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Short Review

RIFM fragrance ingredient safety assessment, 2,4-dimethyl-4-phenyltetrahydrofuran, CAS registry number 82461-14-1

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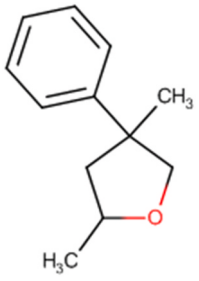
Version: 031,820. This version replaces any previous versions.

Name: 2,4-Dimethyl-4-phenyltetrahydrofuran



CAS Registry Number: 82,461-14-1

Additional CAS*

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(*continued*)

99,343-90-5 Furan, tetrahydro-2,4-dimethyl-4-phenyl-, (2R,4R)-rel-*Included because the materials are isomers

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

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(*continued*)

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 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 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 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.

2,4-Dimethyl-4-phenyltetrahydrofuran was evaluated for genotoxicity, repeated dose toxicity, reproductive toxicity, local respiratory toxicity, phototoxicity/photoallergenicity, skin sensitization, and environmental safety. Data show that 2,4-dimethyl-4-phenyltetrahydrofuran 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 III material, and the exposure to 2,4-dimethyl-4-phenyltetrahydrofuran is below the TTC (0.0015 mg/kg/day, 0.0015 mg/kg/day, and 0.47 mg/day, respectively). The skin sensitization endpoint was completed using the Dermal Sensitization Threshold (DST) for non-reactive materials (900 μg/cm^2); exposure is below the DST. The phototoxicity/photoallergenicity endpoints were evaluated based on data and ultraviolet (UV) spectra; 2,4-dimethyl-4-phenyltetrahydrofuran is not expected to be phototoxic/photoallergenic. The environmental endpoints were evaluated; 2,4-dimethyl-4-phenyltetrahydrofuran 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

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North America (i.e., Predicted Environmental Concentration/Predicted No Effect Concentration [PEC/PNEC]), are <1.

Human Health Safety Assessment

Genotoxicity: Not genotoxic. (RIFM, 1980c; RIFM, 2014)
Repeated Dose Toxicity: No NOAEL available. Exposure is below the TTC.
Reproductive Toxicity: No NOAEL available. Exposure is below the TTC.
Skin Sensitization: No safety concerns at current, declared use levels; Exposure is below the DST.
Phototoxicity/Photoallergenicity: Not phototoxic/photoallergenic. (UV Spectra, RIFM Database; RIFM, 1981; RIFM, 1980b)
Local Respiratory Toxicity: No NOAEC available. Exposure is below the TTC.

Environmental Safety Assessment

Hazard Assessment:
Persistence: Critical Measured Value: 28.5% (OECD 301B) for CAS # 82,461-14-1 RIFM (1993)
Bioaccumulation: Screening-level: 86.73 L/kg (EPI Suite v4.11; US EPA, 2012a)
Ecotoxicity: Screening-level: 48-h *Daphnia* LC50: 4.759 mg/L (ECOSAR; US EPA, 2012b)
Conclusion: Not PBT or vPvB as per IFRA Environmental Standards
Risk Assessment:
Screening-level: PEC/PNEC (North America and Europe) > 1 (RIFM Framework; Salvito et al., 2002)
Critical Ecotoxicity Endpoint: 48-h *Daphnia* LC50: 4.759 mg/L (ECOSAR; US EPA, 2012b)
RIFM PNEC is: 0.4759 μg/L
- Revised PEC/PNECs (2015 IFRA VoU): North America and Europe <1

