GreenScreen® Assessment for [*Triphenyl Phosphate (CAS#115-86-6)*]

Method Version: GreenScreen® Version 1.2[1]

Verified or Non-Verified[2]: NON-VERIFIED

Introduction[3,4,5]

This GreenScreen assessment is based on the information reported in the corresponding chemical hazard profile in "An Alternatives Assessment for the Flame Retardant Decabromodiphenyl ether (DecaBDE) Final Report"[3]. Additional information on hazard endpoints beyond what was included in the final report was not sought with the exception of reactivity. Hazard classification information for reactivity was supplemented because it is not included in the DfE report but is needed to apply the GreenScreen Benchmark system.

Hazard classification levels reported in the DfE profiles and in this GreenScreen report may differ 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.

Non-Verified GreenScreen® Assessment Prepared By:	**Non-Verified GreenScreen® Assessment Quality Control Performed By:**
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Date: February 9, 2014 (expires after 3 years)	Date: March 19, 2014
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 #):

[1] Use GreenScreen® Assessment Procedure (Guidance) V1.2
[2] "NON-VERIFIED" means that Verification Has Not Been Performed on this GreenScreen Assessment
[3] An Alternatives Assessment for the Flame Retardant Decabromodiphenyl ether (DecaBDE) Final Report Available at: http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf, p 4-681, accessed 2/9/2014.
[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

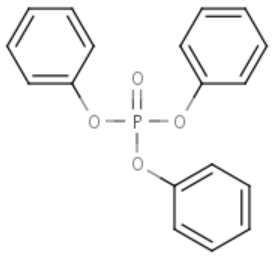
Triphenyl Phosphate (CAS#115-86-6)

Also Called:
Phosphoric acid, triphenyl ester (TSCA Inventory)

Tradenames:
TPP

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)
2. Structure (e.g., amorphous vs. crystalline)
3. Mobility (e.g., water solubility, volatility)
4. Bioavailability

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

GreenScreen Benchmark Score and Hazard Summary Table:[8,9,10,11]
Triphenyl phosphate was assigned a **Benchmark Score of 2** based on moderate Group I human toxicity endpoints (carcinogenicity and endocrine activity); high Group II human toxicity endpoints (repeat dose systemic) and very high ecotoxicity endpoints (acute and chronic aquatic toxicity).

[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 #.
[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.

Triphenyl phosphate could be a Benchmark 1_{TP} if any of the transformation products were determined to be Benchmark 1 and feasible and relevant.

Green Screen Hazard Ratings: [*Triphenyl 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										
M	L	L	L	M	L		H		L	L	DG	L	M	vH	vH	L	L	*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.

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	Trans-formation Pathway	Environmental Transformation Products	CAS #	Feasible and Relevant?	GreenScreen List Translator Score or GreenScreen Benchmark Score
			Diphenyl phosphate	838-85-7		LT-U (GreenWERCS)
			Phenol	108-95-2		LT-P1 (Pharos)

Introduction

According to the DfE report, "This is a discrete organic chemical with a MW <1,000. EPI v 4.0 was used to estimate physical/chemical and environmental fate values due to an absence of experimental data. Measured values from experimental studies were incorporated into the estimations."[14]

[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.
[14] An Alternatives Assessment for the Flame Retardant Decabromodiphenyl ether (DecaBDE) Final Report Available at: http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf, p 4-681,accessed 2/9/2014.

Hazard Classification Summary Section:

For all hazard endpoints:

- **Search all GreenScreen specified lists. Report relevant results either in each hazard endpoint section or attach to the end of the report.**
- **Always indicate if suitable analogs or models were used.**
- **Attach modeling results (See Appendix C).**
- **Include all references either in each hazard endpoint section or at the end of the report.**

Group I Human Health Effects (Group I Human)

Carcinogenicity (C) Score (H, M or L): *M*
Triphenyl phosphate was assigned a score of MODERATE for Carcinogenicity 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 measured endpoints. The score was based on modeling within the 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: OncoLogic modeling indicates a marginal to low potential for carcinogenicity. No long-term carcinogenicity assays were found.

Mutagenicity/Genotoxicity (M) Score (H, M or L): L
Triphenyl phosphate was assigned a score of LOW for Mutagenicity based on a moderate score within the EPA's DfE alternatives assessment. The low designation in both GreenScreen and EPA's Alternatives assessment is based on the same measured endpoints. The score was based on empirical data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: Triphenyl phosphate was not mutagenic in bacteria or mammalian cells *in vitro* and did not cause chromosomal aberrations *in vitro*. In addition, triphenyl phosphate did not result in DNA damage in hamster fibroblast cells.

