# GreenScreen™ Assessment for
## *Tris (2-chloro-1-methylethyl) phosphate (TCPP) CAS# 13674-84-5*

**Method Version: GreenScreen™ Version 1.2[1]**

**GreenScreen (GS) Assessment Type[2]: CERTIFIED**

**Introduction[3,4,5]**

This GreenScreen assessment, for all hazard endpoints (except reactivity), is based solely on the information reported in the corresponding chemical hazard profile in "An Alternatives Assessment for Flame Retardants Used in Flexible Polyurethane Foam[3].

Additional information on hazard endpoints (other than reactivity) beyond what was reported in the draft June 2014 report was not sought. It was necessary to supplement the hazard classification for reactivity as it is not included in the DfE approach but is needed in order to apply the GreenScreen Benchmarks.

Differences in hazard classification levels reported in the DfE profiles and in this GreenScreen report may be due to differences between criteria as defined in the DfE "Alternatives Assessment Criteria for Hazard Evaluation"[4] and the GreenScreen for Safer Chemicals v1.2 methods[5]. Any differences in interpretation are explained and justified in this GreenScreen report.

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| Licensed Profiler or Certified Practitioner (specify): N/A | Licensed Profiler or Certified Practitioner (specify): N/A |

**Confirm application of the *Disclosure and Assessment Rules and Best Practice*[6]:** (List any deviations)
Disclosure thresholds applied by DfE are unclear in the DfE report.

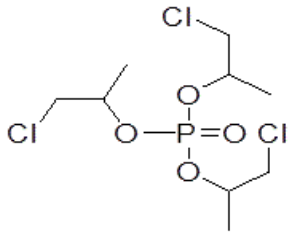
**Chemical Name (CAS #):**
Tris (2-chloro-1-methylethyl) phosphate (TCPP) CAS# 13674-84-5

[1] Use GreenScreen™ Assessment Procedure (Guidance) V1.2
[2] Available at: http://www.greenscreenchemicals.org/about/greenscreen-terms-of-use
[3] Available at: http://www.epa.gov/dfe/pubs/projects/flameret/ffr-update-complete.pdf, accessed 11/2014.
[4] Available at: http://www.epa.gov/dfe/alternatives_assessment_criteria_for_hazard_eval.pdf, accessed 10/2013.
[5] Details available at: http://www.cleanproduction.org/Greenscreen.v1-2.php, accessed 10/2013.
[6] See GreenScreen Guidance V1.2 Section 8

**Also Called:**
2-Propanol, 1-chloro-, 2,2`,2``-phosphate; TCPP; TCIPP; Tris(1-chloro-2-propyl)phosphate; Tris(2-chloroisopropyl)phosphate; 2-propanol, 1-chlorophosphate (3:1); 1-chloro-2-propyl phosphate (1:3); tris(1-chloromethylethyl) phosphate; phosphoric acid, tris(2-chloro-1-methyl ethyl) ester

**Suitable analogs or moieties of chemicals used in this assessment (CAS #'s):**
No analog

**Chemical Structure(s):**
*Note: Include chemical structure(s) of all suitable analogs (and /or moieties) used in the assessment.




**Notes related to production specific attributes[7]:**

**For Inorganic Chemicals and relevant particulate organics (*if not relevant, list NA*)**
**Define Properties:**

1. Particle size (e.g., silica of respirable size): NA
2. Structure (e.g., amorphous vs. crystalline): NA
3. Mobility (e.g., water solubility, volatility): NA
4. Bioavailability: TCPP is readily absorbed. Absorption through human skin membranes in vitro was calculated to be 2.3- 32.8% of the applied dose

**Identify Applications/Functional Uses: (e.g., Cleaning product, TV casing)**

1. Flame Retardant

[7] Note any composition or hazard attributes of the chemical product relevant to how it is manufactured. For example, certain synthetic pathways or processes result in typical contaminants, by-products or transformation products. Explain any differences between the manufactured chemical product and the GreenScreen assessment of the generic chemical by CAS #.

