# GreenScreen® Assessment for [*Phosphoric acid, mixed esters with [1,1'-bisphenyl-4,4'-diol] and phenol; BPBP (CAS#1003300-73-9)*]

**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 Decabromodiphenylether (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)

[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 Decabromodiphenylether (DecaBDE) Final ReportAvailable at: http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf, p 4-519, 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.

Disclosure thresholds applied by DfE are unclear in the DfE report.

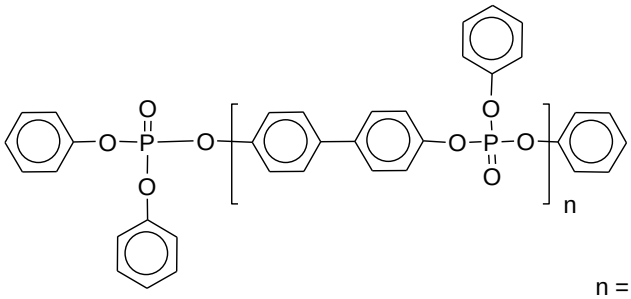
**Chemical Name (CAS #):**
Phosphoric acid, mixed esters with [1,1'-bisphenyl-4,4'-diol] and phenol; BPBP (CAS#1003300-73-9)

**Also Called:**
Phosphoric acid, P,P'-[1,1'-biphenyl]-4,4'-diyl P,P,P',P'-tetraphenyl ester; Biphenyl-4,4'-diyl tetraphenyl bis(phosphate); BPBP;

**Tradenames:**
ADK STAB FP-800; T-1752F.

**Suitable analogs or moieties of chemicals used in this assessment (CAS #'s):**
Confidential compounds

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




n = 1-4

**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: Its absorption and systemic availability after topical or oral administration is expected to be limited, because of its MW (650.6), low water solubility (<0.01 mg/L at 20°C) and high lipophilicity (Log $K_{ow}$ = 5.5 at 25°C) and because of the absence of relevant toxicity findings in available toxicity studies. Based on professional judgment, only limited absorption is expected by any route, followed by rapid excretion in feces and urine. This judgment is supported by a closely related analog.

**For Polymeric Materials: (*delete this section if not a polymeric material*)**
**Identify Monomers and Corresponding Properties[8]**

[6] See GreenScreen Guidance V1.2 Section 8
[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 #.

According to the DfE report, "The n = 1 (>80% of composition) and n = 2 oligomers are amenable to EPI v4.1 estimation methods for physical/chemical and environmental fate values and ECOSAR v1.11 for ecotoxicity values in the absence of experimental data. The higher MW oligomers (n = 2-4) that have MWs >1,000 are assessed together using information contained in the literature concerning polymer assessment and professional judgment (Boethling et al., 1997).

The n = 1 structure comprises >80% of the mixture, with the balance primarily made up of higher oligomers (n = 2, 3, 4, etc.). "[9]

Information to address the following section is not available in the DfE report

1. % of Each Monomer
   a) Monomer 1: The n = 1 structure comprises >80% of the mixture with the balance primarily made up of higher oligomers (n = 2, 3, 4, etc.).
   b) Monomer 2
   c) Monomer 3
2. Are the monomers blocked? (Y/N)
3. Molecular Weight (MW) of polymeric material
4. % of polymeric material with
   a) MW <500
   b) MW <1,000: The higher MW oligomers (n = 2-4) that have MWs >1,000
5. % Weight Residual Monomers
6. Solubility/Dispersability/Swellability
7. Particle size
8. Overall charge of polymeric material
9. Identify constituents and residual concentrations of
   a) Catalysts
   b) Processing aids
10. Identify any monomers, oligomers, catalysts or processing aids classified as Benchmark 1 according to the hazard identification lists in the GreenScreen List Translator.

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

**GreenScreen Benchmark Score and Hazard Summary Table:**[10,11,12,13]
BPBP was assigned a **Benchmark Score of U** (Unspecified) based on a data gap score for carcinogenicity. Following GreenScreen guidance, a chemical must have sufficient data to assess at

[8]While Phosphoric acid, mixed esters with [1,1'-bisphenyl-4,4'-diol] and phenol is a polymer, information to address these items is not available in the DfE report.
[9]An Alternatives Assessment for the Flame Retardant Decabromodiphenylether (DecaBDE) Final Report Available at: http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf, p 4-519, accessed 2/9/2014.
[10] See Appendix A for a glossary of hazard endpoint acronyms
[11] See Appendix B for alternative GreenScreen Hazard Summary Table (Classification presented by exposure route)
[12] For inorganic chemicals only, see GreenScreen Guidance V1.2 Section 14.4. (Exceptions for Persistence)
[13] 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.

least 3 out of 5 hazard endpoints (max 2 DGs). Permissible data gaps may only include Endocrine Activity and either Reproductive or Developmental Toxicity.

