POLYQUATERNIUM-10

(CAS #68610-92-4)

GREENSCREEN® FOR SAFER CHEMICALS (GREENSCREEN®) ASSESSMENT

Prepared by:

ToxServices LLC

Assessment Date: July 9, 2025

ToxServices Review Date: July 9, 2030[1]

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING
1526 New Hampshire Ave., N.W., Suite 350
Washington, D.C. 20036

[1] Although CPA's Assessment Expiration Policy (CPA 2018a) indicates that Benchmark 1 assessments have no expiration date, ToxServices strives to review BM-1s in a five-year period to ensure currency of data presented in the BM-1 GreenScreen® assessments.

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GreenScreen® Executive Summary for Polyquaternium-10 (CAS #68610-92-4)

Polyquaternium-10 (also known as cellulose, 2-hydroxyethyl 2-(2-hydroxy-3-(trimethyl ammonio) propoxy) ethyl 2-hydroxy-3-(trimethylammonio)propyl ether, chloride) is a cationic, polymeric derivative of hydroxyethylcellulose. Polyquaternium-10 is produced by reacting hydroxyethyl cellulose with epichlorohydrin, followed by quaternization using trimethylamine. It functions as a film-forming and anti-static agent in personal care product formulations. Although polyquaternium-10 has a high molecular weight of $2.5 \times 10^6 - 6.0 \times 10^6$ g/mol, ToxServices did not evaluate it against the GreenScreen® polymer criteria, because it is a natural polymer that is neither a thermoset nor a thermoplastic polymer, which are typically evaluated under the GreenScreen® polymer criteria. Additionally, alkoxylate polymers (of which polyquaternium-10 is a member) are not considered polymers under REACH. Polyquaternium-10 has variable structures leading to variable molecular weights and charge densities. This report evaluates all variations of polyquaternium-10 based on publicly available data.

Polyquaternium-10 was conservatively assigned a **GreenScreen Benchmark™ Score of 1** ("Avoid – Chemical of High Concern"). This score is based on the following hazard score combinations:

- Benchmark 1c
    - Very High Persistence-P + Very High Ecotoxicity (acute aquatic-AA and chronic aquatic-CA)

It should be noted that this score may not apply to all forms of polyquaternium-10, as this class of polymers has variable molecular weights and charges; some forms of this polymer may be designed to have enhanced biodegradability and/or lower aquatic toxicity, which would result in a more favorable Benchmark score.

Data gaps (DG) exist for carcinogenicity-C, endocrine activity-E, systemic toxicity (repeated dose)-STr*, and neurotoxicity (single and repeated exposure)-Ns and Nr*. As outlined in GreenScreen® Guidance Section 11.6.2.1 and Annex 5 (Conduct a Data Gap Analysis), polyquaternium-10 meets requirements for a GreenScreen Benchmark™ Score of 1 despite the hazard data gaps.

New Approach Methodologies (NAMs) used in this GreenScreen® include use of *in vitro* assays to assess genotoxicity and endocrine activity, and evaluation of structural alerts for the assessment of carcinogenicity and respiratory tract sensitization. The quality, utility, and accuracy of NAM predictions are greatly influenced by two primary types of uncertainties:

- Type I: Uncertainties related to the input data used
- Type II: Uncertainties related to extrapolations made

Type I (input data) uncertainties in polyquaternium-10's NAMs dataset include lack of, or insufficient, experimental data to assess carcinogenicity, endocrine activity, and respiratory sensitization, and there are no validated test methods for respiratory sensitization. Polyquaternium-10's Type II (extrapolation output) uncertainties include reliance on structural alerts to assess some endpoints without defined applicability domains, use of *in vitro* assays that do not entirely mimic *in vivo* metabolic conditions, limitations of *in vitro* genotoxicities in focusing on a few events in the process of mutagenicity that may or may not be repaired, uncertain *in vivo* relevance of high throughput screening assays for endocrine receptor activity, and EDSP's insufficient coverage of critical endocrine pathways. Some of polyquaternium-10's type II uncertainties were alleviated by the use of *in vitro* test batteries and/or in combination of *in vivo* data.

GreenScreen® Hazard Summary Table for Polyquaternium-10

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*	*	*								
DG	**L**	*L*	**L**	DG	**L**	*L*	DG	DG	DG	**L**	*L*	*L*	**L**	*vH*	*vH*	*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 in the hazard classification. 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. 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 A for a glossary of hazard acronyms.

GreenScreen® Chemical Assessment for Polyquaternium-10 (CAS #68610-92-4)

Method Version: GreenScreen® Version 1.4
Assessment Type[2]: Certified
Assessor Type: Licensed GreenScreen® Profiler

GreenScreen® Assessment (v.1.4) Prepared By:
Name: Nancy Linde, M.S.
Title: Senior Toxicologist
Organization: ToxServices LLC
Date: March 24, 2025; June 27, 2025

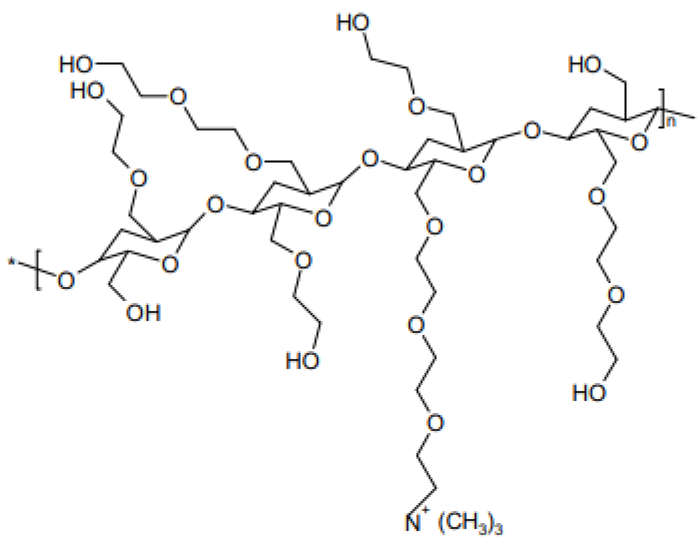
Quality Control Performed By:
Name: Bingxuan Wang, Ph.D., D.A.B.T.
Title: Senior Toxicologist
Organization: ToxServices LLC
Date: March 27, 2025; July 9, 2025

ToxServices Review Date: July 9, 2030[3]

Chemical Name: Polyquaternium-10

CAS Number: 68610-92-4; 81859-24-7; 53568-66-4; 54351-50-7; 55353-19-0; 68610-92-4; 81859-24-7 (EC 2025)

Chemical Structure(s): (representative subunit)



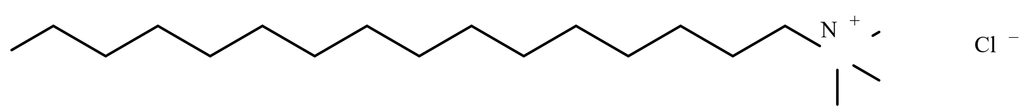
Polyquaternium-10 (CAS #68610-92-4) (Cumming 2008)

Also called: Cellulose, 2-(2-hydroxy-3-(trimethylammonio)propoxy) ethyl ether, chloride; Cellulose, 2-hydroxyethyl 2-[2-hydroxy-3-(trimethylammonio)propoxy]ethyl 2-hydroxy-3-(trimethylammonio) propyl ether, chloride Cellulose, ether with alpha-[2-hydroxy-3-(trimethylammonio)propyl]-omega-hydroxypoly(oxy-1,2-ethanediyl), chloride (EC 2025). Cellulose,etherwith.alpha.-[2-hydroxy-3-(trimethylammonio)propyl]-.omega.-hydroxypoly(oxy-1,2-ethanediyl)chloride; [3-(2-

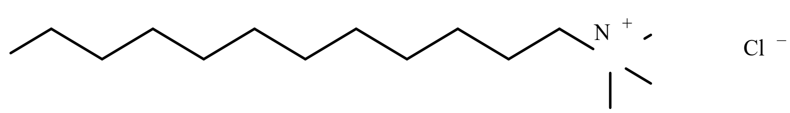
[2] GreenScreen® reports are either "UNACCREDITED" (by unaccredited person), "AUTHORIZED" (by Authorized GreenScreen® Practitioner), or "CERTIFIED" (by Licensed GreenScreen® Profiler or equivalent).
[3] Although CPA's Assessment Expiration Policy (CPA 2018a) indicates that Benchmark 1 assessments have no expiration date, ToxServices strives to review BM-1s in a five-year period to ensure currency of data presented in the BM-1 GreenScreen® assessments.

{[(2R,3R,4S,5S,6R)-2,4-dihydroxy-5-{[(3R,4R,5R,6R)-3-hydroxy-4,5-bis(2-hydroxyethoxy)-6-(hydroxymethyl)oxan-2-yl]oxy}-6-[(hydroxymethoxy)methyl]oxan-3-yl]oxy}ethoxy)-2-hydroxypropyl]trimethylazanium chloride; Cellulose ether with ethoxylated 2-hydroxy-3-(trimethylammonio)propanol chloride; Hydroxyethylcellulose ethoxylate, quaternized; Quaternium-19; PQ10; EC 617-262-2; EC 611-015-2; and EC 614-667-6 (EC 2025).

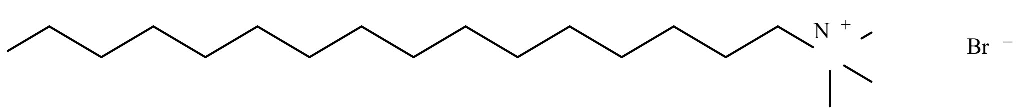
Suitable surrogates or moieties of chemicals used in this assessment (CAS #'s):
Data for polyquaternium-10 (CAS #68610-92-4) were not identified for all endpoints. Therefore, data for alkyl trimonium compounds, cetrimonium chloride (CAS #112-02-7), laurtrimonium chloride (CAS #112-00-5), and cetrimonium bromide (CAS #57-09-0) were evaluated. Trimoniums are cationic quaternary ammonium salts with alkyl chain, alkanol, and/or polymer N-substituents that function mainly as surfactant-cleansing agents, hair conditioning agents, and antistatic agents. The common feature of the group is the trimonium moiety. Although structurally diverse, the trimoniums share similar structure-activity relationships (the quaternary ammonium predominates), biologic functions, and product usage patterns, which suggests that data may be extrapolated among these substances (CIR 2012). Alkyl trimonium compounds are likely to provide a conservative and thus protective estimate of toxicity, as polymeric compounds are expected to have lower bioavailability due to their larger size. Additionally, polyquaternium-10 is largely hydroxyethylcellulose, and although this functional unit is not present in the surrogates, cellulose derivatives pass essentially unchanged through the gastrointestinal tract following oral administration in rats, dogs, and humans, and are practically non-toxic (CIR 2009).



