
GREENSCREEN® SUMMARY REPORT

DOCUMENT STATUS FINAL

REPORT TITLE | GreenScreen® Version 1.4 Summary Results for Aluminum Diethylphosphinate (CAS #225789-38-8)

CHEMICAL NAME | Aluminum Diethylphosphinate

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DATE: March 6, 2024

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INTRODUCTION

This report presents the results of a GreenScreen[®] for Safer Chemicals (version 1.4) assessment for the following substance:

- Aluminum diethylphosphinate (CAS #225789-38-8)

Thousands of chemicals have undergone GreenScreen[®] assessments since Clean Production Action published version 1.0 of the GreenScreen[®] for Safer Chemicals methodology in 2009. Of note, Clariant Plastics and Coatings (Deutschland) GmbH was an early adopter of GreenScreen[®]. Clariant's aluminum diethylphosphinate was one of the first chemicals to undergo a GreenScreen[®] assessment, as reflected by this chemical's low GreenScreen[®] document control number ("GS-4"), which indicates that it was the fourth chemical assessed by ToxServices under CPA's GreenScreen[®] methodology (ToxServices 2010). This GreenScreen[®] assessment has been updated over the years to incorporate additional health effects and environmental studies performed on aluminum diethylphosphinate, as well as updates to GreenScreen[®] assessment methodology.

This summary report reflects the most recent GreenScreen[®] assessment for aluminum diethylphosphinate completed by ToxServices (ToxServices 2024). This GreenScreen[®] was completed on February 28, 2024 and expires on February 28, 2029.

OVERVIEW: ALUMINUM DIETHYLPHOSPHINATE

Aluminum diethylphosphinate is an aliphatic, acyclic, organophosphorus compound used as a flame retardant. It has high temperature stability, is slow to dissolve in water, and owes its efficiency to its high phosphorus content (23-24%) (U.S. EPA 2015a). Aluminum diethylphosphinate is marketed by Clariant Corp. under the tradenames Exolit OP 1230, Exolit OP 1240, Exolit OP 930, Exolit OP 935, and Exolit OP 945. These differ by particle size (5 to 40 µm) and variations in the production process. Aluminum diethylphosphinate is used on its own in engineering plastics like polyamides and polyesters or thermosets like epoxy resins. In addition, it is combined with nitrogen-containing and other synergists such as melamine polyphosphate or cyanurate to impart flame retardancy in certain polymers such as polyamides (Braun et al. 2007, 2008).

GREENSCREEN[®] FOR SAFER CHEMICALS FRAMEWORK

The GreenScreen[®] for Safer Chemicals is a chemical screening method designed to identify less hazardous chemicals using a standardized approach that considers both human health endpoints and environmental fate and toxicity endpoints (CPA 2018). A GreenScreen[®] chemical hazard assessment can identify substances that are inherently less hazardous for humans and the environment, and effectively manages chemical risk by reducing hazard rather than controlling exposure to potentially toxic chemicals.

Under the GreenScreen[®] for Safer Chemicals (version 1.4) criteria (CPA 2018), chemicals are assessed according to the following six steps (see Appendix B):

1. Identify chemical to assess.
2. Research (collect and review toxicological data and authoritative/screening lists).
3. Classify hazards for 18 endpoints against endpoint-specific criteria.
4. Identify environmental transformation products.
5. Assess environmental transformation products.
6. Assign a GreenScreen Benchmark™ Score.

Each of the 18 hazard endpoints relates to human health effects, aquatic toxicity, or flammability / reactivity. Each hazard endpoint is given a score of Very Low hazard (vL), Low hazard (L), Moderate hazard (M), High hazard (H), or Very High hazard (H).

As shown in Appendix C, Figure C-1, the combination of hazards for the 18 endpoints translates to a GreenScreen Benchmark™ Score, which expresses decreasing hazard with increasing Benchmark scores in following order:

- Benchmark One: Avoid (Chemical of High Concern)
- Benchmark Two: Use (But Search for Safer Substitutes)
- Benchmark Three: Use (But Still Opportunity for Improvement)
- Benchmark Four: Prefer (Safer Chemical)

In addition, chemicals that have insufficient data or data gaps for specific hazard endpoints are assigned a Benchmark™ Score of Unspecified (“U”).