1 Identification

Chemical Name: 2,4-Dimethyl-4-phenyltetrahydrofuran	Chemical Name: Furan, tetrahydro-2,4-dimethyl-4-phenyl-, (2R,4R)-rel-
CAS Registry Number: 82,461-14-1	**CAS Registry Number:** 99,343-90-5
EC Number: 279-967-8	**EC Number:** 639-631-7
Synonyms: Furan, tetrahydro-2,4-dimethyl-4-phenyl-; Rhubafurane; Rhubafuran; 2,4-Dimethyl-4-phenyltetrahydrofuran	**Synonyms:** Furan, tetrahydro-2,4-dimethyl-4-phenyl-, *cis*-; Furan, tetrahydro-2,4-dimethyl-4-phenyl-, (2R,4R)-rel-
Molecular Formula: $C_{12}H_{16}O$	**Molecular Formula:** $C_{12}H_{16}O$
Molecular Weight: 176.25	**Molecular Weight:** 176.25
RIFM Number: 6003	**RIFM Number:** 7154
Stereochemistry: No isomer specified. Two stereocenters and 4 total stereoisomers possible.	**Stereochemistry:** (2R,4R) isomer specified. Two stereocenters and 4 total stereoisomers possible.

2 Physical data

CAS # 82,461-14-1	CAS # 99,343-90-5
Boiling Point: 534 K (260 °C) (RIFM, 2013a), 244.24 °C (EPI Suite)	**Boiling Point:** 534 K (260 °C) (RIFM, 2013a), 244.24 °C (EPI Suite)
Flash Point: >93 °C (GHS), 100.5 °C (averaged and rounded to the nearest 0.5 °C) (RIFM, 2013f)	**Flash Point:** Not Available
Log K_{OW}: log Pow = 3.0 (RIFM, 2012), 3.44 (EPI Suite), 3.0 (Givaudan, 2012bn: #70270)	**Log K_{OW}:** 3.44 (EPI Suite)
Melting Point: 32.17 °C (EPI Suite)	**Melting Point**: 32.17 °C (EPI Suite)
Water Solubility: 650 mg/L at 20 °C (RIFM, 2013c), 65.97 mg/L (EPI Suite)	**Water Solubility:** 650 mg/L at 20 °C (RIFM, 2013c), 65.97 mg/L (EPI Suite)
Specific Gravity: Not Available	**Specific Gravity:** Not Available
Vapor Pressure: 2.5 Pa at 20 °C (RIFM, 2013b), 0.0308 mm Hg @ 25 °C (EPI Suite), 0.0179 mm Hg @ 20 °C (EPI Suite v4.0)	**Vapor Pressure:** 2.5 Pa at 20 °C (RIFM, 2013b), 0.0308 mm Hg @ 25 °C (EPI Suite), 0.0179 mm Hg @ 20 °C (EPI Suite v4.0)
UV Spectra: No significant absorbance between 290 and 700 nm; molar absorption coefficient is below the benchmark (1000 L mol^{-1} · cm^{-1})	**UV Spectra:** No significant absorbance between 290 and 700 nm; molar absorption coefficient is below the benchmark (1000 L mol^{-1} · cm^{-1})
Appearance/Organoleptic: Not Available	**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. **95**th **Percentile Concentration in Hydroalcoholics:** 0.018% (RIFM, 2017)
2. **Inhalation Exposure*:** 0.00013 mg/kg/day or 0.0098 mg/day (RIFM, 2017)
3. **Total Systemic Exposure**:** 0.00059 mg/kg/day (RIFM, 2017)

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

***When a safety assessment includes multiple materials, the highest exposure out of all included materials will be recorded here for the 95th Percentile Concentration in hydroalcoholics, inhalation exposure, and total exposure.

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 III, High

Expert Judgment	Toxtree v 2.6	OECD QSAR Toolbox v 3.2
III	III	III

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)

2,4-Dimethyl-4-phenyltetrahydrofuran and furan, tetrahydro-2,4-dimethyl-4-phenyl-, (2R,4R)-rel- are not reported to occur in foods by the VCF*.

*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

Dossier available for 2,4-dimethyl-4-phenyltetrahydrofuran (ECHA, 2016; accessed 08/12/19); no dossier available for furan, tetrahydro-2, 4-dimethyl-4-phenyl-, (2R,4R)-rel-.