Surrogate #1: Cetrimonium chloride (CAS #112-02-7) (PubChem 2025)



Surrogate #2: Laurtrimonium chloride (CAS #112-00-5) (PubChem 2025)



Surrogate #3: Cetrimonium bromide (CAS #57-09-0) (PubChem 2025)

Identify Applications/Functional Uses:
1. Film-forming and anti-static agent in personal care products formulations (EC 2025)
2. Surfactant (Pharos 2025).

Known Impurities[4]:
Common impurities include water (≤0.5%), nitrogen (1.7-2.2%), and ash (NaCl ≤2%) (CIR 1988).

[4] Impurities of the chemical will be assessed at the product level instead of in this GreenScreen®.

GreenScreen® Summary Rating for Polyquaternium-10[5,6] [7,8]: Polyquaternium-10 was assigned a **GreenScreen Benchmark™ Score of 1** ("Avoid – chemical of High Concern") (CPA 2018b). This score is based on the following hazard score combinations:

- Benchmark 1c
  - Very High Persistence-P + Very High Ecotoxicity (acute aquatic-AA and chronic aquatic-CA)

Data gaps (DG) exist for carcinogenicity-C, endocrine activity-E, systemic toxicity (repeated dose)-STr*, and neurotoxicity (single and repeated exposure)-Ns and Nr*. As outlined in GreenScreen® Guidance Section 11.6.2.1 and Annex 5 (Conduct a Data Gap Analysis), polyquaternium-10 meets requirements for a GreenScreen Benchmark™ Score of 1 despite the hazard data gaps.

Figure 1: GreenScreen® Hazard Summary Table for Polyquaternium-10

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*	*	*								
DG	**L**	*L*	**L**	DG	**L**	*L*	DG	DG	DG	**L**	*L*	*L*	**L**	*vH*	*vH*	*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 in the hazard classification. 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. 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 A for a glossary of hazard acronyms.

Environmental Transformation Products

No data were found in the public literature. Polyquaternium-10 is largely comprised of hydroxyethylcellulose and a quaternary ammonium. Hydroxyethylcellulose is ubiquitous in the environment and in the human diet and presents low concerns for environmental and/or human health. The quaternary ammonium fragment, if released, is known to have high aquatic toxicity, but would not be expected to be more persistent or more hazardous than the parent compound. Accordingly, there are low concerns for environmental transformation products from polyquaternium-10.

Introduction

Polyquaternium-10 is produced by reacting hydroxyethyl cellulose with epichlorohydrin, followed by quaternization using trimethylamine (CIR 1988).

ToxServices assessed polyquaternium-10 against GreenScreen® Version 1.4 (CPA 2018b) following procedures outlined in ToxServices' SOPs (GreenScreen® Hazard Assessment) (ToxServices 2021).

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5 For inorganic chemicals with low human and ecotoxicity across all hazard endpoints and low bioaccumulation potential, persistence alone will not be deemed problematic. Inorganic chemicals that are only persistent will be evaluated under the criteria for Benchmark 4.
6 See Appendix A for a glossary of hazard endpoint acronyms.
7 For inorganic chemicals only, see GreenScreen® Guidance v1.4 Section 12 (Inorganic Chemical Assessment Procedure).
8 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 v1.4 Annex 2.

U.S. EPA Safer Choice Program's Safer Chemical Ingredients List

The SCIL is a list of chemicals that meet the Safer Choice standard (U.S. EPA 2025a). It can be accessed at: http://www2.epa.gov/saferchoice/safer-ingredients. Chemicals on the SCIL have been assessed for compliance with the Safer Choice Standard and Criteria for Safer Chemical Ingredients (U.S. EPA 2024a).

Polyquaternium-10 in not currently present on the SCIL.

GreenScreen® List Translator Screening Results

The GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to identify GreenScreen Benchmark™ 1 chemicals (CPA 2018b). Pharos (Pharos 2025) is an online list-searching tool that is used to screen chemicals against all of the lists in the List Translator electronically. ToxServices also checks the U.S. Department of Transportation (U.S. DOT) lists (U.S. DOT 2008a,b),[9] which are not considered GreenScreen® Specified Lists but are additional information sources, in conjunction with the Pharos query. The output indicates benchmark or possible benchmark scores for each human health and environmental endpoint. The output for polyquaternium-10 can be found in Appendix C.

- Polyquaternium-10 does not have a List Translator score, or an existing GreenScreen Benchmark score (Pharos 2025, Appendix C). Therefore, a full GreenScreen® is required.
- Polyquaternium-10 is not listed on the U.S. DOT list.
- Polyquaternium-10 is not present on any GreenScreen®-specified lists.

Hazard Statement and Occupational Control

No Globally Harmonized System of Classification and Labelling of Chemicals (GHS) hazard statements that were harmonized across the European Union (EU). There are no ECHA registration dossiers for polyquaternium-10. However, self-classifications by the majority of EU notifiers are presented in Table 1, below. No occupational exposure limits (OELs) were identified, however, general personal protective equipment (PPE) recommendations, as applicable to the handling of all chemicals, are presented in Table 2, below.

Table 1: GHS H Statements for Polyquaternium-10 (CAS #68610-92-4) (ECHA C&L 2025)	
H Statement	**H Statement Details**
H315	Causes skin irritation [Skin corrosion/irritation – Category 2]
H319	Causes serious eye irritation [Serious eye damage/eye irritation – Category 2A]

Table 2: Occupational Exposure Limits and Recommended Personal Protective Equipment for Polyquaternium-10 (CAS #68610-92-4)			
Personal Protective Equipment (PPE)	**Reference**	**Occupational Exposure Limits (OEL)**	**Reference**
P280 - Wear protective gloves/protective clothing/eye protection/face protection/hearing protection.	Interchimie 2020	N/A	N/A
N/A: Not applicable OEL: Occupational Exposure Limit PEL: Permissible Exposure Limit			

[9] DOT lists are not required lists for GreenScreen® List Translator v1.4. They are reference lists only.

Physicochemical Properties of Polyquaternium-10

Polyquaternium-10 is a white granular powder under normal conditions. It decomposes without melting at ≥ 160°C. Based on its high molecular weight of 2.5 x 10^6 – 6.0 x 10^6 g/mol, it is not expected to be volatile. Polyquaternium-10 is soluble in water.

Table 3: Physical and Chemical Properties of Polyquaternium-10 (CAS #68610-92-4)		
Property	**Value**	**Reference**
Molecular formula	N/A (UVCB) $(C_{10}H_{24}N_2O)n$ Formula corresponding to representative hydroxyethylcellulose and quaternary ammonium fragments is $C_{48}H_{90}{*}_2NO_{23}.Cl$	N/A Guidechem 2025 Biovia 2019
SMILES Notation	N/A (polymer); however representative SMILES based on the molecular hydroxyethylcellulose and quaternary ammonium fragments is [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO	Biovia 2019
Molecular weight	2.5 x 10^6 – 6.0 x 10^6 g/mol	CIR 1988
Physical state	Solid	CIR 1988
Appearance	White, granular powder with a characteristic amine odor	CIR 1988
Melting point	N/A – decomposes at ≥ 160°C*	Dow Chemical Company 2023a,b, 2025
Boiling point	Not applicable*	Dow Chemical Company 2023a,b, 2025
Vapor pressure	< 10^{-8} mm Hg (estimated)	U.S. EPA 2013
Water solubility	Soluble	CIR 1988
Dissociation constant	Not identified	
Density/specific gravity	Not identified	
Partition coefficient	Not identified	

* Value based on mixtures that are ≥ 91% polyquaternium-10.

Toxicokinetics

No toxicokinetic data were found for polyquaternium-10. Based on its very high molecular weight, i.e., several orders of magnitude greater than 1,000 Daltons, polyquaternium-10 may have limited bioavailability. However, the polyethoxylated chains and the ethoxy cellulose moieties may be subject to metabolism. One study for the much smaller surrogate cetrimonium bromide (CAS #57-09-0) (100% purity) examined transplacental distribution. The surrogate was evaluated in a non-guideline embryotoxicity and teratogenicity study (GLP not specified). Pregnant NMRI Mice were administered a single intraperitoneal dose of radiolabeled test substance on day 14 of gestation, and animals were sacrificed at 1, 8, or 24 hours post-injection. About 3% of the administered dose was in the placentae 1 hour after injection, and the decline of radioactivity was slower than that in maternal blood and liver (no further toxicokinetic details were provided) (Klimisch 1, reliable without restriction) (ECHA CHEM, CAS #57-09-0, 2025).

Hazard Classification Summary

<u>Group I Human Health Effects (Group I Human)</u>

Carcinogenicity (C) Score (H, M, or L): DG

Polyquaternium-10 was assigned a Data Gap for carcinogenicity. No measured data were found, and no structural alerts for genotoxic or nongenotoxic carcinogenicity were identified in Toxtree (using the SMILES notation for the molecular hydroxyethylcellulose and quaternary ammonium fragments of polyquaternium-10). However, no other statistical and expert rule-based models were identified that were suitable for the structure, or provided reasonably reliable predictions. Analysis of structural alerts alone is not sufficient to assign a hazard rating.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists for this endpoint.
    - *Screening:* Not present on any screening lists for this endpoint.
- No experimental data were found. It may be noted the CIR expert panel included data on choline chloride in its assessment of trimoniums used in cosmetics (CIR 2012). However, choline chloride is non-polymeric, has a very short alkanol side chain, and was not considered a suitable surrogate for this assessment. Additionally, the data on choline chloride are very limited in study design and reported details, rendering them low reliability.
- For QSAR modeling purposes, ToxServices generated the following SMILES notation for the molecular hydroxyethylcellulose and quaternary ammonium fragments of polyquaternium-10 using Biovia Draw:
  OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)COC4COCCOCCO)OC3COCCO CCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO (Biovia 2019).
    - Toxtree 2018
        - Toxtree modeling did not identify any structural alerts for genotoxic or non-genotoxic carcinogenicity (Appendix D).
    - OECD 2024
        - Modeling could not be performed with QSAR Toolbox because no sufficiently similar compounds with data were identified.
    - VEGA 2024
        - Modeling was not performed in VEGA, as the current version of VEGA (v1.2.4) cannot model ionic compounds.
    - DTU 2025
        - Modeling was not performed with the Danish QSAR database as there was no match for the CAS number or SMILES notation.
    - U.S. EPA 2024b
        - Modeling was not performed in Oncologic as functional groups and structural variability of polyquaternium-10 do not fit the chemical classes in version 9.4.

