dione in rainbow trout (Oncorhynchus mykiss) was investigated in edibles, non-edibles and whole fish by means of a flow-through system following the OECD 305E guidelines. The fish were continuously exposed to the test material at an average low dose concentration of 31.66 mg/L and an average high dose concentration of 288.45 for 10 days. Thereafter, the fish were transferred to flowing untreated water and the depuration of radioactivity was followed for 21 days. During bioaccumulation of the (14C) test material, radioactivity in rainbow trout fish and fish parts approached plateau levels within 10 days of continuous exposure, resulting in bioconcentration factors (BCF) of 1335–2639 for edibles, non-edibles and whole fish.

10.2.4. Ecotoxicity

RIFM, 1990d: A 48-h acute toxicity study was conducted with Daphnia magna according to the OECD 202 method under static conditions. The 48-h EC50 of the test material was 21.2 mg/L.

RIFM, 1990c: A fish (Cyprinus carpio) acute study was conducted according to the OECD 203 method under semi-static conditions. Under the conditions of the study, the 96-h LC50 was between 3.2 and 5.6 mg/L (nominal concentration).

RIFM, 1994: A 72-h algae inhibition test was conducted according to the OECD 201 method. Under the conditions of this study, the EC50 values for integral biomass and growth rate were 11 and 16 mg/L, respectively.

10.2.5. Other available data

Within the RIFM database, there are a number of microcyclic lactone/lactides materials that are structurally related and can be used for read across purposes. A robust summary of available environmental data has been published in “Macro cyclic fragrance materials – A screening level environmental assessment using chemical categorization” (Salvito et al., 2011).

10.2.5.1. Risk assessment refinement. Since oxacyclohexadecane-2,13-dione has passed the screening criteria, measured data is included in this document for completeness only and has not been used in PNEC derivation.

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

Endpoints used to calculate PNEC are underlined.

<table>
<thead>
<tr>
<th>LC50 (Fish)</th>
<th>EC50 (Daphnia)</th>
<th>EC50 (Algae)</th>
<th>AF</th>
<th>PNEC</th>
<th>Chemical Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIFM Framework</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening Level (Tier 1)</td>
<td>5.11 mg/L</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Endpoints used to calculate PNEC are underlined.
A.M. Api et al.

Exposure information and PEC calculation (following RIFM Framework: Salvo et al., 2002).

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Europe (EU)</th>
<th>North America (NA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Kow Used</td>
<td>4.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Biodegradation Factor Used</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dilution Factor</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Regional Volume of Use</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Tonnage Band</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk Characterization: PEC/PNEC

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

The RIFM PNEC is 0.00511 μg/L. The revised PEC/PNECs for EU and NA: Not Applicable; cleared at screening level and therefore, does not present a risk to the aquatic environment at the current reported volumes of use.

Literature Search and Risk Assessment Completed on: 03/15/2017.

11. Literature search*

- RIFM database: target, Fragrance Structure Activity Group materials, other references, JECA, CIR, SIDS
- ECHA: http://echa.europa.eu/
- OECD Toolbox
- SciFinder: https://scifinder.cas.org/scifinder/view/scifinder/scifinderExplore.jsf
- IARC: (http://monographs.iarc.fr)
- OECD SIDS: http://www.chem.unep.ch/irptc/sids/oecdsid/sidspub.html
- EPA Actor: http://actor.epa.gov/actor/faces/ACToRHome.jsp?jsessionid=0E5F5C21B7960229F477472A9A4D50B87
- US EPA Robust Summary: http://cfpub.epa.gov/hpv-s/
- Japan Existing Chemical Data Base: http://dra4.nih.go.jp/mhwl_data/jsp/SearchPageENG.jsp
- Google: https://www.google.com/webhp?tab=ww&ei=KMSOupiQKarsQS324GwBq&ved=0CBQQ15L

*Information sources outside of RIFM’s database are noted as appropriate in the safety assessment. This is not an exhaustive list.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.fct.2017.11.013.

References


Comiskey, D., Api, A.M., Barrett, C., Daly, E.J., Ellis, G., McNamara, C., O'Mahony, C., 2017. Integrating habits and practices data for soaps, cosmetics and air care products into an existing aggregate exposure model. Regul. Toxicol. Pharmacol. 88, 144-156.