BPBP could be a Benchmark 1 if the data gap for carcinogenicity or endocrine activity was filled with data indicating a high hazard score. In addition, BPBP could be a Benchmark $1_{TP}$ if the transformation products are determined to be feasible, relevant and Benchmark 1.

| **Green Screen Hazard Ratings: [*Phosphoric acid, mixed esters with [1,1'-bisphenyl-4,4'-diol] and phenol*]** | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** | *L* | *L* | DG | **L** | | **L** | | *L* | **L** | DG | **L** | **L** | *H* | *H* | *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.

**Environmental Transformation Products and Ratings[14]:**
**Identify feasible and relevant environmental transformation products (i.e., dissociation products, transformation products, valence states) and/or moieties of concern[15]**

| **Functional Use** | **Life Cycle Stage** | **Transformation Pathway** | **Environmental Transformation Products** | **CAS #** | **Feasible and Relevant?** | **GreenScreen List Translator Score or GreenScreen Benchmark Score** |
|---|---|---|---|---|---|---|
| | | | Phenol | 108-95-2 | | LT-P1 (Pharos) |
| | | | 4'-dihydroxybiphenyl | 92-88-6 | | LT-P1 (Pharos) |
| | | | Diphenyl phosphate | 838-85-7 | | LT-U (GreenWERCS) |

The DfE report lists transformation products as "none identified".

Additional information within the Alternatives assessment report indicates:"Degradation of Phosphoric acid, mixed esters with [1,1'-bisphenyl-4,4'-diol] and phenol has not been well demonstrated in experimental studies (Submitted confidential study); no degradates have been identified. Degradation of Phosphoric acid, mixed esters with [1,1'-bisphenyl-4,4'-diol] and phenol by sequential dephosphorylation could produce phenol (CASRN 108-95-2), 4,4'-dihydroxybiphenyl (CASRN 92-88-6) and diphenyl phosphate (CASRN 838-85-7). The importance of

[14] See GreenScreen Guidance V1.2 Section 13
[15] 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.

dephosphorylation relative to possible competing pathways has not been demonstrated in a published study. Therefore hazards of theoretical degradation products were not considered in this hazard assessment."

## Introduction

**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):** DG
BPBP was assigned a score of DATA GAP for Carcinogenicity based on a lack of any data provided within the EPA's DfE alternatives assessment and no insight into the professional judgment was discussed within the DfE report. While the moderate designation for carcinogenicity within both GreenScreen and EPA's Alternatives assessment is based on the same measured endpoints, the lack of any study data or insight into the rational for the moderate designation led to the assigned data gap score.

The summary provided within the EPA's alternatives assessment was summarized as follows: MODERATE: BPBP may have low potential for carcinogenicity based on professional judgment; there were no structural alerts in the molecule, and a similar confidential analog was negative for carcinogenicity. However, there is uncertainty regarding the carcinogenicity of BPBP due to the lack of data for this substance. Carcinogenic effects cannot be completely ruled out.

**Mutagenicity/Genotoxicity (M) Score (H, M or L): L**
BPBP was assigned a score of LOW for Mutagenicity based on a low score within the EPA's DfE alternatives assessment. The low designation in both GreenScreen and EPA's alternatives assessment for mutagenicity/genotoxicity is based on the same measured endpoints. The score was based on empirical data for BPBP 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 summarized as follows: LOW: BPBP was not mutagenic to bacteria in vitro or in mouse lymphocyte (L5178Y) cells. No chromosomal aberrations were detected in an in vitro mammalian chromosomal aberration assay with Chinese hamster fibroblasts.

**Reproductive Toxicity (R) Score (H, M, or L):** *L*
BPBP 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. The score within EPA's alternatives assessment was based on expert judgment and the finding of no maternal or fetal toxicity reported at 1,000 mg/kg-day (highest dose tested) and therefore is reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was summarized as follows:
LOW: Estimated based on analogy to a similar confidential analog. There were no reproductive effects reported in studies using a confidential structural analog at doses up to 1,000 mg/kg-day.

**Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M or L):** *L*
BPBP was assigned a score of LOW for Developmental Toxicity based on a low score within the EPA's DfE alternatives assessment. 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 and reproductive toxicity conclusions to comparable GreenScreen hazard scores is done on a case by case basis. The score within EPA's alternatives assessment was based on expert judgment and the finding of no maternal or fetal toxicity reported at 1,000 mg/kg-day (highest dose tested) and therefore is reported in italics within the GreenScreen assessment.