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

Polyquaternium-10 was assigned a score of Low for mutagenicity/genotoxicity as it was not mutagenic or clastogenic in multiple *in vitro* assays using bacterial cells and cultured mammalian germ cells, and *in vivo* assays in mice. GreenScreen® criteria classify chemicals as a Low hazard for mutagenicity/genotoxicity when they are neither mutagenic nor clastogenic (CPA 2018b). The confidence in the score is high based on measured data for the target compound.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists for this endpoint.
    - *Screening:* Not present on any screening lists for this endpoint.
- CIR 1988
    - *In vitro:* Polyquaternium-10 (purity not reported, vehicle unspecified) was not mutagenic in a bacterial reverse mutation test performed in triplicate with *Salmonella typhimurium* tester strains TA98, TA100, TA1535, and TA1537 at five unspecified concentrations with and without metabolic activation (S9 prepared from the livers of male Sprague-Dawley induced with Aroclor 1254) (no further details provided).
    - *In vitro:* Polyquaternium-10 (purity not reported) was not clastogenic in a mammalian chromosomal aberration test performed with cultured Chinese hamster ovary (CHO) cells exposed to 0.12-0.285% in DMSO with and without metabolic activation (S9 prepared from the livers of male Sprague-Dawley induced with Aroclor 1254) for 5 hours. Some degree of aberrations was observed in both tests in both experiments with and without metabolic activation; however, the response was not dose dependent. The study authors considered polyquaternium-10 to be not clastogenic in the CHO test (no further details provided).
    - *In vitro:* Polyquaternium-10 (purity not reported) was not clastogenic in a sister chromatid exchange assay (SCE) test performed with CHO cells exposed to 0.14-0.3% in DMSO with and without metabolic activation (S9 prepared from the livers of male Sprague-Dawley induced with Aroclor 1254) for 5 hours. Polyquaternium-10 with and without metabolic activation did not increase the frequency of SCE over the range of concentrations tested.
    - *In vitro:* Polyquaternium-10 (purity not reported, vehicle unspecified) was evaluated in a DNA repair test performed with rat hepatocyte primary cells exposed to six concentrations in the range of 0.0009-0.23% (vehicle unspecified). Results from duplicate samples were positive for 3 of 6 doses, however, they were not dose dependent, the hepatocytes were from a single preparation, and the results were quantitated by liquid scintillation counting which is less reliable than quantitative autoradiography. Accordingly, the results were considered not valid.
    - *In vivo:* Polyquaternium-10 (purity not reported) was not clastogenic in an *in vivo* micronucleus test male and female Swiss mice (5/group) were injected single doses of polyquaternium at doses of 0.125, 0.25, and 0.4 g/kg into the peritoneal cavity. Blood samples were collected 24, 48, and 72 hours after the injection, and blood smears were prepared and stained for evaluating presence of micronuclei. There were no mortalities, body weight changes, necropsy findings, or clinical signs. There were no increases in micronucleated polychromatic erythrocytes at any dose level.

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

Polyquaternium-10 was assigned a score of Low for reproductive toxicity based on lack of reproductive effects observed with surrogate cetrimonium bromide (CAS #57-09-0) in an oral exposure combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD Test Guideline (TG) 422) in rats. GreenScreen® criteria classify chemicals as a Low hazard for reproductive toxicity when adequate data exist and GHS classification is not warranted (CPA 2018b). Confidence is low because the evaluation of reproductive toxicity was based on a screening test, which is not as comprehensive as, for example, a two-generation reproductive toxicity study. It may also be noted that the REACH dossier for the surrogate cetrimonium chloride (CAS #112-02-7) includes two 2-generation reproductive toxicity studies for the read-across substance, quaternary ammonium compounds, benzyl C12-16 (even numbered)-alkyldimethyl chlorides (CAS #68424-85-1). However, ToxServices did not consider it to be an appropriate surrogate for polyquaternium-10 as it contains a benzyl moiety that is not present in cetrimonium chloride or polyquaternium-10.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- ECHA CHEM, CAS #57-09-0, 2025
  - *Oral: Surrogate: Cetrimonium bromide (CAS #57-09-0):* Cetrimonium bromide (100% purity) was evaluated in a GLP-compliant combined repeated dose toxicity study with the reproduction/developmental toxicity screening test performed according to OECD TG 422. Wistar rats were exposed to the test substance by gavage in water at 0, 5, 15, or 50 mg/kg/day (10/sex/dose). Males were exposed to the test substance for 2 weeks prior to mating, and through mating, for a total of 28-29 days. Females were exposed from 2 weeks prior to mating, through mating, gestation, and up through at least 13 days post-delivery, for a total of up to 42-54 days. There were no significant findings based on systemic toxicity, reproductive toxicity, or developmental toxicity in treated animals compared to controls. The NOAEL was assigned at 50 mg/kg/day, the highest dose tested (Klimisch 1, reliable without restriction).

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

Polyquaternium-10 was assigned a score of Low for developmental toxicity based on surrogate data for the oral and dermal routes of exposure. There were no indications of developmental toxicity up to the highest dose tested for several alkyl trimonium compounds in rats, mice, and rabbits exposed during gestation. GreenScreen® criteria classify chemicals as a Low hazard for developmental toxicity when adequate negative data are available and they are not GHS classified (CPA 2018b). The confidence in the score is high based on reliable studies for conservative surrogates in multiple species.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- ECHA CHEM, CAS #57-09-0, 2025
  - *Oral: Surrogate: Cetrimonium bromide (CAS #57-09-0)*: As summarized previously, cetrimonium bromide (100% purity) was evaluated in a GLP-compliant combined repeated dose toxicity study with the reproduction/developmental toxicity screening test performed according to OECD TG 422. Wistar rats were exposed to the test substance by gavage in water at 0, 5, 15, or 50 mg/kg/day (10/sex/dose). Males were exposed to the test substance for 2 weeks prior to mating, and through mating, for a total of 28-29 days. Females were exposed from 2 weeks prior to mating, through mating, gestation, and up through at least 13 days post-delivery, for a total of up to 42-54 days. There were no significant findings based on systemic toxicity, reproductive toxicity, or developmental toxicity in treated animals compared to controls. The NOAEL was assigned at 50 mg/kg/day, the highest dose tested (Klimisch 1, reliable without restriction).
  - *Oral: Surrogate: Cetrimonium bromide (CAS #57-09-0):* Cetrimonium bromide (100% purity) was evaluated in a non-guideline embryotoxicity and teratogenicity study (GLP not specified). Pregnant NMRI Mice were administered the test substance in aqueous solution

by intraperitoneal injection as a single dose on gestation day (GD) 8, 10, 12, or 14, and were sacrificed on GD 19. Doses were 10.5, or 35.0 mg/kg with 8 mice per dose per group, and 20 controls. There were no significant findings based on maternal body weight gain in treated animals compared to controls. There was a dose-dependent increase in the number of dead implantations at 35 mg/kg, and there was a dose-dependent increase in the number of malformed fetuses (primarily cleft palate and minor skeletal defects) at 10 and 35 mg/kg. Authors noted that as the test substance is a strong irritant, observed effects may have been due to local effects incurred via i.p. injection, and that no conclusion can be taken with regard to reproductive toxicity in relation to other and more relevant routes of exposure (Klimisch 1, reliable without restriction). *ToxServices agrees that this route of exposure is not relevant as i.p. injection bypasses the first-pass metabolism. Accordingly, this study is included for completeness, but is not included in the overall weight of evidence.*

- ECHA CHEM, CAS #112-02-7, 2025
  - *Oral:* *Surrogate: Cetrimonium chloride (CAS #112-02-7):* Cetrimonium chloride was evaluated in a GLP-compliant prenatal developmental toxicity study performed according to OECD TG 414. Sprague-Dawley rats were administered the test substance by gavage in softened water at 0, 18.75, 37.5, and 75 mg/kg/day (25 animals/group) on GD 3 to 19. Clinical observations included dose-related increases in piloerection at ≥ 18.75 mg/kg/day, and lunched posture at 75 mg/kg/day. There were no mortalities during the study. There was a statistically significant decrease in body weight gain (up to -6%) at the highest dose compared to controls, and the difference was statistically significant on GD 6 and 20 (but not on GD 9 and 18), and there was decreased food consumption at the highest dose starting on GD 6 (~ -29%), GD 15 (~ -8%), and GD 20 (~ -20%), but no difference on GD 18. There were no significant findings based on hematology, thyroid hormone, thyroid weight, gross pathology, or histopathology in treated animals compared to controls. The terminal body weights for dams exposed at 75 mg/kg/day were approximately ~6% lower than controls, gravid uterus weights were ~11% lower than that of controls, and there was a ~29% reduction in absolute weight gain. There were no significant findings based on number of abortions, pre- and post-implantation loss, total litter resorption, early or late resorptions, dead fetuses, changes in pregnancy duration or number of pregnant, uterine deaths (early, late, and total), or anogenital distances of pups. Although the fetal body weights in treated animals of the high dose group were decreased ~4% in females and ~5% in males, and ~4% overall, the values were with the range of historical controls. There were no significant effects based on number of live offspring, sex ratio, external-, skeletal-, or visceral malformations. The highest dose of 75 mg/kg/day was considered slightly toxic to the dams, but did not result in adverse developmental effects. The NOAEL for developmental toxicity was assigned at 75 mg/kg/day, the highest dose tested (Klimisch 1, reliable without restriction).
- CIR 2012
  - *Oral:* *Surrogate: Laurtrimonium chloride (CAS #112-00-5)*: In a range finding developmental toxicity test (exposure on GD 6-18) was performed with pregnant female New Zealand White rabbits (3/group) orally administered laurtrimonium chloride (purity and vehicle unspecified) at 20, 50, 100, 200, or 400 mg/kg/day on GD 7-18. At 20 mg/kg, 50 mg/kg, 100 mg/kg, and 400 mg/kg 1/3, 1/3, 2/3, and 3/3 rabbits died, respectively. There were developmental toxicity effects observed at the 50 mg/kg/day dose (not the highest dose) and no further information was provided. Therefore, the study authors did not identify maternal toxicity and developmental toxicity NOAELs for this range finding study (Reliability 2, reliable with restrictions) (CIR 2012).