**GreenScreen Benchmark™ Score and Hazard Summary Table:**[8,9,10,11]

Tris (2-chloro-1-methylethyl) phosphate (TCPP) was assigned a **GS Benchmark Score of U** based on a data gap for the carcinogenicity endpoint. In a worst case scenario Tris (2-chloro-1-methylethyl) phosphate (TCPP) would be a benchmark 1 if the data gap for carcinogenicity was determined to be a high hazard score.

| Green Screen Hazard Ratings: Tris (2-chloro-1-methylethyl) phosphate | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group I Human | | | | | Group II and II* Human | | | | | | | | | Ecotox | | Fate | | Physical | |
| C | M | R | D | E | AT | ST | | N | | SnS* | SnR* | IrS | IrE | AA | CA | P | B | Rx | F |
| | | | | | | single | repeated | single | repeated | | | | | | | | | | |
| DG | *L* | **M** | **M** | **M** | **L** | NA | **L** | NA | *M* | **L** | DG | **L** | **M** | **H** | *M* | **vH** | **vL** | *L* | *L* |

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e., vH, H, M and L) instead of three (i.e., H, M and L), and are based on single exposures instead of repeated exposures. NA reflects that there was not data for this endpoint in the DfE assessment; however, it is not considered a data gap if the DfE report assesses repeated dose data for the same endpoint.

[8] See Appendix A for a glossary of hazard endpoint acronyms
[9] See Appendix B for alternative GreenScreen Hazard Summary Table (Classification presented by exposure route)
[10] For inorganic chemicals only, see GreenScreen Guidance V1.2 Section 14.4. (Exceptions for Persistence)
[11] For Systemic Toxicity and Neurotoxicity, repeated exposure data are preferred. Lack of single exposure data is not a Data Gap when repeated exposure data are available. In that case, lack of single exposure data may be represented as NA instead of DG. See GreenScreen Guidance V1.2 Section 9.3.

**Environmental Transformation Products and Ratings[12]:**
**Identify feasible and relevant environmental transformation products (i.e., dissociation products, transformation products, valence states) and/or moieties of concern[13]**

| Functional Use | Life Cycle Stage | Transformation Pathway | Environmental Transformation Products | CAS # | Feasible and Relevant? | GreenScreen List Translator or Benchmark Score |
|---|---|---|---|---|---|---|
| | | | O,O-[bis(l-chloro-2-propyl)]-O-(2-Propionic acid) phosphate | | | |
| | | | bis(1-chloro-2-propyl) phosphate | 789440-10-4 | | **NF** |
| | | | bis(1-chloro-2-propyl) 1-hydroxy-2-propyl phosphate | | | |
| | | | bis(1-chloro-2-propyl) 1-carboxy -2-propyl phosphate | | | |
| | | | 1-chloro-2-propyl,1-hydroxy-2-propyl phosphate | | | |

**NF = Not found in the GreenScreen ListTranslator**

[12] See GreenScreen Guidance V1.2 Section 13
[13] A moiety is a discrete chemical entity that is a constituent part or component of a substance. A moiety of concern is often the parent substance itself for organic compounds. For inorganic compounds, the moiety of concern is typically a dissociated component of the substance or a transformation product.

**Introduction**

CASRN 13674-84-5 is a discrete organic chemical with a MW below 1,000. EPI v4.11 was used to estimate physical/chemical and environmental fate values in the absence of experimental data. Measured values from experimental studies were incorporated into the estimations. TCPP is produced by the reaction of phosphorus oxychloride and propylene oxide. The most abundant isomer in commercial products is the branched isomer, 2-Propanol, 1-chloro-, phosphate (3:1) (CASRN 13674-84-5) however other isomers are expected to be present and will be discussed in this report as appropriate when determining hazard designations. Chemical, fate, and toxicity data for the isomers represented by other CASRN were collected in the preparation of this AA and are listed below:
1-Propanol, 2-chloro-, 1,1`,1``-phosphate (3:1) (CASRN 6145-73-9);
Phosphoric acid, bis(2-chloro-1-methylethyl) 2-chloropropyl ester (CASRN 76025-08-6) and
Phosphoric acid, 2-chloro-1-methylethyl bis(2-chloropropyl) ester (CASRN 76649-15-5) (NAS, 2000).

**Hazard Classification Summary Section:**

**Group I Human Health Effects (Group I Human)**

**Carcinogenicity (C) Score (H, M or L): DG**

Tris (2-chloro-1-methylethyl) phosphate was assigned a score of DATA GAP for carcinogenicity based on no data provided within the Alternatives Assessment to support a classification. The EPA's moderate classification is based on no experimental data located for this endpoint; carcinogenic effects cannot be ruled out. The moderate carcinogenic designation in the EPA's Alternatives Assessment is equivalent to a moderate designation within the GreenScreen. However, without any data available to support the conclusion the endpoint is assigned a data gap under GreenScreen.