GREENSCREEN® HAZARD ASSESSMENT RESULTS FOR ALUMINUM DIETHYLPHOSPHINATE

Aluminum diethylphosphinate was assigned a **GreenScreen Benchmark™ Score of 3** (“Use but Still Opportunity for Improvement”). This score is based on the following hazard score combinations:

- Benchmark 3a
 - Very High Persistence - P

A data gap (DG) exists for endocrine activity-E. As outlined in GreenScreen® Guidance Section 11.6.2.1 and Annex 5 (Conduct a Data Gap Analysis), aluminum diethylphosphinate meets requirements for a GreenScreen Benchmark™ Score of 3 despite the hazard data. In a worst-case scenario, if aluminum diethylphosphinate were assigned a High score for the data gap E, it would be categorized as a Benchmark 1 Chemical.

The GreenScreen® Benchmark Score for aluminum diethylphosphinate has changed over time. The original GreenScreen® assessment was performed in 2010 under version 1.0 criteria and ToxServices assigned a Benchmark 2 (BM-2) score. The BM-2 score was maintained with version 1.0, 1.2, and 1.3 updates in 2011, 2012, 2013, and 2016. The BM-2 score was raised to a BM-3 due to availability of more data in a version 1.3 update in October 2016, and this benchmark score was maintained in several rounds of version 1.4 updates. Most recently, ToxServices maintained the BM-3 score, but added

supporting toxicokinetic data, and changed the confidence ratings for the persistence (P) and reactivity (Rx) endpoints from low to high confidence.

GreenScreen® Benchmark Score for Relevant Route of Exposure:

As a standard approach for GreenScreen® evaluations, all exposure routes (oral, dermal, and inhalation) are evaluated together, so the GreenScreen® Benchmark Score of 3 (“Use but Still Opportunity for Improvement”) is applicable for all routes of exposure.

Table 1: GreenScreen® Hazard Summary Table for Aluminum Diethylphosphinate

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
						s	r*	s	r*	*	*								
<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	DG	L	L	L	<i>L</i>	L	<i>L</i>	L	L	L	L	L	vH	vL	L	L

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect lower confidence in the hazard classification while hazard levels in **BOLD** font reflect higher confidence. 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 instead of repeated exposures. Group II* Human Health endpoints are indicated by an * after the name of the hazard endpoint or after “repeat” for repeated exposure sub-endpoints. Please see Appendix D for a glossary of hazard acronyms.

CONCLUSION

This Executive Summary report presents the results of a GreenScreen® for Safer Chemicals assessment (version 1.4) for the following substance:

- ToxServices has determined that Aluminum diethylphosphinate (CAS #225789-38-8) has a **GreenScreen Benchmark™ Score of 3** (“Use but Still Opportunity for Improvement”).

REFERENCES

Braun, U., H. Bahr, H. Sturm, and B. Schartel. 2008. Flame retardancy mechanisms of metal phosphinates and metal phosphinates in combination with melamine cyanurate in glass-fiber reinforced poly(1,4-butylene terephthalate): The influence of metal cation. *Polymers for Adv. Technologies* 19(6):680-692.

Braun, U., B. Schartel, M. Fichera. 2007. Flame retardancy mechanisms of aluminum phosphinate in combination with melamine polyphosphate and zinc borate in glass-fibre reinforced polyamide 6,6. *Polymer Degradation and Stability* 92(8):1528-1545.

Clean Production Action (CPA). 2018. The GreenScreen® for Safer Chemicals Guidance. Version 1.4 Guidance. Dated January 2018. Available: https://www.greenscreenchemicals.org/static/ee_images/uploads/resources/GreenScreen_Guidance_v1_4_2018_01_Final.pdf

ToxServices. 2010. Aluminum Diethylphosphinate (CAS #225789-38-8) GreenScreen® for Safer Chemicals Assessment. GS-4. Version 1.0. Dated August 15, 2010.