- CIR 2012, U.S. EPA 2008
  - *Oral:* *Surrogate: Laurtrimonium chloride (CAS #112-00-5)*: The main developmental toxicity test (exposure on GD 6-18) was performed with pregnant female New Zealand White rabbits (13-14/group) orally administered laurtrimonium chloride (purity and vehicle unspecified) at 2, 8, and 24 mg/kg/day on GD 7-18. There were no adverse effects observed for maternal toxicity and developmental or teratogenic toxicity. No other information was provided. ToxServices identifies maternal toxicity and developmental toxicity NOAELs of 24 mg/kg/day, the highest dose tested (Reliability 2, reliable with restrictions).
- CIR 2012, U.S. EPA 2008, ECHA CHEM, CAS #112-02-7, 2025
  - *Dermal:* *Surrogate: Cetrimonium chloride (CAS #112-02-7):* A GLP-compliant prenatal developmental toxicity test conducted in a manner similar to OECD Guideline 414 (exposure on GD 7-18 only) was performed with pregnant female New Zealand White rabbits (20/group) administered dermal applications of cetrimonium chloride (as 1-hexadecanaminium, N,N,N-trimethyl-, chloride, 25% aqueous solution) in water at 0, 10, 20, or 40 mg a.i./kg, 2 hours/day, on GD 7-18. Maternal examinations included clinical signs of toxicity, assessment of dermal irritation, body weights, food consumption, and ovarian and uterine content. Fetal evaluations included examinations of body weight, sex, and external, visceral, and skeletal malformations. No treatment-related effects were detected on maternal health or developmental endpoints. Therefore, the study authors identified maternal toxicity and developmental toxicity NOAELs of 40 mg/kg/day, the highest dose tested (Reliability 2, reliable with restrictions).
- CIR 2012
  - *Surrogate alkyl trimonium compounds:* Based on CIR Expert Panel recommendation, alkyl trimonium compounds are safe for use in baby products due to lack of dermal penetration, low concentration of use levels providing assurance that use of these products would not present risk of systemic or dermal adverse effects, and use of compounds in hundreds of products.

Endocrine Activity (E) Score (H, M, or L): DG
Polyquaternium-10 was assigned a score of Data Gap for endocrine activity based on insufficient data. No data were found for the target compound. In repeated dose toxicity studies with the surrogates cetrimonium bromide and cetrimonium chloride, there were no adverse effects identified that were plausibly related to endocrine activity, and there were no endocrine-related effects identified based on evaluations of serum levels of thyroid hormone T4 and based on thyroid weights and histopathology at study termination. However, there were no further assessments for endocrine activity. *In vitro* high throughput assays indicate potential for endocrine activity but the relevance of these studies to *in vivo* conditions is not known.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- ECHA CHEM, CAS #57-09-0, 2025
  - *Oral:* *Surrogate: Cetrimonium bromide (CAS #57-09-0):* As summarized previously, cetrimonium bromide (100% purity) was evaluated in a GLP-compliant combined repeated dose toxicity study with the reproduction/developmental toxicity screening test performed according to OECD TG 422. Wistar rats were exposed to the test substance by gavage in water at 0, 5, 15, or 50 mg/kg/day (10/sex/dose). Males were exposed to the test substance for 2 weeks prior to mating, and through mating, for a total of 28-29 days. Females were exposed from 2 weeks prior to mating, through mating, gestation, and up through at least 13

days post-delivery, for a total of up to 42-54 days. There were no significant findings based on serum levels of total T4 in F0-males, or serum T4 levels in male and female pups on PND 14-16 (Klimisch 1, reliable without restriction).

- ECHA CHEM, CAS #112-02-7, 2025
  - *Oral:* <u>*Surrogate: Cetrimonium chloride (CAS #112-02-7):*</u> As previously summarized, cetrimonium chloride was evaluated in a GLP-compliant prenatal developmental toxicity study performed according to OECD TG 414. Sprague-Dawley rats were administered the test substance by gavage in softened water at 0, 18.75, 37.5, and 75 mg/kg/day (25 animals/group) on GD 3 to 19. There were no significant findings based thyroid hormone, thyroid weight, or thyroid histopathology in treated animals compared to controls (no further details provided). (Klimisch 1, reliable without restriction).
- U.S. EPA 2025b
  - <u>*Surrogate: Cetrimonium chloride (CAS #112-02-7):*</u> Cetrimonium chloride was active in 3/6 estrogen receptor (ER) assays, 6/8 androgen receptor (AR) assays, 2/2 steroidogenesis assays, and 5/8 thyroid receptor assays performed as part of the U.S. EPA's Endocrine Disruptor Screening Program (EDSP) in the 21st Century (Appendix E).
  - <u>*Surrogate: Laurtrimonium chloride (CAS #112-00-5)*</u>: Lautrimonium chloride was active in 4/21 ER assays, 8/14 AR assays, 1/15 steroidogenesis assays, and 6/17 thyroid receptor assays performed as part of the U.S. EPA's EDSP in the 21st Century (Appendix E).
  - <u>*Surrogate: Cetrimonium bromide (CAS #57-09-0):*</u> Cetrimonium bromide (CAS #57-09-0) was active in 10/21 ER assays, 10/14 AR assays, 2/2 steroidogenesis assays, and 13/19 thyroid receptor assays performed as part of the U.S. EPA's EDSP in the 21st Century (Appendix E).

<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 1.4 Benchmark system (the asterisk indicates repeated exposure). For Systemic Toxicity and Neurotoxicity, Group II and II* are considered sub-endpoints. See GreenScreen® Guidance v1.4, Annex 2 for more details.

Acute Mammalian Toxicity (AT) (Group II) Score (vH, H, M, or L): L

Polyquaternium-10 was assigned a score of Low for acute toxicity based on oral and dermal LD_{50} values > 2,000 mg/kg (data are insufficient to evaluate the inhalation route of exposure). GreenScreen® criteria classify chemicals as a Low hazard for acute toxicity when oral and dermal LD_{50} values are > 2,000 mg/kg (CPA 2018b). The confidence in the score is high based on measured data for the target compound.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- RTECS 1999
  - *Oral:* LD_{50} > 2,000 mg/kg (rats, unspecified) (no further details provided).
  - *Dermal:* LD_{50} > 4,000 mg/kg (rabbit, unspecified) (no further details reported)
  - *Dermal:* LD_{50} > 1,000 mg/kg (rabbit, unspecified) (no further details reported)
- CIR 1988
  - *Oral:* In an acute oral toxicity study, 10 rats (sex and strain unspecified) received a single dose of 16,000 mg/kg polyquaternium-10 in corn oil via gavage. There were 3/10 deaths. The authors identified an LD_{50} > 16,000 mg/kg.
  - *Oral:* In an acute oral toxicity study, 10 rats (sex and strain unspecified) received a single dose of 13,100 mg/kg polyquaternium-10 in corn oil via gavage. There were 7/10 deaths.

The authors identified an LD_{50} > 13,100 mg/kg. *ToxServices notes the LD_{50} had to be < 13,100 mg/kg if 7/10 animals died, or there is a typo in the reported values.*
- *Oral:* In an acute oral toxicity study, 10 rats (sex and strain unspecified) received a single dose of 16,000 mg/kg polyquaternium-10 in corn oil via gavage. There were no deaths. The authors identified an LD_{50} > 16,000 mg/kg.
- *Dermal:* Samples from three lots of polyquaternium-10 were tested individually using three groups of 5 rabbits each (strain not specified). No deaths occurred when 4,000 mg/kg was applied to the skin under occlusion (duration not specified). Erythema developed, but no other remarkable gross lesions were observed. Authors concluded the test substance was at most, slightly irritating to the skin (no further details provided). *ToxServices notes that while this appears to have been a skin irritation study, the dose was very high and a dermal LD_{50} of >4,000 mg/kg can be inferred, but with caution as the duration of the observation period was not specified.*
- *Dermal:* The dermal toxicity of a shampoo containing 0.5% polyquaternium-10 was evaluated according to the procedure of 16 CFR 1500.3(c)(1)(ii)(c) and 1500.40. The test substance was applied to the clipped or abraded skin of 5 rabbits/group (strain and sex not specified). Authors reported an LD_{50} > 2,000 mg/kg (no further details provided).
- *Inhalation:* In an acute inhalation toxicity study, 6 rats (sex and strain unspecified) were exposed to a dust concentration of 50 g polyquaternium-10 on a 200 cm^2 tray for 8 hours in a sealed chamber. No signs of toxicity were observed during the exposure period. No other information was provided. *As data are insufficient to determine the air concentration, the LC_{50} cannot be determined.*

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST-single) (Group II) Score (vH, H, M, or L): *L*

Polyquaternium-10 was assigned a score of Low for systemic toxicity (single dose) based on lack of indications of systemic toxicity in several acute oral toxicity studies (data are insufficient to evaluate the dermal and inhalation routes of exposure). GreenScreen® criteria classify chemicals as a Low hazard for systemic toxicity (single dose) when adequate data exist, and GHS classification is not warranted (CPA 2018b). The confidence in the score is low as the hazard rating is based on clinical observations and necropsy findings for a few studies with limited reporting.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- CIR 1988
  - *Oral:* As summarized previously, in an acute oral toxicity study, 10 rats (sex and strain unspecified) received a single dose of 16,000 mg/kg polyquaternium-10 in corn oil via gavage. There were 3/10 deaths. Clinical signs on day 1 were sluggishness, wet fur, and diarrhea. No other information was provided.
  - *Oral:* As summarized previously, in an acute oral toxicity study, 10 rats (sex and strain unspecified) received a single dose of 13,100 mg/kg polyquaternium-10 in corn oil via gavage. There were 7/10 deaths. Clinical signs on day 1 were sluggishness, wet fur, and nose covered with blood. No other information was provided. *ToxServices notes the LD_{50} had to be < 13,100 mg/kg if 7/10 animals died, or there is a typo in the reported values.*
  - *Oral:* As summarized previously, in an acute oral toxicity study, 10 rats (sex and strain unspecified) received a single dose of 16,000 mg/kg polyquaternium-10 in corn oil via gavage. There were no deaths. Clinical signs on day 1 were wet fur and diarrhea. No other information was provided.

  - *Inhalation:* As summarized previously, in an acute inhalation toxicity study, 6 rats (sex and strain unspecified) were exposed to a dust concentration of 50 g polyquaternium-10 on a 200 cm^2 tray for 8 hours in a sealed chamber. No signs of toxicity were observed during the exposure period. No other information was provided. *Reported study details are insufficient to determine the air concentration.*
- Additional oral and dermal studies previously summarized under acute oral toxicity are not included in the weight of evidence because they did not include details of clinical observations or necropsy findings.

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST-repeat) (Group II*) Score (H, M, or L): DG

Polyquaternium-10 was assigned a score of Data Gap for systemic toxicity (repeated dose) based on insufficient data for the oral and dermal routes of exposure, and no data for the inhalation route of exposure. Two oral repeated dose studies for the surrogates cetrimonium chloride and cetrimonium bromide provide NOAEL values of ≥ 21 and 45 mg a.i./kg/day, the highest doses tested, which are greater than the GHS Category 1 guidance value of 10 mg ai./kg/day, but below the GHS Category 2 guidance value of 100 mg a.i./kg/day. Therefore, the data are insufficient to discern between GHS Category 2 and Not Classified. .