The summary provided within the EPA's Alternatives Assessment was as follows:
MODERATE: There were no experimental data located for this endpoint; carcinogenic effects cannot be ruled out.

**Mutagenicity/Genotoxicity (M) Score (H, M or L):** *L*

Tris (2-chloro-1-methylethyl) phosphate was assigned a score of LOW for mutagenicity based on a moderate score within the EPA's DfE Alternatives Assessment. The EPA's classification is based on a weight of evidence approach when evaluating mixed results in the *in vivo* data set. The low designation for mutagenicity in both GreenScreen and EPA's Alternatives Assessment is based on the same criteria. The score was based on weight of evidence and expert judgment within EPA's Alternatives Assessment and therefore is reported in italics within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
LOW: Based on weight of evidence from multiple studies, TCPP did not cause gene mutations in bacteria *in vitro* or chromosome aberrations in rat bone marrow *in vivo*.

**Reproductive Toxicity (R) Score (H, M, or L): M**

Tris (2-chloro-1-methylethyl) phosphate was assigned a score of MODERATE for reproductive toxicity based on data provided within the EPA's DfE Alternatives Assessment. The EPA's classification is supported by a rat LOAEL of 99 mg/kg-day based on effects on uterus weights (lowest dose tested) within an adequate guideline (OECD 416) and GLP-compliant study. For reproductive toxicity, EPA's DFE uses numerical data quantifying the hazard associated with the 3 different hazard levels, whereas GreenScreen does not base the hazard score on a numerical rating

system but bases classifications on listing under GHS, the EU, and NTP. Therefore the conversion of DfE's reproductive toxicity conclusion to comparable GreenScreen hazard scores is done on a case by case basis. It has been concluded herein that the reproductive effects within the DfE report's toxicity studies do not fulfill the level of confidence required to assign a GHS category 1 reproductive hazard classification. The available data is more adequately characterized as a GHS category 2 and a moderate hazard under the GreenScreen. The score was based upon study data included within the EPA's Alternatives Assessment and therefore bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was summarized as follows:
HIGH: Based on an unestablished NOAEL and a LOAEL of 99 mg/kg-day for decreased uterine weights in F0 female rats fed TCPP in a 2-generation reproduction study. Two other studies reported no significant effects on reproductive parameters in rats exposed to TCPP in the diet at doses greater than 893 mg/kg-day.

**Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M or L): M**
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of MODERATE for developmental toxicity based on data provided within the EPA's DfE Alternatives Assessment. The EPA's classification is based on a LOAEL of 99 mg/kg-day for an increased number of runts in rats exposed to TCPP in the diet in a 2-generation reproduction study. For developmental toxicity, EPA's DFE uses numerical data quantifying the hazard associated with the 3 different hazard levels, whereas GreenScreen does not base the hazard score on a numerical rating system but bases classifications on listing under GHS, the EU, and NTP. Therefore the conversion of DfE's developmental toxicity conclusions to comparable GreenScreen hazard scores is done on a case by case basis. It has been concluded herein that the developmental effects within the DfE report's toxicity studies do not fulfill the level of confidence required to assign a GHS category 1 developmental hazard classification. The available data is more adequately characterized as a GHS category 2 and a moderate hazard under the GreenScreen. The score was based upon study data included within the EPA's Alternatives Assessment and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
HIGH: Based on an unestablished NOAEL and a LOAEL of 99 mg/kg-day for an increased number of runts in rats exposed to TCPP in the diet in a 2-generation reproduction study. Another study reported no significant developmental effects in offspring of rats gestationally exposed to TCPP in the diet at doses up to 893 mg/kg-day. There were no data located for the developmental neurotoxicity endpoint; there is uncertain concern for developmental neurotoxicity based on the potential for Cholinesterase (ChE) inhibition in dams that may result in alterations of fetal neurodevelopment.

**Endocrine Activity (E) Score (H, M or L): M**
The DfE Alternative Assessment does not assign a hazard score for endocrine activity but provides information relevant to this endpoint. Using EPA provided data tris (2-chloro-1-methylethyl) phosphate was assigned a score of MODERATE for endocrine activity based on evidence of endocrine activity without clear evidence of related human health effects. The score was based study data included within the EPA's Alternatives Assessment and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:

TCPP increased 17B estradiol and testosterone production in H295R cells, up-regulated steroidogenic genes and down-regulated sulfotransferases. TCPP also inhibited dihydrotestosterone and 17B estradiol induced expression indicating antiandrogenic or antiestrogenic activity, while TCPP was found to not induce estrogenic or anti-estrogenic effects in a yeast reporter gene assay and a human endometrial cancer cell assay.