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, 2,4-dimethyl-4-phenyltetrahydrofuran does not present a concern for genotoxicity.

11.1.1.1. Risk assessment. 2,4-Dimethyl-4-phenyltetrahydrofuran 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, 2013d). 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 2,4-dimethyl-4-phenyltetrahydrofuran has been evaluated in a bacterial reverse mutation assay using the pre-incubation method. *Salmonella typhimurium* strains TA98, TA100, TA1535, TA1537, and TA1538 were treated with 2,4-dimethyl-4-phenyltetrahydrofuran in methanol at concentrations up to 300 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, 1980c). Under the conditions of the study, 2,4-dimethyl-4-phenyltetrahydrofuran was not mutagenic in the Ames test.

The clastogenic activity of 2,4-dimethyl-4-phenyltetrahydrofuran 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 2,4-dimethyl-4-phenyltetrahydrofuran in dimethyl sulfoxide at concentrations up to 1702 μg/mL in the DRF study; micronuclei analysis was conducted at concentrations up to 420 μg/mL in the presence of S9 for 4 h and in the absence of S9 for 4 h and 24 h 2,4-Dimethyl-4-phenyltetrahydrofuran did not induce binucleated cells with micronuclei when tested up to the maximum concentration in either the presence or absence of an S9 activation system (RIFM, 2014). Under the conditions of the study, 2, 4-dimethyl-4-phenyltetrahydrofuran was considered to be non-clastogenic in the *in vitro* micronucleus test.

Based on the data available, 2,4-dimethyl-4-phenyltetrahydrofuran does not present a concern for genotoxic potential.

Additional References: None.

Literature Search and Risk Assessment Completed On: 10/17/19.

11.1.2. Repeated dose toxicity

There are no repeated dose toxicity data on 2,4-dimethyl-4-phenyltetrahydrofuran or any read-across materials. The total systemic exposure to 2,4-dimethyl-4-phenyltetrahydrofuran is below the TTC for the repeated dose toxicity endpoint of a Cramer Class III material at the

current level of use.

11.1.2.1. Risk assessment. There are no repeated dose toxicity data on 2,4-dimethyl-4-phenyltetrahydrofuran or any read-across materials that can be used to support the repeated dose toxicity endpoint. The total systemic exposure to 2,4-dimethyl-4-phenyltetrahydrofuran (0.59 μg/kg/day) is below the TTC (1.5 μg/kg/day; Kroes et al., 2007) for the repeated dose toxicity endpoint of a Cramer Class III material at the current level of use.

Additional References: None.

Literature Search and Risk Assessment Completed On: 10/01/19.

11.1.3. Reproductive toxicity

There are no reproductive toxicity data on 2,4-dimethyl-4-phenyltetrahydrofuran or on any read-across materials. The total systemic exposure to 2,4-dimethyl-4-phenyltetrahydrofuran is below the TTC for the reproductive toxicity endpoint of a Cramer Class III material at the current level of use.

11.1.3.1. Risk assessment. There are no reproductive toxicity data on 2,4-dimethyl-4-phenyltetrahydrofuran or on any read-across materials that can be used to support the reproductive toxicity endpoint. The total systemic exposure to 2,4-dimethyl-4-phenyltetrahydrofuran (0.59 μg/kg/day) is below the TTC (1.5 μg/kg/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: 08/28/19.