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- CIR 2012, ECHA CHEM, CAS #112-02-7, 2025, SCCS 2009
  - *Oral: Surrogate: Cetrimonium chloride (CAS #112-02-7):* A GLP-compliant repeated dose toxicity study conducted in a manner similar to OECD Guideline 407 was performed with Sprague-Dawley rats (10/sex/group) administered gavage doses of cetrimonium chloride (24-26% aqueous solution) at 0, 30, 100, or 300 mg/kg/day for 28 days. Additional groups of 5 animals/sex were exposed to 0 or 300 mg/kg/day for 28 days and then maintained for at least 27 days without treatment (recovery groups). The animals were evaluated for clinical signs of toxicity, body weight, food consumption, ophthalmology, hematology, clinical chemistry, organ weights, gross pathology, and histopathology. No treatment-related effects were detected on body weight, food consumption, ophthalmology, or hematology. Clinical signs of toxicity were limited to local irritation in the high dose group during the last week of treatment. High dose animals exhibited a significant increase in alanine aminotransferase (ALT) activity. Due to the lack of other correlated hepatic effects, the study authors considered this finding to be incidental. High dose males exhibited changes to the absolute and relative spleen and adrenals (direction and magnitude not specified). Gross pathological changes in the high dose group included edema of the forestomach mucosa, thickening of the mucosa, and ulceration. No irritation effects of the mucosa were detected after the recovery period. Histopathological findings of the gastrointestinal tract of high dose animals identified inflammatory edema of the submucosa and sporadic ulceration and acanthosis of the mucosa up to papillomatous hyperplasia. The recovery group animals exhibited a complete and regular regeneration of the forestomach mucosa. The study authors identified a NOAEL of 300 mg/kg/day, the highest dose tested, based on the reversibility of the gross pathological and histopathological effects, compared to the REACH dossier which reports a NOEL of 100 mg/kg/day (Klimisch 2, reliable with restrictions). *Note: The ECHA entry for this study indicates that there is uncertainty as to the quantification of the dose. Specifically, it is unclear if the doses mentioned are for the aqueous solution or the undiluted active ingredient. The SCCS (2009) authors state that the doses are for the trade name containing*

24-26% cetrimonium chloride. Therefore, the NOAEL for the active ingredient is 72 to 78 mg/kg/day (300 mg/kg/day x 24% = 72 mg/kg/day, and 300 mg/kg/day x 26% = 78 mg/kg/day). Applying Haber's Rule, these values are comparable to 21 to 24 mg/kg/day for 13-week studies (72 mg/kg/day x 4 weeks/13 weeks = 21 mg/kg/day, and 78 mg/kg/day x 4 weeks/13 weeks = 24 mg/kg/day).

- ECHA CHEM, CAS #112-02-7, 2025, CIR 2012
  - *Oral:* <u>*Surrogate: Cetrimonium bromide (CAS #57-09-0):*</u> A chronic oral toxicity study was performed as reported in 1976 (guideline and GLP not specified). Sprague-Dawley rats were exposed to cetrimonium bromide in drinking water at 10, 20, or 45 mg/kg/day (10/sex/group) for 1 year. Observations included body weight, tail length, food and water consumption, appearance, and behavior. Animals were sacrificed 56-60 weeks after the beginning of the experiment. Evaluations at necropsy included hematology, organ weights, and histopathology of specimens from the stomach and small intestine. Body weights were reduced in both sexes in high dose animals for the first 9 weeks of the study, but at study termination, the difference was only significant for males. High dose males had decreased food efficiency during the first 7 weeks of the study. Skeletal growth (judged by tail growth) was significantly reduced in high dose males and females and coincided with reduced body weights. Clinical observations in about 50% of high dose animals included wetting over the anterior ventral region, often with brown discoloration of the fur, and decreased in intensity over the course of the study. There were no treatment-related effects on mortality. There were no significant findings on gross pathology. Liver weights (absolute/relative not specified) were reduced in high dose males compared to controls, and cecal weights (absolute/relative not specified) were increased in mid- and high-dose males, and high-dose females. There were no significant findings on clinical chemistry or hematology. Authors of the REACH dossier assigned a NOEL of 10 mg/kg/day, and a NOAEL of 45 mg/kg/day, the highest dose tested, noting the effects on body weight, growth, and cecal weights were considered indirect effects secondary to the irritant nature of the test substance, which led to diarrhea (Klimisch 2, reliable with restrictions).
- CIR 1988
  - *Dermal:* Although subchronic dermal studies were not available for polyquaternium-10, systemic exposure potential following topical application is low because of the polymer's high molecular weight (250,000-600,000) and because of adsorption to proteins such as keratin.
  - *Dermal:* An *in vivo* rat study showed at most 1.75% dermal penetration. Studies with isolated stratum corneum from fetal pigs, neonatal rats, and adult humans similarly suggested low dermal penetration potential.
  - *Dermal:* In a 21-day subchronic dermal toxicity study, rabbits (5/sex/group, strain unspecified) were given 0.5 mL undiluted (purity unspecified) conditioner containing 1% polyquaternium-10 applied to the clipped dorsal trunk of the rabbits and the skin of one group was abraded once a day, for 6 hours under occlusion, for 21 consecutive days. No mortalities or treatment related effects on body weight or clinical signs of toxicity were noted. There were no changes in clinical chemistry and hematological parameters and no lesions were observed at necropsy. No other information was provided.
- ECHA CHEM, CAS #112-02-7, 2025
  - *Dermal:* <u>*Surrogate: Cetrimonium chloride (CAS #112-02-7):*</u> A repeated dose toxicity study conducted in 1979 in a manner similar to OECD Guideline 410 was performed with New Zealand White rabbits (5/sex/group) administered topical applications of cetrimonium chloride (purity not specified) in water at 0 or 10 mg/kg/day without coverage for 6.5-7

hours/day, 5 days/week, for 4 weeks. The animals were evaluated for clinical signs of toxicity, dermal irritation, body weight, hematology, gross pathology, organ weights (liver and kidneys only), and histopathology. At the application sites, mild to marked acanthosis with active mitosis, hyperkeratosis, partial to extensive necrosis of the epidermis and hair follicles, and encrustation were detected. No evidence of systemic toxicity was detected and the study authors identified a NOAEL of 10 mg/kg/day (equivalent to 7.1 mg/kg/day for a 7-day/week exposure frequency), the only dose tested (Klimisch 2, reliable with restrictions).

Neurotoxicity (single dose, N-single) (Group II) Score (vH, H, M, or L): DG
Polyquaternium-10 was assigned a score of Data Gap for neurotoxicity (single dose) based on insufficient data. Although several acute oral, dermal, and inhalation toxicity studies did not report indications of neurotoxicity, only some of the studies report clinical observations, and none report findings based on gross pathology of neuronal tissues. Accordingly, data are insufficient to rule out concerns for neurotoxicity.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- CIR 1988
  - *Oral:* In the previously summarized acute oral toxicity study in 10 rats (sex and strain unspecified) that received a single dose of 16,000 mg/kg polyquaternium-10 in corn oil via gavage, there were 3/10 deaths, and clinical signs of toxicity on day 1 were sluggishness, wet fur, and diarrhea. No other information was provided.
  - *Oral:* In the previously summarized acute oral toxicity study in 10 rats (sex and strain unspecified) that received a single dose of 13,100 mg/kg polyquaternium-10 in corn oil via gavage, there were 7/10 deaths, and clinical signs of toxicity on day 1 were sluggishness, wet fur, and nose covered with blood. No other information was provided.
  - *Oral:* In the previously summarized acute oral toxicity study in 10 rats (sex and strain unspecified) that received a single dose of 16,000 mg/kg polyquaternium-10 in corn oil via gavage, there were no deaths, and clinical signs of toxicity on day 1 were wet fur and diarrhea. No other information was provided.
  - *Dermal:* As previously summarized, samples from three lots of polyquaternium-10 were tested individually using three groups of 5 rabbits each (strain not specified). No deaths occurred when 4,000 mg/kg was applied to the skin under occlusion (duration not specified). Erythema developed, but no other remarkable gross lesions were observed. Authors concluded the test substance was at most, slightly irritating to the skin (no further details provided). *ToxServices notes that this appears to have been a skin irritation study, and the animals may not have been observed for up to 14 days.*
  - *Dermal:* As summarized previously, the dermal toxicity of a shampoo containing 0.5% polyquaternium-10 was evaluated according to the procedure of 16 CFR 1500.3(c)(1)(ii)(c) and 1500.40. The test substance was applied to the clipped or abraded skin of 5 rabbits/group (strain and sex not specified) (no further details provided).
  - *Inhalation:* As summarized previously, in an acute inhalation toxicity study, 6 rats (sex and strain unspecified) were exposed to a dust concentration of 50 g Polyquaternium-10 on a 200 cm2 tray for 8 hours in a sealed chamber. No signs of toxicity were observed during the exposure period. No other information was provided. *Reported study details are insufficient to determine the air concentration.*

Neurotoxicity (repeated dose, N-repeated) (Group II*) Score (H, M, or L): DG
Polyquaternium-10 was assigned a score of Data Gap for neurotoxicity (repeated dose) based on insufficient data. The surrogate cetrimonium bromide has an oral NOAEL of 50 mg/kg/day, the highest dose tested, for a neurological behavioral battery in an oral combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD TG 422). Although the NOAEL of 50 mg/kg/day exceeds the duration-adjusted GreenScreen® guidance value of 30 mg/kg/day for a 28-day study for a High hazard, it is below the guidance value of 300 mg/kg/day necessary to rule out a Moderate hazard (CPA 2018b). For the dermal route of exposure, none of the available repeated-dose studies report neurological findings based on clinical observations or gross pathology, however, none included a comprehensive assessment of neurological endpoints.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- ECHA CHEM, CAS #57-09-0, 2025
  - *Oral: Surrogate: Cetrimonium bromide (CAS #57-09-0):* As summarized previously, cetrimonium bromide (100% purity) was evaluated in a GLP-compliant combined repeated dose toxicity study with the reproduction/developmental toxicity screening test performed according to OECD TG 422. Wistar rats were exposed to the test substance by gavage in water at 0, 5, 15, or 50 mg/kg/day (10/sex/dose). Males were exposed to the test substance for 2 weeks prior to mating, and through mating, for a total of 28-29 days. Females were exposed from 2 weeks prior to mating, through mating, gestation, and up through at least 13 days post-delivery, for a total of up to 42-54 days. At 50 mg/kg/day, a non-adverse lower grip strength of the hindlimbs was recorded for males, and there were no significant findings based on forelimb grip strength. In females, a non-adverse lower ambulatory (e.g., walking) motor activity was recorded at 50 mg/kg/day, however, there were no significant differences based on total movements (including ambulation, and fine motor movements like grooming, weaving or movements of the head). There were no significant findings in either sex compared to controls for motor activity habituation pattern. As limited findings based on grip strength and motor activity were recorded in opposite sexes and were not associated with concurrent clinical signs or histopathological changes in examined muscle and neuronal tissues, authors considered the findings not treatment-related. The NOAEL was assigned at 50 mg/kg/day, the highest dose tested (Klimisch 1, reliable without restriction).
- None of the previously summarized repeated exposure dermal toxicity studies report neurological findings based on clinical observations and gross pathology, however, none appear to have performed a comprehensive assessment of neurological endpoints.