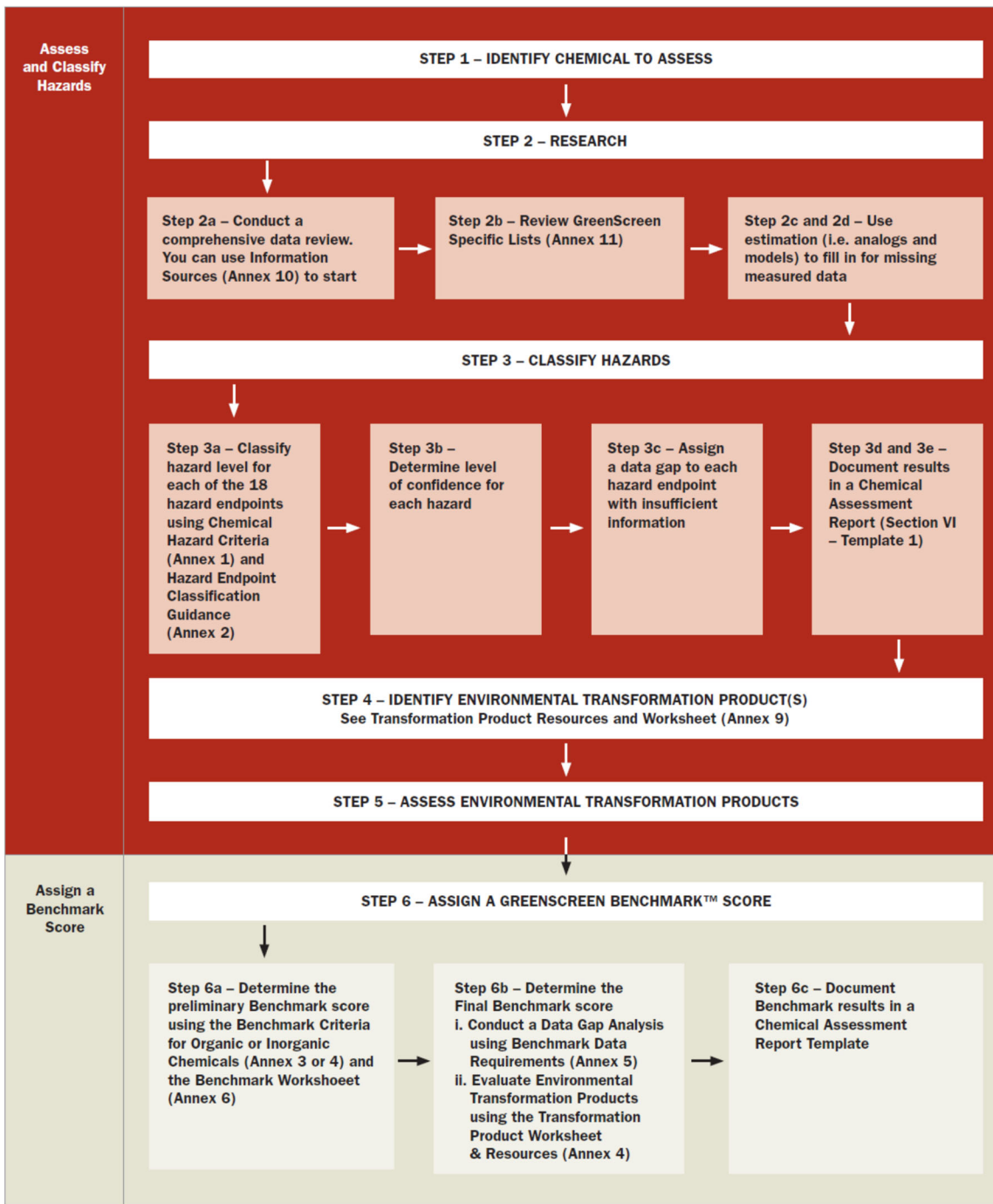
ToxServices. 2024. Aluminum Diethylphosphinate (CAS #225789-38-8) GreenScreen® for Safer Chemicals Assessment. GS-4. Version 1.4. Dated February 28, 2024. Available: <https://database.toxservices.com/>

APPENDIX A: TOXSERVICES' QUALIFICATIONS

The date of the GreenScreen® for Safer Chemicals assessment is **February 28, 2024** and the expiration date is **February 28, 2029**.