11.1.4. Skin sensitization

Based on existing data and the application of DST, 2,4-dimethyl-4-phenyltetrahydrofuran does not present a safety 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 not be expected to react directly with skin proteins while its metabolite is expected to be reactive (Roberts et al., 2007; Toxtree 3.1.0; OECD Toolbox v4.3). No predictive *in vitro* skin sensitization studies are available for 2,4-dimethyl-4-phenyltetrahydrofuran. However, in a guinea pig maximization test, 2,4-dimethyl-4-phenyltetrahydrofuran did not present reactions indicative of sensitization at 100% (RIFM, 1980a). Due to the limited data, the reported exposure was benchmarked utilizing the non-reactive DST of 900 μg/cm^2 (Safford, 2008; Safford et al., 2011; Roberts et al., 2015; Safford et al., 2015b). While the metabolite is predicted to be reactive based on *in silico* models, the Expert Panel for Fragrance Safety decided to use non-reactive DST. The current exposure from the 95th percentile concentration is below the DST for non-reactive materials when evaluated in all QRA categories. Table 1 provides the maximum acceptable concentrations for 2,4-dimethyl-4-phenyltetrahydrofuran that present no appreciable risk for skin sensitization based on the non-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: 09/16/19.

11.1.5. Phototoxicity/photoallergenicity

Based on the available UV/Vis spectra and study data, 2,4-dimethyl-4-phenyltetrahydrofuran would not be expected to present a concern for phototoxicity or photoallergenicity.

11.1.5.1. Risk assessment. UV/Vis absorption spectra indicate minor absorbance between 290 and 700 nm. The corresponding molar absorption coefficient is below the benchmark of concern for phototoxicity and photoallergenicity (Henry et al., 2009). In animal studies, application of 10% 2,4-dimethyl-4-phenyltetrahydrofuran in ethanol was not phototoxic to rabbits (RIFM, 1981), and induction with 20% 2,4-dimethyl-4-phenyltetrahydrofuran in ethanol followed by challenge with 10% 2,4-dimethyl-4-phenyltetrahydrofuran in ethanol did not result in any reactions in a guinea pig photoallergenicity study (RIFM, 1980b). Based on the lack of significant absorbance in the critical range and the *in vivo* study data, 2,4-dimethyl-4-phenyltetrahydrofuran does not present a concern for phototoxicity or photoallergenicity.

11.1.5.2. UV spectra analysis. UV/Vis absorption spectra (OECD TG 101) for 2,4-dimethyl-4-phenyltetrahydrofuran 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 et al., 2009).

Additional References: None.

Table 1
Maximum acceptable concentrations for 2,4-dimethyl-4-phenyltetrahydrofuran that present no appreciable risk for skin sensitization based on non-reactive DST.

IFRA Category[a]	Description of Product Type	Maximum Acceptable Concentrations in Finished Products Based on Non-reactive DST	Reported 95th Percentile Use Concentrations in Finished Products
1	Products applied to the lips	0.069%	NRU[b]
2	Products applied to the axillae	0.021%	0.0040%
3	Products applied to the face using fingertips	0.41%	3.8 x 10^{-4}%
4	Fine fragrance products	0.39%	0.018%
5	Products applied to the face and body using the hands (palms), primarily leave-on	0.10%	0.012%
6	Products with oral and lip exposure	0.23%	0.015%
7	Products applied to the hair with some hand contact	0.79%	0.0015%
8	Products with significant ano-genital exposure	0.041%	No Data[c]
9	Products with body and hand exposure, primarily rinse-off	0.75%	0.0040%
10	Household care products with mostly hand contact	2.7%	0.017%
11	Products with intended skin contact but minimal transfer of fragrance to skin from inert substrate	1.5%	No Data[c]
12	Products not intended for direct skin contact, minimal or insignificant transfer to skin	Not Restricted	0.50%

Note.
[a] For a description of the categories, refer to the IFRA/RIFM Information Booklet.
[b] No reported use.
[c] Fragrance exposure from these products is very low. These products are not currently in the Creme RIFM Aggregate Exposure Model.

Literature Search and Risk Assessment Completed On: 10/09/19.

11.1.6. Local Respiratory Toxicity

The MOE could not be calculated due to a lack of appropriate data. The exposure level for 2,4-dimethyl-4-phenyltetrahydrofuran 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 2,4-dimethyl-4-phenyltetrahydrofuran. Based on the Creme RIFM Model, the inhalation exposure is 0.0098 mg/day. This exposure is 48 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: None.