**Group II and II* Human Health Effects (Group II and II* Human)**

*Note: Group II and Group II* endpoints are distinguished in the v 1.2 Benchmark system (the asterisk indicates repeated exposure). For Systemic Toxicity and Neurotoxicity, Group II and II* are considered sub-endpoints. When classifying hazard for Systemic Toxicity/Organ Effects and Neurotoxicity endpoints, repeated exposure results are required and preferred. Lacking repeated exposure results in a data gap. Lacking single exposure data does not result in a data gap when repeated exposure data are present (shade out the cell in the hazard table and make a note). If data are available for both single and repeated exposures, then the more conservative value is used.*

**Acute Mammalian Toxicity (AT) Group II Score (vH, H, M or L): L**

Tris (2-chloro-1-methylethyl) phosphate was assigned a score of LOW for acute mammalian toxicity based on a low score within the EPA's DfE Alternatives Assessment. Acute mammalian toxicity classification in both the EPA's DfE and GreenScreen is based on the same criteria. The acute mammalian toxicity score was based on test data and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
LOW: Based on $LD_{50}$ and $LC_{50}$ values for the oral, dermal, and inhalation routes of exposure.

**Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)**

**(ST-single) Group II Score (single dose: vH, H, M or L):**

DfE evaluates Systemic Toxicity based on repeated exposures. Lack of data for Systemic Toxicity based on a single exposure does not constitute a data gap when data for repeated exposures are available. This endpoint was not assessed in this evaluation and is assigned an 'NA'.

**(ST-repeat) Group II* Score (repeated dose: H, M, L): L**

Tris (2-chloro-1-methylethyl) phosphate was assigned a score of LOW for repeated exposure systemic toxicity/organ effects based on data within the EPA's DfE report. While the moderate designation for repeated exposure systemic toxicity/organ effects in both GreenScreen and EPA's Alternatives Assessment is based on the same criteria, the GreenScreen hazard score differs from the moderate score assigned by DfE. The DfE's score for this endpoint is based on conservative assumptions (i.e. not being able to exclude effects occurring within the moderate range based on a NOAEL that exists within the moderate hazard score threshold). No positive data was available within the DfE to support the moderate classification; however, positive effects data for TCPP was available to support a low hazard score. The score was based on study data and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
MODERATE: Based on reported morphological changes in the kidney and thyroid reported in rats fed the Fyrol PCF mixture (tris (2-chloroisopropyl) phosphate [~70%] and 2-chloropropanol phosphate [~ 23%]) in the diet for 90 days at doses of 481 mg/kg-day and 570 mg/kg-day in males

and females, respectively. Decreased body weight gain and food consumption was reported in rats fed Fyrol PCF for 14 days. Also, rats exposed to TCPP in the diet for 28 days reported increased mortality in females at a dose of 1,000 mg/kg-day; the NOAEL for this study was identified as 100 mg/kg-day which falls within the Moderate hazard criteria range. Criteria values are tripled for chemicals evaluated in 28-day studies. There is uncertainty about where effects may occur given that the identified NOAEL (100 mg/kg-day) and LOAEL (1,000 mg/kg-day) bridges the Moderate (30 - 300 mg/kg-day) and Low (> 300 mg/kg-day) hazard designation range; effects occurring within the Moderate range cannot be ruled out.

In addition for immunotoxicity:

No data located

**Neurotoxicity (N)**
**(N-single) Group II Score (single dose: vH, H, M or L):**
DfE evaluates Neurotoxicity based on repeated exposures. Lack of data for Neurotoxicity based on a single exposure does not constitute a data gap when data for repeated exposures are available. This endpoint was not assessed by DfE in this evaluation and is assigned an 'NA'.

**(N-repeat) Group II* Score (repeated dose: H, M, L):** *M*
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of MODERATE for neurotoxicity based on a moderate score within the EPA's DfE Alternatives Assessment. The moderate designation in both GreenScreen and EPA's Alternatives Assessment is based on the same criteria. The score was based on expert judgment and *in vitro* study data within EPA's Alternatives Assessment and therefore is reported in italics within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
MODERATE: Based on the weight of evidence from a structural alert for organophosphates and an in vitro study. In an in vitro study using undifferentiated and differentiating PC12 cells, TCPP promoted differentiation of the cholinergic phenotype of PC12 cells. There were no effects on cholinesterase activity in a dietary study in rats fed TDCPP and no evidence of delayed neurotoxicity in one study of hens orally treated with TCPP.

