

GreenScreen® Assessment for [Poly[phosphonate-co-carbonate] (CAS# 77226-90-5)]

Method Version: GreenScreen® Version 1.2¹

Verified or Non-Verified²: 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 methods⁵. Any differences in interpretation are explained and justified in this GreenScreen report.

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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 #):
Poly[phosphonate-co-carbonate] (CAS# 77226-90-5)

¹ Use GreenScreen® Assessment Procedure (Guidance) V1.2

² “NON-VERIFIED” means that Verification Has Not Been Performed on this GreenScreen Assessment

³ Available at: <http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf>, 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

Also Called:

Carbonic acid, diphenyl ester, polymer with diphenyl P-methylphosphonate and 4,4'- (1-methylethylidene)bis[phenol]

Tradenames:

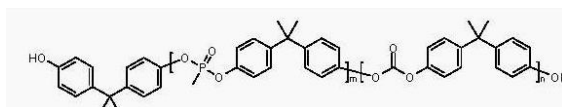
FRX CO35; FRX CO60

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 attributes⁷:

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: There is no absorption expected for any route of exposure for the neat material. Poor absorption of the low MW fraction in solution can be expected for all routes. This polymer is large, with a MW >1,000. Based on professional judgment, it is expected to have limited bioavailability and therefore is not expected to be readily absorbed, distributed or metabolized in the body.

For Polymeric Materials: (delete this section if not a polymeric material)

Identify Monomers and Corresponding Properties

“This alternative is a polymer. Poly[phosphonate-co-carbonate] polymers differ in their ratio of polyphosphonate/polycarbonate (m to n) but would have identical hazard characterizations. The MW of the oligomers are generally >1,000 and are assessed using information contained in the literature concerning polymer assessment and professional judgment (Boethling et al., 1997). A representative structure is drawn to show simplest combination of all feedstock.

The MW for the Poly[phosphonate-co-carbonate] polymers range between 10,000 and 50,000; with <1% MW <1,000 oligomers expected. Phenoxy terminated oligomers are anticipated to predominate.”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 #.

1. % of Each Monomer - NA
 - a) Monomer 1
 - b) Monomer 2
 - c) Monomer 3
2. Are the monomers blocked? (Y/N) - NA
3. Molecular Weight (MW) of polymeric material
4. % of polymeric material with
 - a) MW <500
 - b) MW <1,000 The MW for the Poly[phosphonate-co-carbonate] range between 10,000 and 50,000; with <1% MW <1,000 oligomers expected
5. % Weight Residual Monomers NA
6. Solubility/Dispersability/Swellability - NA
7. Particle size - NA
8. Overall charge of polymeric material - NA
9. Identify constituents and residual concentrations of
 - a) Catalysts - NA
 - b) Processing aids - NA
10. Identify any monomers, oligomers, catalysts or processing aids classified as Benchmark 1 according to the hazard identification lists in the GreenScreen List Translator. - NA

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

1. Flame Retardant

GreenScreen Benchmark Score and Hazard Summary Table:^{9,10,11,12}

Poly[phosphonate-co-carbonate] was assigned a **Benchmark Score of 2** based on very high persistence and moderate Group II human toxicity endpoints (skin and eye irritation). Poly[phosphonate-co-carbonate] could be a benchmark 1 if the data gap for endocrine activity or respiratory sensitization was filled with data indicating a high hazard score.

Green Screen Hazard Ratings: Poly[phosphonate-co-carbonate]																			
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										
L	L	L	L	DG	L		L		L	L	DG	M	M	L	L	vH	vL	L	L

⁸ An Alternatives Assessment for the Flame Retardant Decabromodiphenylether (DecaBDE) Final Report. <http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf>. 4-552

⁹ See Appendix A for a glossary of hazard endpoint acronyms

¹⁰ See Appendix B for alternative GreenScreen Hazard Summary Table (Classification presented by exposure route)

¹¹ For inorganic chemicals only, see GreenScreen Guidance V1.2 Section 14.4. (Exceptions for Persistence)

¹² 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.

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 Ratings¹³:

Identify feasible and relevant environmental transformation products (i.e., dissociation products, transformation products, valence states) and/or moieties of concern¹⁴

Functional Use	Life Cycle Stage	Transformation Pathway	Environmental Transformation Products	CAS #	Feasible and Relevant?	GreenScreen List Translator Score or GreenScreen Benchmark Score
			None			

Introduction

This alternative is a polymer. Poly[phosphonate-co-carbonate] polymers differ in their ratio of polyphosphonate/polycarbonate (m to n) but would have identical hazard characterizations. The MW of the oligomers are generally >1,000 and are assessed together using the Sustainable Futures (SF) polymer assessment criteria (U.S. EPA, 2010).