The summary provided within the EPA's Alternatives assessment was as follows:
LOW: Estimated based on analogy to a similar confidential analog. There were no developmental effects reported in a confidential structural analog at doses up to 1,000 mg/kg-day. Although predicted to have low hazard, there is high uncertainty due to lack of data related to developmental neurotoxicity.

**Endocrine Activity (E) Score (H, M or L):** DG
BPBP was assigned a score of DATA GAP for Endocrine Activity based on the reporting of no experimental data located within the EPA's DfE alternatives assessment.

**<u>Group II and II* Human Health Effects (Group II and II* Human)</u>**
*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, the more conservative value is used.*

**Acute Mammalian Toxicity (AT) Group II Score (vH, H, M or L): L**
BPBP 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. Specifically DfE reports BPBP to have an oral and dermal $LD_{50}$> 2,000 mg/kg. The score was based on study data and therefore is not reported in italics within the GreenScreen assessment.

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

LOW: Based on oral and dermal $LD_{50}$ values of >2000 mg/kg in rats for BPBP. No experimental data were available for the inhalation route, but due to mist particle size and solubility properties, the inhalation potential is estimated to be low.

**Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)**
**(ST-single) Group II Score (single dose: vH, H, M or L):** *N/A*
BPBP was assigned a score of Not Applicable (N/A) for Systemic Toxicity/Organ Effects based on single exposure. Data were not provided by EPA on single dose toxicity for systemic toxicity/organ effects. Using GreenScreen criteria, absence of single dose data is not considered a data gap as long as data are available for repeated dose.

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): L**
BPBP was assigned a score of LOW for Systemic Toxicity/Organ Effects based on repeated exposure. The low designation for systemic toxicity/organ effects based on repeated exposure in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based GLP OECD 407 study data reported in a submitted confidential study and professional judgment and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: No treatment-related effects were reported in a sub-acute 28-day rat oral (gavage) study with BPBP, indicating a NOAEL of 1,000 mg/kg.

In addition, BPBP is estimated to have low potential for immunotoxicity based on expert judgment. No experimental data for this substance were located.

**Neurotoxicity (N)**
**(N-single) Group II Score (single dose: vH, H, M or L):** *N/A*
BPBP was assigned a score of NOT APPLICABLE (N/A) for Neurotoxicity based on single exposure. Data were not provided by EPA on single dose toxicity for neurotoxicity. Using GreenScreen criteria, absence of single dose data is not considered a data gap as long as data are available for repeated dose.

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*
BPBP 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 upon GLP OECD 407 study data reported in a submitted confidential study and professional judgment; however, there is uncertainty due to lack of data on cholinesterase inhibition which is associated with phosphate esters and therefore is reported in italics within the GreenScreen assessment.

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

LOW: There were no neurotoxic effects observed at doses up to 1,000 mg/kg in a 28-day rat oral (gavage) study. Although low hazard is predicted, there is uncertainty due to lack of data on cholinesterase inhibition which is associated with phosphate esters.

**Skin Sensitization (SnS) Group II* Score (H, M or L): L**
BPBP was assigned a score of LOW for Skin Sensitization. This conclusion was made based upon a GLP OECD 429 study data. 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 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 summarized as follows:
LOW: No sensitizing effect detected in a Mouse Local Lymph Node Assay (LLNA) with BPBP.

**Respiratory Sensitization (SnR) Group II* Score (H, M or L):** DG
BPBP 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**
BPBP was assigned a score of LOW for Skin Irritation/Corrosivity based on tests results provided within the EPA's DfE alternatives assessment that indicates BPBP is not irritating in rabbit skin tests. DfE categorizes BPBP as a very low eye irritant that corresponds to a low score under GreenScreen Skin Irritation/Corrosivity. The score was based upon GLP OECD 405 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 summarized as follows:
VERY LOW: BPBP is not a skin irritant in rabbits.

**Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M or L): L**
BPBP was assigned a score of LOW for Eye Irritation based on tests results provided within the EPA's DfE alternatives assessment which indicates BPBP is not irritating in rabbits. DfE categorizes BPBP as a very low eye irritant which corresponds to a low score under GreenScreen Eye Irritation/Corrosivity. The score was based upon a GLP OECD 405 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: BPBP is not an eye irritant in rabbits.