**Skin Sensitization (SnS) Group II* Score (H, M or L): L**
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of LOW for skin sensitization based on a low score within the EPA's DfE Alternatives Assessment. The low designation for skin sensitization in both GreenScreen and EPA's Alternatives Assessment is based on the same criteria. The score was based on study data within EPA's Alternatives Assessment and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
LOW: TCPP is not a skin sensitizer.

**Respiratory Sensitization (SnR) Group II* Score (H, M or L):** DG
Tris (1,3-dichloro-2-propyl) phosphate was assigned a score of data gap for respiratory sensitization. This conclusion was made based on no data located.

**Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M or L): L**

Tris (1,3-dichloro-2-propyl) phosphate was assigned a score of LOW for Skin Irritation/Corrosivity based on a low score within the EPA's DfE Alternatives Assessment. While the DfE's low dermal irritant score corresponds to a moderate score under GreenScreen Skin Irritation/Corrosivity, the presence of human data indicating TCPP is not an irritant was used to determine the appropriate GreenScreen score. The score was based on study data within EPA's Alternatives Assessment and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
LOW: Based on weight of evidence from multiple studies. TCPP is not irritating to skin in humans and rabbits.

**Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M or L): M**
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of MODERATE based on a low score within the EPA's DfE Alternatives Assessment. The DfE score is based on study reporting TCPP as slightly irritating in rabbits with transient effects in rabbits typically resolved 24 to 72 hours post-administration. The DfE low hazard score for eye irritation corresponds to a moderate score under GreenScreen Eye Irritation/Corrosivity. The score was based on test data within EPA's Alternatives Assessment and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
LOW: TCPP was not irritating to slightly irritating in rabbits.

**Ecotoxicity (Ecotox)**

**Acute Aquatic Toxicity (AA) Score (vH, H, M or L): H**
Tris (1,3-dichloro-2-propyl) phosphate was assigned a score of MODERATE for acute aquatic toxicity based on a moderate score within the EPA's DfE Alternatives Assessment. The moderate designation for acute aquatic toxicity in both GreenScreen and EPA's Alternatives Assessment is based on the same criteria. The score was based on study data and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
MODERATE: Based on experimental $LC_{50}$ and $EC_{50}$ values for fish, daphnia, and algae.

**Chronic Aquatic Toxicity (CA) Score (vH, H, M or L):** *M*
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of MODERATE for chronic aquatic toxicity based on data provided within the EPA's DfE Alternatives Assessment. While the high designation for chronic aquatic toxicity in both GreenScreen and EPA's Alternatives Assessment is based on the same criteria, it was concluded that the data provided within the EPA report supported a moderate classification. Specifically, the most sensitive reported effect was a ChV for daphnia of 3.2 mg/l. This falls within the moderate hazard score under GreenScreen. The score was based on estimated data and therefore is reported in italics within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
HIGH: Based on estimated ChV values in fish (estimated for the phosphate esters ECOSAR class). An experimental NOEC for Daphnia magna indicate a Low hazard designation for mortality and reproduction, while estimated ChV values fall within a Low to Moderate hazard range. Estimated ChV values for algae indicate a Moderate hazard designation. While experimental data for Daphnia

suggest a Low hazard, there are no experimental chronic aquatic toxicity data available for fish and algae; therefore, an estimated High hazard designation is assigned to this endpoint.

## Environmental Fate (Fate)

**Persistence (P) Score (vH, H, M, L, or vL): vH**
Tris (1,3-dichloro-2-propyl) phosphate was assigned a score of VERY HIGH for persistence based on a high persistence score within the DfE report. The score was based on measured persistence data indicating a half-life greater than 60 days. A half-life greater than 60 days in water results in a Very High rating for persistence in water by GreenScreen. The hazard score is based measured half-life value within EPA's Alternatives Assessment and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was summarized as follows:
HIGH: Based on measured persistence data. TCPP had 14% biodegradation after 28 days according to OECD 301E, although in the modified MITI test, OECD 301C, 0% biodegradation was found after 28 days using an activated sludge inoculum. TCPP achieved 21% degradation after 28 days in an inherent modified MITI test, OECD 302C. These data suggest a half-life greater than 60 days. TCPP is not expected to be susceptible to direct photolysis by sunlight. The atmospheric half-life of vapor-phase TCPP is estimated to be 2.9 hours, however it is not expected to partition greatly to the atmosphere.