Literature Search and Risk Assessment Completed On: 09/20/19.

11.2. Environmental endpoint summary

11.2.1. Screening-level assessment

A screening-level risk assessment of 2,4-dimethyl-4-phenyltetrahydrofuran was performed following the RIFM Environmental Framework (Salvito et al., 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, 2,4-dimethyl-4-phenyltetrahydrofuran was identified as a fragrance material with the 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 2,4-dimethyl-4-phenyltetrahydrofuran 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 et al., 2015). As noted in the Criteria Document, the screening criteria applied are the same as those used in the EU for REACH (ECHA, 2012). 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). Data on persistence and bioaccumulation are reported below and summarized in the Environmental Safety Assessment section prior to Section 1.

11.2.1.1. Risk assessment. Based on the current Volume of Use (IFRA, 2015), 2,4-dimethyl-4-phenyltetrahydrofuran presents a risk to the aquatic compartment in the screening-level assessment.

11.2.1.2. Key studies

11.2.1.2.1. Biodegradation. For CAS # 82,461-14-1.

RIFM, 1993: Inherent biodegradability of the test material was evaluated using the sealed vessel test according to the OECD 301B guidelines. Biodegradation of 28.5% was observed after 28 days.

RIFM, 1996: Ultimate and ready biodegradability of the test material was evaluated using the sealed vessel test according to the OECD 301B guidelines. Biodegradation of 21.5% was observed after 28 days.

RIFM, 2013e: Ready biodegradability of the test material was evaluated using the modified MITI test according to the OECD 301C guidelines. No biodegradation was observed after 28 days.

11.2.1.2.2. Ecotoxicity. For CAS # 82,461-14-1.

RIFM, 2015a: The *Daphnia* acute immobilization test was conducted according to the OECD 202 guidelines under static conditions. The 48-h EC50 value based on geometric mean concentrations was reported to be 24 mg/L.

RIFM, 2015b: The algae growth inhibition test was conducted according to the OECD 201 guidelines under static conditions. The 72-h EC50 value based on nominal concentrations for growth rate was reported to be 18 mg/L.

11.2.1.3. Other available data. 2,4-Dimethyl-4-phenyltetrahydrofuran has been registered for REACH with no additional data available at this time.

11.2.2. Risk assessment refinement

Since 2,4-dimethyl-4-phenyltetrahydrofuran has passed the screening criteria, measured data is included for completeness only and has not been used in PNEC derivation.

	LC50 (Fish) (mg/L)	EC50 (*Daphnia*) (mg/L)	EC50 (Algae) (mg/L)	AF	PNEC (µg/L)	Chemical Class
RIFM Framework Screening-level **(Tier 1)**	32.07			1000000	0.03207	
ECOSAR Acute Endpoints **(Tier 2) *Ver 1.11***	7.337	4.759	6.148	10000	0.4759	Neutral Organics

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 et al., 2002).

Exposure	Europe	North America
Log K_{ow} Used	3.0	3.0
Biodegradation Factor Used	0	0
Dilution Factor	3	3
Regional Volume of Use Tonnage Band*	1–10	<1
Risk Characterization: PEC/PNEC	**<1**	**<1**

*Combined regional Volume of Use.

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

*Combined regional Volume of Use.

The RIFM PNEC is 0.4759 μg/L. The revised PEC/PNECs for EU and NA are <1; therefore, the material does not present a risk to the aquatic environment at the current reported volumes of use.

Literature Search and Risk Assessment Completed On: 09/24/19.

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**
- **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://hpvchemicals.oecd.org/ui/Default.aspx
- **EPA ACToR:** https://actor.epa.gov/actor/home.xhtml
- **US EPA HPVIS:** https://ofmpub.epa.gov/oppthpv/public_search.publicdetails?submission_id=24959241&ShowComments=Yes&sqlstr=null&recordcount=0&User_title=DetailQuery%20Results&EndPointRpt=Ysubmission
- **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 01/30/20.

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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