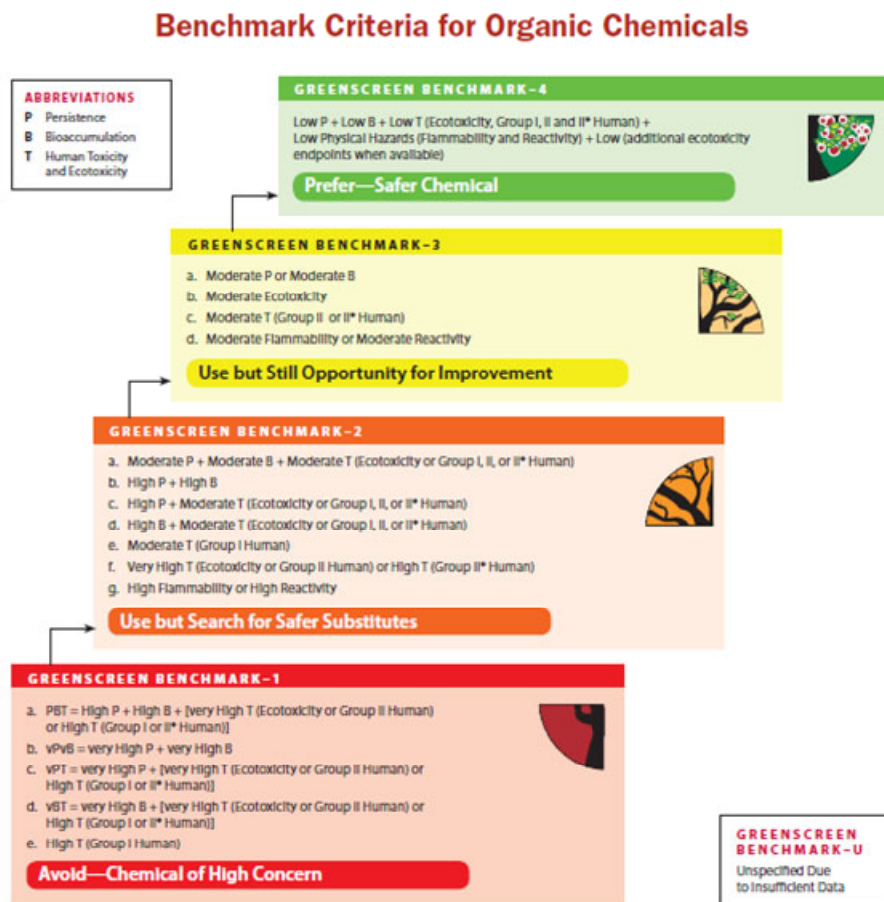
Name of assessor (Person or Firm)	ToxServices LLC
Demonstration that assessor meets the applicable qualifications	Accredited Clean Production Action GreenScreen® Profiler
A degree in chemistry, chemical engineering, biology, toxicology, environmental sciences, or a related field relevant to the subject matter in the assessment	Staff consists of numerous degreed toxicologists, green chemists, and environmental scientists
Documented training in conducting chemical hazard alternative assessments	Accredited Clean Production Action GreenScreen® Profiler
Experience in conducting at least one assessment that has been peer reviewed by experts in the field or published in relevant journals or in repositories of reviewed assessments	ToxServices to date as completed over 2,000 GreenScreen® assessments

**APPENDIX B: GREENSCREEN® CHEMICAL ASSESSMENT PROCESS
(REPRODUCED FROM CPA 2018)**



APPENDIX C: GREENSCREEN® BENCHMARK TABLE
(Reproduced from CPA 2018)

Figure C-1: GreenScreen® Benchmarks



See Section 11.6 for instructions.

Group I Human includes Carcinogenicity, Mutagenicity/Genotoxicity, Reproductive Toxicity, Developmental Toxicity (incl. Developmental Neurotoxicity), and Endocrine Activity. **Group II Human** includes Acute Mammalian Toxicity, Systemic Toxicity/Organ Effects-Single Exposure, Neurotoxicity-Single Exposure, Eye Irritation and Skin Irritation. **Group II* Human** includes Systemic Toxicity/Organ Effects-Repeated Exposure, Neurotoxicity-Repeated Exposure, Respiratory Sensitization, and Skin Sensitization. Immune System Effects are included in Systemic Toxicity/Organ Effects. **Ecotoxicity** includes Acute Aquatic Toxicity and Chronic Aquatic Toxicity.

* For inorganic chemicals, see "Annex 4: Benchmark Criteria for Inorganic Chemicals."

**APPENDIX D: GREENSCREEN® HAZARD BENCHMARK ACRONYMS
(alphabetical order)**

- (AA) Acute Aquatic Toxicity**
- (AT) Acute Mammalian Toxicity**
- (B) Bioaccumulation**
- (C) Carcinogenicity**
- (CA) Chronic Aquatic Toxicity**
- (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**