**Bioaccumulation (B) Score (vH, H, M, L, or vL): vL**
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of VERY LOW for bioaccumulation based on a low score within the EPA's DfE Alternatives Assessment. The low designation for bioaccumulation in EPA's Alternatives Assessment is equivalent to a very low score in GreenScreen. The score is based on study data and therefore is bolded within the GreenScreen assessment.

The summary provided within the EPA's Alternatives Assessment was as follows:
LOW: Multiple experimental BCF values are below 100, the Low bioaccumulation designation criteria. Toxicokinetic studies indicate that TCPP and metabolites are rapidly formed and eliminated, consistent with the estimated BAF. Biomonitoring studies report detection of this compound in human milk samples and herring gull eggs, demonstrating that these materials are likely bioavailable and could be observed in a biological matrix. However, the rate of metabolism and elimination may be successfully competing with that of uptake, which is also consistent with the experimental BCF results. The biomonitoring studies are not inconsistent with a Low designation

## Physical Hazards (Physical)

**Reactivity (Rx) Score (vH, H, M or L):** *L*
Tris (2-chloro-1-methylethyl) phosphate was assigned a score of LOW for reactivity based upon its use as a flame retardant, information available in a material safety data sheet and a review of potential degradation products. In addition, potential degradation products are also non-reactive which indicates the parent compound is also likely to have low reactivity. DfE does not assess reactivity and this data is added to the information found in the DfE Alternatives Assessment. This conclusion was based on expert judgment and is reported in italics.

**Flammability (F) Score (vH, H, M or L):** *L*

Tris (2-chloro-1-methylethyl) phosphate was assigned a score of LOW for flammability based upon its use as a flame retardant. This conclusion was based on expert judgment and is reported in italics.

**Reactivity References:**

Sigma-Aldrich Safety Data Sheet (SDS), tris (2-chloro-1-methylethyl) phosphate, Product Number 119660, Version 3.0, published 05/05/2009, 6 pages, Section 16, Other Information. '*NFPA Rating, Reactivity Hazard = 0*', accessed 11/16/2014.

**Expert judgment:**

Tris (2-chloro-1-methylethyl) phosphate is a halogenated phosphate compound which degrades into phosphoric acid, 1-chloro-2-propanol or related compounds. The US National Institute of Health's Hazardous Substances Database indicates that both phosphoric acid and 1-chloro-2-propanol have '*Reactivity: 0. 0 = Includes materials that are normally stable, even under fire exposure conditions, and that do not react with water. Normal fire fighting procedures may be used.*' For these reasons, tris (2-chloro-1-methylethyl) phosphate is expected to be non-reactive.

## APPENDIX A: Hazard Benchmark Acronyms (alphabetical order)

| | |
|---|---|
| (AA) | Acute Aquatic Toxicity |
| (AT) | Acute Mammalian Toxicity |
| (B) | Bioaccumulation |
| (C) | Carcinogenicity |
| (CA) | Chronic Aquatic Toxicity |
| (Cr) | Corrosion/ Irritation (Skin/ Eye) |
| (D) | Developmental Toxicity |
| (E) | Endocrine Activity |
| (F) | Flammability |
| (IrE) | Eye Irritation/Corrosivity |
| (IrS) | Skin Irritation/Corrosivity |
| (M) | Mutagenicity and Genotoxicity |
| (N) | Neurotoxicity |
| (P) | Persistence |
| (R) | Reproductive Toxicity |
| (Rx) | Reactivity |
| (SnS) | Sensitization- Skin |
| (SnR) | Sensitization- Respiratory |
| (ST) | Systemic/Organ Toxicity |

## Appendix B
## Optional Exposure Stratified GreenScreen Hazard Hazard Summary Table

| Exposure Route | GreenScreen Hazard Ratings: [*Chemical Name*] | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group I Human | | | | | Group II and II* Human | | | | | | | | | Ecotox | | Fate | | Physical | |
| | C | M | R | D | E | AT | ST | | N | | SnS* | SnR* | IrS | IrE | AA | CA | P | B | Rx | F |
| | | | | | | | single | repeate | single | repeated[†] | | | | | | | | | | |
| oral | | | | | | | | | | | | | | | | | | | | |
| dermal | | | | | | | | | | | | | | | | | | | | |
| inhalation | | | | | | | | | | | | | | | | | | | | |

## Appendix C
## Modeling Results

**Attach:**

- **EPISuite Results for Chemical Name (CAS #)**
- **ECOSAR Results for Chemical Name (CAS #)**
- **Other**