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): L

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Carcinogenicity based on a low score within the EPA's DfE alternatives assessment due to limited bioavailability and SF polymer assessment guidance. The low designation in both GreenScreen and EPA's alternatives assessment is

¹³ See GreenScreen Guidance V1.2 Section 13

¹⁴ 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.

based on the same measured endpoints. The score was based on professional judgment and is therefore is reported in italics within the GreenScreen assessment.

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

LOW: This polymer is large, with a MW >1,000. Based on expert judgment, it is expected to have few to no residual monomers. Additionally, crosslinking, swellability, dispersability, reactive functional groups, inhalation potential, and hindered amine groups are not expected. Therefore, there is low potential for carcinogenicity based on professional judgment and the SF polymer assessment guidance. No data located.

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

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Mutagenicity based on a low score within the EPA's DfE alternatives assessment due to limited bioavailability and SF polymer assessment guidance. The low designation in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on 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: This polymer is large, with a MW >1,000. It is expected to have limited bioavailability and therefore has low potential for genotoxicity.

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

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Reproductive Toxicity based on a low score within the EPA's DfE alternatives assessment due to limited bioavailability and SF polymer assessment guidance. For reproductive toxicity, EPA's DfE uses numerical data quantifying the hazard associated with the 3 different hazard levels, whereas Green-Screen 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 was based expert judgment 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: This polymer is large, with a MW >1,000. It is expected to have limited bioavailability and therefore has low potential for reproductive effects based on professional judgment.

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M or L): *L*

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Developmental Toxicity within the EPA's DfE alternatives assessment due to limited bioavailability and SF polymer assessment guidance. For developmental toxicity, EPA's DfE uses numerical data quantifying the hazard associated with the 3 different hazard levels, whereas Green-Screen 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 expert judgment and therefore is reported in italics within the GreenScreen assessment.

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

LOW: This polymer is large, with a MW >1,000. It is expected to have limited bioavailability and therefore has low potential for reproductive effects based on professional judgment.

Endocrine Activity (E) Score (H, M or L): DG

Poly[phosphonate-co-carbonate] was assigned a score of DATA GAP for Endocrine Activity based on no data located.

The summary provided within the EPA's alternatives assessment was as follows:
No data located. This polymer is large, with a MW >1,000. Based on expert judgment, it is not expected to have endocrine activity due to its poor bioavailability and inability to be readily metabolized in the body.

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

Poly[phosphonate-co-carbonate] 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 acute mammalian toxicity score was based on test data and expert 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: Based on experimental LD₅₀ values > 2,000 mg/kg. This compound is also expected to have limited bioavailability and therefore is of low potential for acute mammalian toxicity.

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): L

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Systemic Toxicity/Organ Effects based on a low score for repeated exposure within the EPA's DfE report. The low designation for systemic toxicity/organ effects on repeated exposure in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on expert judgment and therefore is reported in italics within the GreenScreen assessment.

The summary provided within the EPA's alternatives assessment was as follows:
LOW: This polymer is large, with a MW >1,000. It is expected to have limited bioavailability; however, because the MW is >10,000, there is the possibility of lung overloading if >5% of the particles are in the respirable range as a result of dust forming operations.

In addition:

This polymer is large, with a MW >1,000. Based on expert judgment, it is expected to have limited bioavailability and therefore is of low concern.

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*

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Neurotoxicity based on a low score within the EPA's DfE alternatives assessment. This conclusion within the DfE report was based on limited bioavailability due to size and professional judgment. The low designation in both GreenScreen and EPA's Alternatives assessment is based on the same measured endpoints. The score was based on 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: This polymer is large, with a MW >1,000. It is expected to have limited bioavailability and therefore has low potential for neurotoxicity based on professional judgment.

Skin Sensitization (SnS) Group II* Score (H, M or L): *L*

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Skin Sensitization. This conclusion was based on expert judgment with no additional information provided. 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 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: Estimated to not have potential for skin sensitization based on expert judgment.

Respiratory Sensitization (SnR) Group II* Score (H, M or L): DG

Poly[phosphonate-co-carbonate] 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): *M*

Poly[phosphonate-co-carbonate] was assigned a score of MODERATE for Skin Irritation/Corrosivity based on expert judgment within the EPA's DfE alternatives assessment which indicates uncertain potential for irritation based on the phenol moieties. DfE categorizes Poly[phosphonate-co-carbonate] as a low dermal irritant which corresponds to a moderate score under GreenScreen Skin Irritation/Corrosivity. The score was based on 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: Uncertain potential for irritation based on the phenol moieties and professional judgment. No data located.