Skin Sensitization (SnS) (Group II*) Score (H, M, or L): L
Polyquaternium-10 was assigned a score of Low for skin sensitization based on numerous negative studies in humans with the target compound, and a negative *in vivo* study in guinea pigs for the surrogate cetrimonium chloride. GreenScreen® criteria classify chemicals as a Low hazard for skin sensitization when adequate data exist, and GHS classification is not warranted (CPA 2018b). The confidence in the score is high based on numerous studies in humans for the target compound, and a guideline animal study for a conservative surrogate.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- CIR 1988

  - In clinical studies, including multiple repeat insult patch tests, polyquaternium-10 (concentrations ranging from 0.5 to 2%) was non-sensitizing.
  - Several product formulations containing polyquaternium-10 had been tested for skin sensitization on a total of 457 subjects using 6 repeat insult patch tests (RIPT), 1 prophetic patch test, and 1 controlled use sensitization test. These studies include tests on shampoo and conditioner formulations containing 0.5-5% polyquaternium-10; there were no reactions indicating sensitization in 7 out of 8 studies. Some reactions were seen only in one of the RIPT studies, as explained below.
    - In a repeat insult patch test, polyquaternium-10 (purity not specified) was not sensitizing in 46 humans (sex not specified). Subjects were induced with 1% polyquaternium-10 in conditioner (0.2 mL, undiluted) applied to the inner arm or back of each subject 3 times per week for a total of 10 induction patches. After a 10-20-day nontreatment period, two challenge patches were applied and observations were made 24 and 48 hours after removal. Two subjects (4%) had minimal erythema during induction, one (2%) subject had minimal reactions, and one (2%) subject had moderate reactions at challenge. Rechallenge to the moderate reactor was negative. The study authors determined polyquaternium-10 was non-sensitizing.
- ECHA CHEM, CAS #112-02-7, 2025
  - *Surrogate: Cetrimonium chloride (CAS #112-02-7):* A GLP-compliant Buehler test conducted in 1994 according to OECD Guideline 406/EU Method B.6 was performed with female Pirbright-White guinea pigs (20 treated animals, 10 controls) administered dermal doses of cetrimonium chloride (as Genamin CTAC, 28.7% purity, 70% water). The induction doses were applied as 4% w/v solutions in water under occlusive dressing, and the challenge dose was applied as 1% w/v solutions in water under occlusive dressing. No positive dermal reactions were identified following the challenge doses. The study authors concluded that cetrimonium chloride was not sensitizing to the skin under the tested conditions (Klimisch 1, reliable without restriction).

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

In accordance with guidance from ECHA (ECHA 2017), polyquaternium-10 was assigned a score of Low for respiratory sensitization based on extrapolation from skin sensitization studies (i.e., non-sensitizing in humans and animals), combined with a lack of structural alerts for respiratory sensitization, and lack of indications of respiratory sensitization in the public literature. GreenScreen® criteria classify chemicals as a Low hazard for respiratory sensitization when adequate data exist and GHS classification is not warranted (CPA 2018b). The confidence in the score is low due to lack of measured data, and because ECHA's guidance notably does not account for non-immunologic mechanisms of respiratory sensitization.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- OECD 2024:
  - Polyquaternium-10 does not have any structural alerts for respiratory sensitization based on analysis of a representative structure of its subunits (Appendix F).
- The guidance from ECHA states that the mechanisms leading to respiratory sensitization are essentially similar to those leading to skin sensitization (ECHA 2017). ECHA recommended that if a chemical is not a dermal sensitizer based on high quality data, it is unlikely to be a respiratory sensitizer. ECHA also noted that this rationale does not cover respiratory hypersensitivity caused by

non-immunological mechanisms, for which human experience is the main evidence of activity (ECHA 2017). Therefore, as polyquaternium-10 was not sensitizing to the skin (see skin sensitization section above), a literature search did not find any human evidence of respiratory sensitization by polyquaternium-10, and polyquaternium-10 does not contain any structural alerts for respiratory sensitization (OECD 2024, Appendix E), it is not expected to be a respiratory sensitizer.

Skin Irritation/Corrosivity (IrS) (Group II) Score (vH, H, M, or L): *L*
Polyquaternium-10 was assigned a score of Low for skin irritation/corrosivity based on numerous negative studies in animals exposed at up to 10% in water, and humans exposed at up 5% in water. It may be noted there is one study in which animals showed significant irritation to a shampoo with 0.5% polyquaternium-10, however this study is discounted due to lack of disclosure of the other ingredients in the shampoo. ToxServices did not use data on surrogates for this endpoint as they are known to be corrosive, and they may be too conservative due to much smaller molecule size than the target chemical. The lack of ethoxylation in the surrogates also introduces uncertainties in the irritation potential. GreenScreen® criteria classify chemicals as a Low hazard for skin irritation/corrosivity when adequate data exist and GHS classification is not warranted (CPA 2018b). The confidence in the score is low as none of the studies provide test results for the undiluted material.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- RTECS 1999
  - Mildly irritating to rabbits exposed at 500 mg (no further details provided).
- CIR 1988
  - Polyquaternium-10 (purity not reported) was not irritating to the skin in a range finding toxicity study in rabbits (pre-GLP, guideline not specified). Five rabbits (strain not specified) were exposed to polyquaternium-10 on clipped, uncovered, and intact skin of the belly at various concentrations, for 24 hours (observation period not specified). Results reported for the 2% solution in water were no irritation for 4/5 rabbits, and moderate capillary injection for 1/5 rabbits. Results reported for the 5% solution in water were no irritation for 3/5 rabbits, and moderate capillary injection for 2/5 rabbits. Results reported for the 10% solution in water were no irritation for 2/5 rabbits, and moderate capillary injection for 3/5 rabbits.
  - Polyquaternium-10 (purity not reported) was irritating in a dermal irritation study conducted according to CFR 16:1500.3(C)(4), 1500.41 in 12 rabbits (6/group, unspecified sex and strain). Following an administration of shampoo containing 0.5% test material (undiluted/direct) to the abraded skin of rabbits (6) or intact skin of rabbits (6), the primary dermal irritation index (PDII) was 5.37 (max 8). The shampoo was classified as a severe irritant. *ToxServices discounts the reliability of this study because the other ingredients in the shampoo were not disclosed, and testing of the pure substance at up to 5% in water in multiple other studies was non-irritating.*
  - Polyquaternium-10 (purity not reported) was not irritating in a dermal irritation study in New Zealand White rabbits (unspecified sex). Following a 24-hour occlusive administration of conditioner containing 1% test material (0.5mL of test material, undiluted/direct) to the abraded or intact skin (6/group), the group PDII at 24 and 48 hours was 0 (max 8). Authors reported the conditioner was not a skin irritant.
  - Polyquaternium-10 (purity unspecified) was not irritating in a GLP-unspecified primary dermal irritation study in humans (n=106) following a 48-hour exposure of occlusive

administration of the test material (5% w/v of test material, water vehicle). No irritation was observed at 48 and 72 hours after application.
  - Polyquaternium-10 (purity unspecified) was not irritating in a GLP-unspecified primary dermal irritation study in humans (20/dose) following a 48-hour exposure of occlusive administration of the test material (5% w/v of test material, water vehicle). No irritation was observed at 48 and 72 hours after application.
  - Polyquaternium-10 (purity unspecified) was not irritating in a GLP-unspecified primary dermal irritation study in 27 humans following a 48-hour and 72-hours exposure of occlusive administration of the test material (5% w/v of test material, water vehicle). No erythema reactions were observed.
  - In clinical studies, including multiple RIPTs, polyquaternium-10 (concentrations ranging from 0.5 to 2%) was nonirritating.

Eye Irritation/Corrosivity (IrE) (Group II) Score (vH, H, M, or L): L
Polyquaternium-10 was assigned a score of Low for eye irritation/corrosivity based on the weight of evidence for numerous studies indicating no eye irritation, or mild eye irritation but below the threshold for classification. GreenScreen® criteria classify chemicals as a Low hazard for eye irritation/corrosivity when adequate data exist and GHS classification is not warranted (CPA 2018b). The confidence in the score is high based on the weight of evidence for numerous supporting studies.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- CIR 1988
  - In an ocular irritation study performed with 5 rabbits (unspecified sex and strain), polyquaternium-10 (0.5 mL directly applied powder, purity unspecified) was instilled into the conjunctival sac of one eye of the tested animals. This was completed in triplicate with 3 different lots of the same chemical. No other information was provided. Polyquaternium-10 was considered not irritating to the eye by the study authors.
  - In an ocular irritation study performed with 5 rabbits (unspecified sex and strain), 2%, 5%, and 10% (suspension) of polyquaternium-10 (0.5mL, purity unspecified, water vehicle) was instilled into the conjunctival sac of one eye of the tested animals, there was no irritation observed in 5/5 rabbits for the 2% concentration, no irritation observed in 5/5 rabbits for the 5% concentration, and trace irritation in 1/5 rabbits and no irritation observed in 4/5 rabbits for the 10% suspension. No other information was provided. Polyquaternium-10 was considered not irritating to the eye by the study authors.
  - Polyquaternium-10 (purity not reported) was not irritating in an eye irritation study conducted according to CFR 16:1500.3(C)(4), 1500.41 in 12 rabbits (6/group, unspecified sex and strain). Following an administration of shampoo containing 0.5% and 1.0% test material (undiluted/direct) to the eyes of rabbits, where one group were rinsed. No irritation at either concentration, rinsed or unrinsed were observed. The conditioner was not classified as an eye irritant.
  - Polyquaternium-10 (purity not reported) was not irritating in an eye irritation study in New Zealand White rabbits (unspecified sex and strain). The test substance was administered in a conditioner containing 1.0% test material (0.1mL, direct) to the eyes of rabbits, and for 3 animals the eyes were rinsed 15 seconds post application. No irritation was observed in rinsed or unrinsed eyes. Authors conclude the test substance was not irritating to the eyes under the conditions of the test.

