

GreenScreen® Assessment for [Aluminum diethylphosphinate (CAS#225789-38-8)]

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.

Note: All assessments were shared with industry representatives and other stakeholders. This assessment includes comments by one manufacturer in response to USEPA’s Alternatives Assessment final report. These comments, if accepted by USEPA might change the hazard classification and subsequently the GreenScreen Benchmark score. The data referred to in the comments are not included in this assessment.

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Date: February 9, 2014 (expires after 3 years)	Date: March 19, 2014
Licensed Profiler or Certified Practitioner (specify): N/A	

¹Use 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 Report <http://www.epa.gov/dfepubs/projects/decaBDE/deca-report-complete.pdf>; p 4-35

⁴ Available at: <http://www.epa.gov/dfepubs/projects/decaBDE/deca-report-complete.pdf>, accessed 10/2013.

⁵ Details available at: <http://www.cleanproduction.org/Greenscreen.v1-2.php>, accessed 10/2013.

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 #):

Aluminum diethylphosphinate (CAS#225789-38-8)

Also Called:

Aluminium diethylphosphinate, Aluminium tris(diethylphosphinate), DEPAL, Alpi

Tradenames:

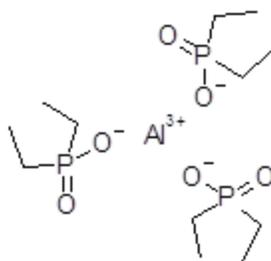
Exolit® OP 930, Exolit® OP 935, Exolit® OP 1230, Exolit® OP 1240

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

Confidential aluminum metal salts

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:

According to the DfE report, “This alternative is an inorganic compound and in the absence of experimental data, professional judgment using chemical class and structural considerations were used to complete this hazard profile.”⁸

1. Particle size (e.g. silica of respirable size)
2. Structure (e.g. amorphous vs. crystalline)
3. Mobility (e.g. Water solubility, volatility)

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 <http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf> chemical by CAS #.

⁸ An Alternatives Assessment for the Flame Retardant Decabromodiphenylether (DecaBDE) Final Report <http://www.epa.gov/dfe/pubs/projects/decaBDE/deca-report-complete.pdf>; p 4-35

4. Bioavailability: Based on estimates of physical and chemical properties, analogs, and professional judgment, aluminum diethylphosphinate is determined to not be readily absorbed through skin but is absorbed through the inhalation of dust and oral exposure.

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

1. Flame Retardant

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

Aluminum diethylphosphinate was assigned a **Benchmark Score of 2** based on moderate Group I human toxicity endpoints (developmental toxicity); and very high persistence (due to the presence of the metal aluminum) along with moderate repeat dose systemic and neurotoxic endpoints. Aluminum diethylphosphinate 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: [<i>Aluminium diethylphosphinate</i>]																			
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										
<i>L</i>	<i>L</i>	<i>L</i>	<i>M</i>	DG	<i>L</i>		<i>M</i>		<i>M</i>	<i>L</i>	DG	<i>L</i>	<i>M</i>	<i>M</i>	<i>M</i>	<i>vH</i>	<i>vL</i>	<i>L</i>	<i>L</i>

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.

⁹See Appendix A for a glossary of hazard endpoint acronyms

¹⁰See 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.

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			

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*

Aluminum diethylphosphinate was assigned a score of LOW for Carcinogenicity 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 estimated based on analogy to confidential metal salts and therefore is reported in italics within the GreenScreen assessment.

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

LOW: Aluminum diethylphosphinate is estimated to be of low hazard for carcinogenicity based on comparison to analogous metal salts and professional judgment.

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

Aluminum diethylphosphinate 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 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: Experimental studies indicate that aluminum diethylphosphinate does not cause gene mutations in bacteria or chromosomal aberrations in mammalian cells.

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.

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

Aluminum diethylphosphinate was assigned a score of LOW for Reproductive Toxicity based on a very 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 very low score was based on a measured NOAEL >1,000 mg/kg-day 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:

VERY LOW: There were no reproductive effects reported in a reproduction/developmental toxicity screen in rats at doses up to 1,000 mg/kg-day. In addition, aluminum diethylphosphinate is estimated to be of low hazard for reproductive effects resulting from the presence of a bioavailable metal species, by professional judgment based on a comparison to analogous metal salts..

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

Aluminum diethylphosphinate was assigned a score of MODERATE 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. DfE's moderate score was estimated based on analogy to confidential metal salts and therefore is reported in italics within the GreenScreen assessment.

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

MODERATE: Aluminum diethylphosphinate is estimated to be of moderate hazard for developmental effects resulting from the presence of a bioavailable metal species, by professional judgment based on a comparison to analogous metal salts

Comment from manufacturer: "EPA in addition gives the reasoning "Estimated based on analogy to phosphate esters and associated cholinesterase inhibition." However, diethylphosphinate cannot cause cholinesterase inhibition because this requires a specific molecular structure which is not present in alkyl phosphinates. See also comment below on non-bioavailability of aluminium from DEPAL."

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

Aluminum diethylphosphinate was assigned a score of DATA GAP for Endocrine Activity. This conclusion was based on no data located.