**<u>Ecotoxicity (Ecotox)</u>**

**Acute Aquatic Toxicity (AA) Score (vH, H, M or L):** *H*
BPBP was assigned a score of HIGH for Acute Aquatic Toxicity. The 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 values from a structurally similar confidential analog. While most study and modeling data within EPA's alternatives assessment indicate a low acute aquatic toxicity score, a single study in algae indicate a high hazard. The score was based on data from an analog 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 summarized as follows: HIGH: Estimated based on an $EC_{50}$ value of <1.0 mg/L in algae for a structurally similar confidential analog. While ECOSAR estimates for algae indicate no effects at saturation (NES), experimental data is preferred over estimates to determine the hazard designation. The results of experimental studies and estimates for fish and daphnia indicate NES.

**Chronic Aquatic Toxicity (CA) Score (vH, H, M or L):** *H*
BPBP was assigned a score of HIGH for Chronic Aquatic Toxicity. The high 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 values from a structurally similar confidential analog. While most study and modeling data within EPA's alternatives assessment indicate a low chronic aquatic toxicity score, a single study in algae indicate a high hazard. The score was based on data from an analog 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 summarized as follows: HIGH: Estimated based on a NOEC value of <0.1 mg/L in algae for a structurally similar confidential analog. While ECOSAR estimates for algae indicate NES, experimental data are preferred over estimates to determine the hazard designation. The results of estimates for fish and daphnia indicate NES.

**Environmental Fate (Fate)**

**Persistence (P) Score (vH, H, M, L, or vL):** *vH*
BPBP was assigned a score of VERY HIGH for Persistence. While the EPA's alternatives assessment gives BPBP a high rating, the information provided within the DfE report indicates that the chemical fulfills criteria for the very high hazard score. The score was based on a confidential guideline study demonstrating the chemical is not readily biodegradable and estimates of BPBP environmental half-lives exceeding 1 year. The very high score is based on modeled estimated values 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 summarized as follows: HIGH: BPBP was not readily biodegradable in a guideline Japanese Ministry of International Trade and Industry (MITI)-I test (1% biodegradation in OECD TG 301C). The n ≥3 oligomers, with a MW >1,000 are expected to have negligible water solubility and poor bioavailability to microorganisms indicating that biodegradation is not expected to be an important removal process in the environment. Abiotic degradation by hydrolysis is limited due to the low water solubility of BPBP (<0.01 mg/L). Similar to other phosphate esters, BPBP hydrolysis is expected to be dependent on pH, occurring slowest under neutral and acidic conditions. BPBP oligomers (n=1 and n=2) do not contain chromophores that absorb at wavelengths >290 nm, and therefore, are not expected to be susceptible to direct photolysis by sunlight. Enzymatic or basic hydrolysis leading to the production of phenol (CASRN 108-95-2), 4,4'-dihydroxybiphenyl (CASRN 92-88-6) and diphenyl phosphate (CASRN 838-85-7) through sequential dephosphorylation is theoretically possible but has not been demonstrated.

**Bioaccumulation (B) Score (vH, H, M, L, or vL): vL**
BPBP was assigned a score of VERY LOW for Bioaccumulation. The low designation for bioaccumulation in EPA's alternatives assessment is equivalent to a very low score in GreenScreen.

The score was based on measured and estimated BAF and BCF values and therefore is not reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was summarized as follows: MODERATE: Although measured BCF values for a commercial mixture result in a Low bioaccumulation hazard designation, the overall bioaccumulation designation is Moderate based on the estimated BCF value for the predominant oligomer component, n = 1, representing 80% of the commercial mixture. The higher MW oligomers that may be found in this mixture (n=2, 3, 4) are expected to have low potential for bioaccumulation.

**Physical Hazards (Physical)**

**Reactivity (Rx) Score (vH, H, M or L):** *L*
BPBP was assigned a score of LOW for Reactivity based upon a confidential study submitted to DfE indicating that the chemical is not explosive and lack of reactive components within the polymer structure. In addition, the DfE alternatives assessment indicates BPBP is expected to have three potential degradation products including phenol (CAS # 108-95-2), 4,4'-dihydroxybiphenyl (CAS # 92-88-6) and diphenyl phosphate (CAS # 838-85-7). All three chemicals have similar structure and are likely to have similar reactivities. Phenol was determined by the European Union's Risk Assessment Report as not being explosive and oxidizing '…*because of structural reasons*' indicating a low level of reactivity. Based upon this information, BPBP was assigned a reactivity of 'low'.[16]

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

[16] http://esis.jrc.ec.europa.eu/doc/risk_assessment/REPORT/phenolreport060.pdf

## 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**