Ecotoxicity (Ecotox)

Acute Aquatic Toxicity (AA) Score (vH, H, M, or L): *vH*
Polyquaternium-10 was conservatively assigned a score of Very High for acute aquatic toxicity based on LC/EC_{50} values of as low as 0.96 mg/L in fish, and a 72-hour EC_{50} of 0.04-0.05 mg/L in algae. Lesser toxicity was observed in invertebrates based on EC_{50} values > 1,000 mg/L in daphnids. GreenScreen® criteria classify chemicals as a Very High hazard for acute aquatic toxicity when the most sensitive trophic level has LC/EC_{50} values ≤ 1 mg/L (CPA 2018b). Confidence in the score is low due to significant variability in the range of toxicity values identified particularly with the vertebrates (fish), which is likely due to different charge densities of the various polyquaternium-10 polymers, i.e., increased charged density is known to correlate with increased toxicity. Therefore, polyquaternium-10 polymers with lower charge densities may be less toxic to aquatic species.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- Cumming 2008
  - In a non-GLP acute aquatic toxicity study, a number of polyquaternium-10 compounds of different molecular weights were tested, under the tradenames of UCare™ JR125, UCare™ JR30M, UCare™ JR400, UCare™ LK, UCare™ LR30M, and UCare™ LR400. The fish species *Gambusia holbrooki* (eastern mosquitofish) was used. Exposure time was 96 hours, under static conditions. Each test sample was tested at a minimum of 5 concentrations plus one control, determined in preliminary tests. It appears that the study author followed the general OECD guideline for aquatic toxicity testing. The 96-hour EC_{50} values for all tradenames above ranged from 0.96 to > 100 mg/L.
  - In a non-GLP acute aquatic toxicity study, a number of polyquaternium-10 compounds of different molecular weights were tested, under the tradenames of UCare™ JR125, and UCare™ JR30M. The invertebrate species brine shrimp (*Artemia sp.*) was used. Exposure time was 48 hours, under static conditions. Each test sample was tested at a minimum of 7 concentrations plus one control, determined in preliminary tests. It appears that the study author followed the general OECD guideline for aquatic toxicity testing. The 48-hour LC_{50} values for all tradenames were > 1,000 mg/L.
  - In a non-GLP acute aquatic toxicity study, a number of polyquaternium-10 compounds of different molecular weights was tested, under the tradenames of UCare™ JR125, UCare™ JR30M, and UCare™ JR400. The algae species *Chlorella sp.* was used. Exposure time was 72 hours, under static conditions. Each test sample was tested at a minimum of 5 concentrations plus one control, determined in preliminary tests. It appears that the study author followed the general OECD guideline for aquatic toxicity testing. The 72-hour EC_{50} values for the three tradenames above were 0.04, 0.05 and 0.05 mg/L, respectively
- U.S. EPA 2013
  - Cationic polymers with molecular weights greater than 1,000, such as polyquaternium-10, may pose a concern for aquatic hazard, especially those that have a net positive charge or may become cationic in the environment.
  - The atoms that will have the positive charge in the polyquaternium-10 would be nitrogen.
  - Polyquaternium-10 has a natural backbone such as cellulose.

Chronic Aquatic Toxicity (CA) Score (vH, H, M, or L): *vH*
Polyquaternium-10 was conservatively assigned a score of Very High for chronic aquatic toxicity based on data in algae, the most sensitive trophic levels based on acute aquatic toxicity data. 72-hour EC_{10}

values of 0.013-0.002 mg/L were measured in algae. GreenScreen® criteria classify chemicals as a Very High hazard when chronic values are ≤ 0.1 mg/L. Confidence in the score is low due to significant variability in the range of toxicity values identified in each species, which is likely due to different charge densities of the various polyquaternium-10 polymers, i.e., increased charged density correlates with increased toxicity. Therefore, polyquaternium-10 polymers with lower charge density would be expected to be less toxic to aquatic species.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- ECHA CHEM, CAS #112-02-7, 2025
  - *Surrogate: Cetrimonium chloride (CAS #112-02-7)*: A GLP-compliant fish early-life stage toxicity test was performed according to U.S. EPA FIFRA 72-4(a). *Pimephales promelas* (Fathead minnows) were exposed to the cetrimonium chloride for 34 days under static conditions (with daily renewal, no aeration) at nominal concentrations up to 490 µg/L, equivalent to 488.7 µg a.i./L (measured). The 28-day post-hatch LC_{50} was 94 µg a.i./L, and the 28-day NOEC post-hatch was 32.2 µg a.i./L based on mortality (equivalent to 0.0322 mg a.i./L), and > 32.2 µg a.i./L based on growth rate (equivalent to > 0.0322 mg a.i./L) (Klimisch 2, reliable with restrictions).
- Cumming 2008
  - As noted above, a number of polyquaternium-10 compounds of different molecular weights were tested in a non-GLP acute aquatic toxicity study, under the tradenames of UCare™ JR125, UCare™ JR30M, and UCare™ JR400. The algae species *Chlorella sp.* was used. Exposure time was 72 hours, under static conditions. Each test sample was tested at a minimum of 5 concentrations plus one control, determined in preliminary tests. It appears that the study author followed the general OECD guideline for aquatic toxicity testing. The 72-hour EC_{10} values were 0.013, and 0.002 mg/L, for UCare™ JR400 and UCare™ JR30M, respectively. The EC_{10} for UCare™ JR125 was not reported.

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): *vH*
Polyquaternium-10 is assigned a score of Very High for persistence based on a conservative assumption that high molecular weight polymers are inherently persistent, and cationic polymers are likely to partition to soil and sediment. GreenScreen® criteria classify chemicals as a Very High hazard for persistence when the dominant medium is soil or sediment, and the half-life is > 180 days (CPA 2018b). The confidence in the score is low due to limited data, and it is not known if some polyquaternium-10 polymers, which are largely cellulosic, may be designed to be more rapidly degradable than others.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists for this endpoint.
  - *Screening:* Not present on any screening lists for this endpoint.
- U.S. EPA 2013
  - The vast majority of polymers are known to be persistent.
  - Most polymers are considered non-biodegradable; however, in the case of highly degradable polymers, assessment of the degradation products may be warranted, such as hydrolysis products.
  - Cationic polymers generally absorb strongly to soil and sediment.
  - Cationic polymers with MW >1,000 generally have 90% removal at water treatment plants.
  - The vapor pressure of polyquaternium-10 is < 10^{-8} mmHg.

- CIR 1988
    - Polyquaternium-10 is soluble in water.

Bioaccumulation (B) Score (vH, H, M, L, or vL): *vL*
Polyquaternium-10 was assigned a score of Very Low for bioaccumulation based on professional opinion that its very high molecular weight, several orders of magnitude > 1,000 Daltons, will render it not bioavailable, and therefore, not bioaccumulative. The confidence in the score is low based on lack of measured data, the log K_{ow} cannot be estimated for this compound, and it is not known if the polymer may be hydrolysable. If it is hydrolysable, small fragments may be bioavailable and it is not known if the fragments may be metabolized, excreted, or bioaccumulated, and these factors would depend also on the hydrolysis rate.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists for this endpoint.
    - *Screening:* Not present on any screening lists for this endpoint.
- U.S. EPA 2013
    - No data were available regarding the bioaccumulation potential of polyquaternium-10; however, based on its large molecular weight, polyquaternium-10 is not expected to be bioavailable and, therefore, it is not expected to be bioaccumulative.
- ToxServices notes the above sources do not address hydrolysis, and if hydrolyzed, it is reasonable to assume the smaller molecular weight byproducts may be bioavailable. Additionally, the log K_{ow} cannot be measured for this compound. Data on surrogates are not considered for this endpoint as the surrogates are much smaller than the target polymer, leading to different physicochemical properties and bioavailability characteristics.

<u>Physical Hazards (Physical)</u>

Reactivity (Rx) Score (vH, H, M, or L): *L*
Polyquaternium-10 was assigned a score of Low for reactivity based on lack of reactive functional groups in the molecular structure. GreenScreen® criteria classify chemicals as a Low hazard for reactivity when adequate data exist and GHS classification is not warranted (CPA 2018b). The confidence in the score is low due to lack of measured data.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists for this endpoint.
    - *Screening:* Not present on any screening lists for this endpoint.
- Interchimie 2020, Dow Chemical Company 2023a,b, 2025
    - Safety data sheets for polyquaternium-10 indicate that it is non-reactive under normal conditions of use, storage, and transport.
- In the absence of additional data, screening procedures for explosivity were used here to estimate the reactivity property of polyquaternium-10 in accordance with GHS guidelines (UN 2023).
    - Based on the structure of its components or moieties, polyquaternium-10 is not considered explosive or self-reactive due to lack of functional groups associated with explosive or self-reactive properties (See Appendix G).
    - Based on the structure of its components or moieties, polyquaternium-10 is not considered to have oxidizing properties as it does not contain any structural groups known to be correlated with a tendency to react exothermally with combustible materials. Specifically, organic substances which contain oxygen, fluorine, or chlorine where these elements are chemically bonded only to carbon or hydrogen, classification as an oxidizing liquid need not be applied.

Therefore, as all of the oxygen atoms in polyquaternium-10 are bonded only to carbon and hydrogen, classification is not warranted.

Flammability (F) Score (vH, H, M, or L): *L*
Polyquaternium-10 was assigned a score of Low for flammability based on lack of flammability warnings on the safety data sheet. GreenScreen® criteria classify chemicals as a Low hazard for flammability when adequate data exist and GHS classification is not warranted (CPA 2018b). The confidence in the score is low based on lack of measured data.

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists for this endpoint.
    - *Screening:* Not present on any screening lists for this endpoint.
- Interchimie 2020, Dow Chemical Company 2023a,b, 2025
    - Safety data sheets for polyquaternium-10 indicate that it is a non-flammable solid and does not require any flammability warnings for workers or for transport.

Use of New Approach Methodologies (NAMs)[10] in the Assessment, Including Uncertainty Analyses of Input and Output

New Approach Methodologies (NAMs) used in this GreenScreen® include use of *in vitro* assays to assess genotoxicity and endocrine activity, and evaluation of structural alerts for the assessment of carcinogenicity and respiratory tract sensitization. NAMs are non-animal alternatives that can be used alone or in combination to provide information for safety assessment (Madden et al. 2020). At present, there is not a uniformly accepted framework on how to report and apply individual NAMs (U.S. EPA 2020, OECD 2020). The expanded application of NAMs greatly amplifies the need to communicate uncertainties associated with their use. As defined by EFSA (2018), uncertainty is "a general term referring to all types of limitations in available knowledge that affect the range and probability of possible answers to an assessment question." The quality, utility, and accuracy of NAM predictions are greatly influenced by two primary types of uncertainties (OECD 2020):

- Type I: Uncertainties related to the input data used
- Type II: Uncertainties related to extrapolations made

As shown in Table 4, Type I (input data) uncertainties in polyquaternium-10's NAMs dataset include lack of, or insufficient, experimental data to assess carcinogenicity, endocrine activity, and respiratory sensitization, and there are no validated test methods for respiratory sensitization. Polyquaternium-10's Type II (extrapolation output) uncertainties include reliance on structural alerts to assess some endpoints without defined applicability domains, use of *in vitro* assays that do not entirely mimic *in vivo* metabolic conditions, limitations of *in vitro* genotoxicities in focusing on a few events in the process of mutagenicity that may or may not be repaired, uncertain *in vivo* relevance of high throughput screening assays for endocrine receptor activity, and EDSP's insufficient coverage of critical endocrine pathways. Some of polyquaternium-10's type II uncertainties were alleviated by the use of *in vitro* test batteries and/or in combination of *in vivo* data.