Reproductive Toxicity (R) Score (H, M, or L): L
Triphenyl phosphate was assigned a score of LOW for Reproductive Toxicity based on a low score within the EPA's DfE alternatives assessment. 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 developmental and reproductive toxicity conclusions to comparable GreenScreen hazard scores is done on a case by case basis. DfE's low score was made based on no reproductive effects observed in multiple studies at the highest doses tested. The score was based on study data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:

LOW: Based on a rat oral reproductive/developmental NOAEL = 690 mg/kg-bw/day for reproductive effects (highest dose tested). In addition, no histopathological effects on reproductive organs were reported following 3 weeks of dermal exposure in rabbits.

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M or L): L
Triphenyl phosphate was assigned a score of LOW for Developmental Toxicity based on a low score within the EPA's DfE alternatives assessment. For developmental toxicity, DfE uses numerical data to quantify 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 and reproductive toxicity conclusions to comparable GreenScreen hazard scores is done on a case by case basis. DfE's low score was based on study results which showed no effects on fetal endpoints within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: Based on a rat oral reproductive/developmental NOAEL = 690 mg/kg-bw/day for fetal effects (highest dose tested).

Endocrine Activity (E) Score (H, M or L): M
Triphenyl phosphate was assigned a score of MODERATE for Endocrine Activity based on *in vivo* androgen binding activity. This information is based test data and therefore is not reported in italics.

The summary provided within the EPA's alternatives assessment was as follows:
Triphenyl phosphate was found to be inactive in an estrogen-receptor binding assay; however, it was shown to be a moderate androgen-receptor (AR) binder in a competitive binding assay. Triphenyl phosphate was also shown to inhibit human AR in the absence of agonist and to inhibit testosterone-induced AR activity.

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
Triphenyl Phosphate was assigned a score of LOW for Acute Mammalian Toxicity. The acute mammalian toxicity classification in both the EPA's DfE and GreenScreen is based on the same measured endpoints. The hazard score was based on a measured test data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: Oral LD_{50} in rats and mice is >5,000 mg/kg and the dermal LD_{50} in rabbits is >7,900 mg/kg. No adequate data were located to assess the toxicity of inhalation 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.

(ST-repeat) Group II* Score (repeated dose: H, M, L): H
Triphenyl phosphate was assigned a score of HIGH for Systemic Toxicity /Organ Effects based on repeated exposure. The high designation for systemic toxicity/organ effects for repeated exposure in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based empirical data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
HIGH: Based on reduced body weight in male rats administered triphenyl phosphate in the diet for 28-days. The NOAEL of 23.5 mg/kg-day and the LOAEL of 161.4 mg/kg-day span across the High and Moderate hazard designation ranges (DfE criteria are for 90-day repeated dose studies; criteria values are tripled for chemicals evaluated in 28-day studies making the High hazard range < 30 mg/kg-day and the Moderate hazard range between 30 and 300 mg/kg-day).

In addition:
Oral exposure of rats to triphenyl phosphate for 4 months and dermal exposure of rabbits for 3 weeks produced no effects on immune function parameters.

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.

(N-repeat) Group II* Score (repeated dose: H, M, L): L
Triphenyl phosphate was assigned a score of LOW for Neurotoxicity based on a low score within the EPA's DfE alternatives assessment. The low designation in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on measured study data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: Based on an adult rat neurotoxicity screening battery NOAEL = 711 mg/kg-bw/day; all other experimental results are consistent with this hazard designation.

Skin Sensitization (SnS) Group II* Score (H, M or L): L
Triphenyl phosphate was assigned a score of LOW for Skin Sensitization. This conclusion was made based on a skin sensitization study in guinea pigs. The low designation for skin sensitization in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on test data within EPA's Alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: Based on an experimental study in guinea pigs indicating that triphenyl phosphate is not a skin sensitizer.

Respiratory Sensitization (SnR) Group II* Score (H, M or L): DG
Triphenyl 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
Triphenyl phosphate was assigned a score of LOW for Skin Irritation/Corrosivity based on tests results provided within the EPA's DfE alternatives assessment which indicates triphenyl polyphosphate is not irritating in rabbit skin tests. DfE categorizes triphenyl polyphosphate as a very low eye irritant which corresponds to a low score under GreenScreen Eye Irritation/Corrosivity. The score was based on study data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
VERY LOW: Triphenyl Phosphate is not a skin irritant based on one study in rabbits.

Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M or L): M
Triphenyl phosphate was assigned a score of MODERATE for Eye Irritation based on tests results provided within the EPA's DfE alternatives assessment which indicates triphenyl phosphate is a slight eye irritant in rabbits. DfE categorizes triphenyl phosphate as a low eye irritant which corresponds to a moderate score under GreenScreen Eye Irritation/Corrosivity. The score was based on empirical data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: Triphenyl phosphate is mildly irritating to the eyes with clearing within 72 hours.

Ecotoxicity (Ecotox)

Acute Aquatic Toxicity (AA) Score (vH, H, M or L): vH
Triphenyl phosphate was assigned a score of VERY HIGH for Acute Aquatic Toxicity. The very high designation for acute aquatic toxicity in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on empirical data within EPA's alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
VERY HIGH: Based on experimental fish 96-hour LC_{50} values of 0.4 and 0.85 mg/L.

Chronic Aquatic Toxicity (CA) Score (vH, H, M or L): vH
Triphenyl phosphate was assigned a score of VERY HIGH for Chronic Aquatic Toxicity. The low designation for chronic aquatic toxicity in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on measured test data and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
VERY HIGH: Based on an experimental fish 30-day LOEC = 0.037 mg/L.

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): L

Triphenyl phosphate was assigned a score of LOW for Persistence. The low designation for persistence in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. Therefore a low hazard score was determined for the GreenScreen profile. The score was based on biodegradability tests and estimated half-lives. The hazard score is based on measured values within EPA's Alternatives assessment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: The persistence of triphenyl phosphate is based on experimental data. Under aerobic conditions in a Japanese MITI ready biodegradability test (OECD Test Guidelines (TG) 301C), 90% biodegradation of triphenyl phosphate occurred after 28 days, and 93.8% triphenyl phosphate removal as dissolved organic carbon (DOC) occurred over 20 days in an OECD 303A guideline study. TPP does not meet the criteria for very low persistence because the ready test values do not occur within a 10-day window. In loamy sand, a half-life of 37 days was observed under aerobic conditions. Triphenyl phosphate was determined to be inherently biodegradable in a river die-away test after degrading 100% over 3 days in river water. Triphenyl phosphate may degrade under anaerobic conditions with primary degradation of 31.1% after 3 days (89.7% after 40 days) in river sediment. However, it is not expected to partition significantly to sediment, and removal under anaerobic conditions is not anticipated to be an important fate process. Triphenyl phosphate will undergo hydrolysis under alkaline conditions, with half-lives of 3 days at pH 9. It is relatively stable to hydrolysis under neutral and acidic conditions, with half-lives of 28 days at pH 5 and 19 days at pH 7. Triphenyl phosphate is not expected to be susceptible to direct photolysis by sunlight, since it does not absorb light at wavelengths >290 nm. The atmospheric half-live of vapor-phase triphenyl phosphate is estimated to be 12 hours.

Bioaccumulation (B) Score (vH, H, M, L, or vL): L
Triphenyl phosphate was assigned a score of LOW for Bioaccumulation. The moderate designation for bioaccumulation in EPA's alternatives assessment is equivalent to a low score in GreenScreen. The score was based on measured BAF values between 100 and 500. As the score is based on measured values, it is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
MODERATE: There is moderate concern for bioaccumulation based on experimental BCF values.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M or L): *L*
Triphenyl phosphate was assigned a score of LOW for Reactivity. EPA does not assess reactivity as one of its hazard criteria and, therefore, no data was available in the EPA assessment to address this criterion. However, the New Jersey Department of Health and Senior Services Hazard Substance Fact Sheet[15] indicates triphenyl phosphate has a low level of reactivity concern. Based upon this information and professional judgment, the reviewer believes a score of 'low' is appropriate.

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

[15] NJ Hazardous Substance Fact Sheet is available at: http://nj.gov/health/eoh/rtkweb/documents/fs/1951.pdf, access 9/2013.

Triphenyl phosphate was assigned a score of LOW for Flammability based on a not flammable description within the DfE report. This conclusion was based on adequate data and is not reported in italics.

References (may be provided under each hazard endpoint or at the end of document)

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