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

Poly[phosphonate-co-carbonate] was assigned a score of MODERATE for Eye Irritation based upon expert judgment within the EPA's DfE Alternatives assessment for eye irritation based on uncertain

potential for irritation based on the phenol moieties. DfE categorizes Poly[phosphonate-co-carbonate] as a low eye irritant which corresponds to a moderate score under GreenScreen Eye Irritation/Corrosivity. The score was based on 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: Uncertain potential for irritation based on the phenol moieties and professional judgment. No data located.

Ecotoxicity (Ecotox)

Acute Aquatic Toxicity (AA) Score (vH, H, M or L): *L*

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Acute Aquatic Toxicity. The low 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 expert judgment and therefore is reported in italics within the GreenScreen assessment.

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

LOW: Non-ionic polymers with a MW >1,000 that do not contain reactive functional groups and are comprised of minimal low MW oligomers are estimated to display no effects at saturation (NES). These polymers display NES because the amount dissolved in water is not anticipated to reach a concentration at which adverse effects may be expressed. Bioavailability is limited because this chemical cannot be absorbed through membranes due to large size.

Chronic Aquatic Toxicity (CA) Score (vH, H, M or L): *L*

Poly[phosphonate-co-carbonate] was assigned a score of LOW 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 expert judgment and therefore is reported in italics within the GreenScreen assessment.

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

LOW: Non-ionic polymers with a MW >1,000 that do not contain reactive functional groups and are comprised of minimal low MW oligomers are estimated to display NES. These polymers display NES because the amount dissolved in water is not anticipated to reach a concentration at which adverse effects may be expressed. Guidance for the assessment of aquatic toxicity hazard leads to a low concern for those materials that display NES.

Environmental Fate (Fate)

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

Poly[phosphonate-co-carbonate] was assigned a score of VERY HIGH for Persistence. The score was based on expert judgment as the substance has a MW >1,000 and is not anticipated to be assimilated by microorganisms. Therefore, biodegradation is not expected to be an important removal process. It is also not expected to be removed by other degradative processes under environmental conditions because of limited water solubility and limited partitioning to air. The hazard score is based on 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 summarized as follows:

VERY HIGH: A very limited fraction of these polymers is expected to have a MW of >1,000; therefore, they are not anticipated to be assimilated by microorganisms and biodegradation is not expected to be an important removal process. They are also not expected to be removed by other degradative processes under environmental conditions because of limited water solubility and limited partitioning to air. They are expected to partition primarily to sediment and soil, where their estimated half-life is >1 year. The polymers lack the functional groups that hydrolyze under environmental conditions. These polymers do not contain chromophores that absorb at wavelengths >290 nm, and therefore, they are not expected to be susceptible to direct photolysis by sunlight.

Bioaccumulation (B) Score (vH, H, M, L, or vL): *vL*

Poly[phosphonate-co-carbonate] 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 an expert judgment as the substance has a MW >1,000 and is not anticipated to be assimilated by aquatic organisms; therefore, bioconcentration is not expected. The score is based on expert judgment and therefore is reported in italics within the GreenScreen assessment.

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

LOW: These polymers are expected to have negligible water solubility and poor bioavailability indicating that these polymers should be of low potential for bioaccumulation.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M or L): *L*

Poly[phosphonate-co-carbonate] was assigned a score of LOW for Reactivity based on professional judgment and structural similarity to other chemicals. Because of the lack of concrete data for this endpoint, the score of LOW was italicized.

Poly[phosphonate-co-carbonate] consists of two major components, an phosphate base and an organic chain based upon Bisphenol A (BPA). BPA (CAS 1344-28-1) is not reactive except in the presence of strong acids, bases acid chlorides or acid anhydrides (HSDB, 2013). New Jersey has assigned BPA a reactivity ranking of '0' indicating BPA has 'minimal' reactivity (New Jersey, 2008).

Based upon professional judgment and information supplied by industry, poly[phosphonate-co-carbonate] is unlikely to be reactive.

References:

National Library of Medicine's Hazardous Substances Database (HSDB), data on [Bisphenol A](#), accessed 12/2013.

New Jersey Department of Health, Right to Know hazardous Substance Fact Sheet on [Bisphenol A](#), December 2008, 6 p., accessed 12/2013.

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

Poly[phosphonate-co-carbonate] 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**