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

Aluminum diethylphosphinate 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: Experimental studies indicate that oral and dermal routes to rats do not produce substantial mortality at levels up to 2,000 mg/kg. There were no lethality data located for 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): M

Aluminum diethylphosphinate was assigned a score of MODERATE for Systemic Toxicity/Organ Effects based on a moderate score within the EPA's DfE alternatives assessment. The moderate designation for systemic toxicity/organ effects on repeated exposure in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints; however, the GreenScreen includes immunotoxicity within the endpoint. The moderate score within the DfE report was based on experimental studies indicating no adverse effects at levels up to 1,000 mg/kg-day and professional judgment. As the immunotoxicity component of this score is based on professional judgment within EPA's Alternatives assessment, it is reported in italics within the GreenScreen assessment.

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

MODERATE: Estimated to be of moderate hazard for immunotoxicity, due to the presence of a bioavailable metal species, based on comparison to analogous metal salts and professional judgment. Experimental studies indicate oral exposure to rats produces no adverse effects at levels up to 1,000 mg/kg-day.

In addition:

Aluminum diethylphosphinate is estimated to be of moderate hazard for immunotoxicity, due to the presence of a bioavailable metal species, based on comparison to analogous metal salts and professional judgment.

Comment from manufacturer: "Clariant commissioned a study at TNO Institute in the Netherlands which shows that the bioavailability / bioaccessibility of the aluminium from DEPAL in mammals is very low (0.1%)."

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):M

Aluminum diethylphosphinate 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 measured endpoints. The score was based on professional judgment and estimated based on analogy to confidential metal salts and therefore is reported in italics within the GreenScreen assessment.

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

MODERATE: Aluminum diethylphosphinate is estimated to be of moderate hazard for neurotoxicity, due to the presence of a bioavailable metal species, based on comparison to analogous metal salts and professional judgment.

Comment from manufacturer: "See previous comment."

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

Aluminum diethylphosphinate was assigned a score of LOW for Skin Sensitization. This conclusion was 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: Negative for skin sensitization in guinea pigs.

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

Aluminum diethylphosphinate was assigned a score of DATA GAP for Respiratory Sensitization. This conclusion was based on no data located.

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

Aluminum diethylphosphinate was assigned a score of LOW for Skin Irritation/Corrosivity based on tests results provided within the EPA's DfE alternatives assessment which indicates aluminum diethylphosphinate is not irritating in rabbit skin tests. DfE categorizes aluminum diethylphosphinate 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: Aluminum diethylphosphinate is not irritating to rabbit skin.

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

Aluminum diethylphosphinate was assigned a score of MODERATE for Eye Irritation based on tests results provided within the EPA's DfE alternatives assessment which indicate aluminum diethylphosphinate is a slight eye irritant in rabbits. DfE categorizes aluminum diethylphosphinate 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: Aluminum diethyphosphinate is slightly- to non-irritating in rabbit eyes.

Ecotoxicity (Ecotox)

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

Aluminum diethyphosphinate was assigned a score of MODERATE for Acute Aquatic Toxicity. The moderate 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 measured in green algae 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:

MODERATE: The measured green algae EC₅₀ is between 10 and 100 mg/L. For fish and Daphnia, adequate toxicity values have not been determined; reported values are not LC₅₀ but the highest dose tested.

Comment from manufacturer: "OECD-/EU-based studies submitted by Clariant show LC50 > 100 mg/L for fish, daphnia and algae; EPA used a more pre-cautionary interpretation of the data."

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

Aluminum diethyphosphinate was assigned a score of MODERATE for Chronic Aquatic Toxicity. The moderate 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 in green algae and therefore is not reported in italics within the GreenScreen assessment.

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

MODERATE: Experimental values for green algae are between 1 mg/L and 10 mg/L, while measured toxicity values for fish and Daphnia are >10 mg/L.

Comment from manufacturer: "EPA used the NOEC value from a submitted study on algae toxicity. However, not NOEC but the EC10 value of 34 mg/L should be considered as representing chronic toxicity. Nevertheless, there are recent studies (non-GLP) indicating Daphnia chronic toxicity effects around 10 mg/L."

Environmental Fate (Fate)

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

Aluminum diethyphosphinate was assigned a score of VERY HIGH for Persistence. The very high designation for persistence in both GreenScreen and EPA's alternatives assessment is based on the same measured endpoints. The score was based on the recalcitrant properties of the metal ion and not on the biodegradation of the organic portion of the chemical. The hazard score is based on estimated values for the metal ion 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:

VERY HIGH: For the organic counter-ion, estimates indicate that the half-life for ultimate aerobic biodegradation in water is less than 60 days, which converts to moderate potential for persistence.

However, the metal ion is recalcitrant to biodegradation or other typical environmental removal processes.

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

Aluminum diethylphosphinate 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 estimated BAF values less than 100. As the score is based on estimated values, it is reported in italics within the GreenScreen assessment.

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

LOW: Aluminum diethylphosphinate is not expected to have potential for bioaccumulation.

Physical Hazards (Physical)

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

Aluminum diethylphosphinate 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.

Aluminum diethylphosphinate consists of two major components, an aluminum (III) ion and diethylphosphinate anions. Aluminum (III) is the most stable form of the element. It can coordinate with anions like the hydroxide ion in water, but its inherent reactivity is very low. The diethylphosphinate portions are similar to phosphate containing flame retardants such as triphenylphosphate (TPP) and resorcinol diphenylphosphate (RDP), both of which are currently used extensively in consumer products and have been found not to be reactive. The combination of these two components is unlikely to be reactive based upon professional judgment.

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

Aluminum diethylphosphinate 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:

**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**