Table 4: Summary of NAMs Used in the GreenScreen® Assessment, Including Uncertainty Analyses	
Uncertainty Analyses (OECD 2020)	
Type I Uncertainty: Data/Model Input	**Carcinogenicity:** No experimental data are available. **Endocrine activity:** Insufficient *in vivo* data are available. **Respiratory sensitization**: No experimental data are available and there are no validated test methods.
Type II Uncertainty: Extrapolation Output	**Carcinogenicity**: Toxtree only identifies structural alerts (SAs), and no applicability domain can be defined (Toxtree 2018). **Genotoxicity:** The bacterial reverse mutation assay (as defined in OECD Guideline 471) only tests point-mutation inducing activity in non-mammalian cells, and the exogenous metabolic activation system does not entirely mimic *in vivo* conditions[11].

[10] NAMs refers to any non-animal technology, methodology, approach, or combination thereof that inform chemical hazard and risk assessments. NAMs include *in silico*/computational tools, *in vitro* biological profiling (e.g., cell cultures, 2,3-D organotypic culture systems, genomics/transcriptomics, organs on a chip), and frameworks (i.e., adverse outcome pathways (AOPs), defined approaches (DA), integrated approaches to testing and assessment (IATA).
[11] https://www.oecd-ilibrary.org/docserver/9789264071247-en.pdf?expires=1614097593&id=id&accname=guest&checksum=89925F80B9F4BD2FFC6E90F94A0EE427

	The *in vitro* chromosome aberration assay (OECD Guideline 473) does not measure aneuploidy and it only measures structural chromosomal aberrations. The exogenous metabolic activation system does not entirely mirror *in vivo* metabolism[12]. The *in vitro* SCE assay (as defined in OECD Guideline 479, a guideline deleted in 2014) detects reciprocal exchange of DNA without providing the underlying mechanism of action[13]. **Endocrine activity:** The *in vivo* relevance of EDSP Tox 21 screening assays is unknown due to lack of consideration of metabolism and other toxicokinetic factors. EDSP Tox 21 assays do not cover all critical endocrine pathways. **Respiratory sensitization**: The OECD Toolbox only identifies structural alerts, and does not define applicability domains. Additionally, the ECHA guidance (2017), on which the use of OECD Toolbox structural alerts is based, does not evaluate non-immunologic mechanisms for respiratory sensitization.

Endpoint	**NAMs Data Available and Evaluated? (Y/N)**	**Types of NAMs Data (*in silico* modeling/*in vitro* biological profiling/frameworks)**
Carcinogenicity	Y	*In silico* modeling: Toxtree
Mutagenicity	Y	*In vitro* data: Bacterial reverse mutation assay/*in vitro* chromosome aberration assay/ *in vitro* sister chromatid exchange assay / *in vitro* mammalian cell DNA repair test
Reproductive toxicity	N	
Developmental toxicity	N	
Endocrine activity	Y	*In vitro* high throughput data: EDSP Tox 21 screening assays
Acute mammalian toxicity	N	
Single exposure systemic toxicity	N	
Repeated exposure systemic toxicity	N	
Single exposure neurotoxicity	N	
Repeated exposure neurotoxicity	N	
Skin sensitization	N	
Respiratory sensitization	Y	*In silico* modeling: OECD Toolbox structural alerts
Skin irritation	N	
Eye irritation	N	

[12] https://www.oecd-ilibrary.org/docserver/9789264264649-en.pdf?expires=1614098015&id=id&accname=guest&checksum=6A4F9CE52EA974F5A74793DD54D54352
[13] https://www.oecd.org/env/ehs/testing/Draft_Intro_Genotoxicity%20TGs%20September%202014.pdf

Acute aquatic toxicity	N	
Chronic aquatic toxicity	N	
Persistence	N	
Bioaccumulation	N	

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APPENDIX A: Hazard Classification Acronyms
(in 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

APPENDIX B: Results of Automated GreenScreen® Score Calculation for Polyquaternium-10 (CAS #68610-92-4)

TOXSERVICES TOXICOLOGY RISK ASSESSMENT CONSULTING

GREEN SCREEN FOR SAFER CHEMICALS

GreenScreen® Score Inspector

Table 1: Hazard Table

Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
						S	R *	S	R *	*	*								
C	M	R	D	E	AT	STs	STr	Ns	Nr	SNS*	SNR*	IrS	IrE	AA	CA	P	B	Rx	F
DG	L	*L*	L	DG	L	*L*	DG	DG	DG	L	*L*	*L*	L	*vH*	*vH*	*vH*	*vL*	*L*	*L*

Table 2: Chemical Details

Inorganic Chemical?	Chemical Name	CAS#
No	Polyquaternium-10	68610-92-4

Table 3: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	Yes	No	No		
2	STOP						
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen® Benchmark Score
Polyquaternium-10	1

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

Chemical Name	Final GreenScreen® Benchmark Score
Polyquaternium-10	1

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												1
2												
3												
4												

APPENDIX C: Pharos Output for Polyquaternium-10 (CAS #68610-92-4)

PHAROS Search... Comparisons Common Products Discussions Account

68610-92-4

Cellulose, ether with α-[2-hydroxy-3-(trimethylammonio)propyl]-ω-hydroxypoly(oxy-1,2-ethanediyl), chloride (>= 2 % quaternisierter Stickstoff)

ALSO CALLED Cationic Hydroxyethyl cellulose, Cellulose ether with ethoxylated 2-hydroxy-3-(trimethylammonio)prop...

View all synonyms (6)

SHARE PROFILE

HAZARDS PROPERTIES FUNCTIONAL USES RESOURCES

All Hazards View

Show PubMed Results REQUEST ASSESSMENT ADD TO COMPARISON

		Group I Human					Group II and II* Human									Ecotox			Fate		Physical		Mult	Non-GSLT			
	GREENSCREEN®	C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other
List Hazard Summary	NoGS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R

Hazard Lists

DOWNLOAD LISTS

ENDPOINT	HAZARD LEVEL	GREENSCREEN®	LIST NAME	HAZARD DESCRIPTION	OTHER LISTS
None Found					

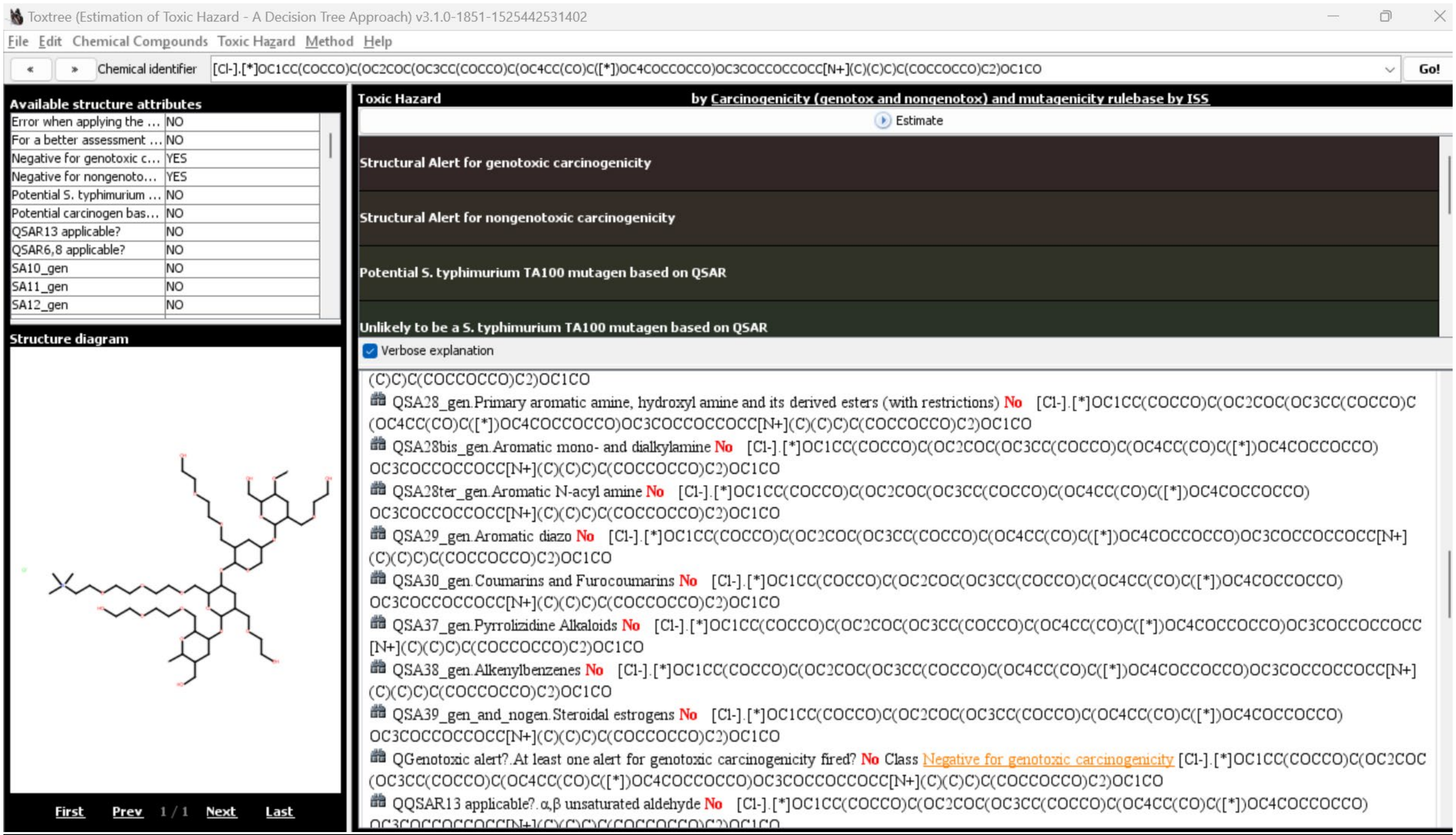
Restricted Substance Lists (4)

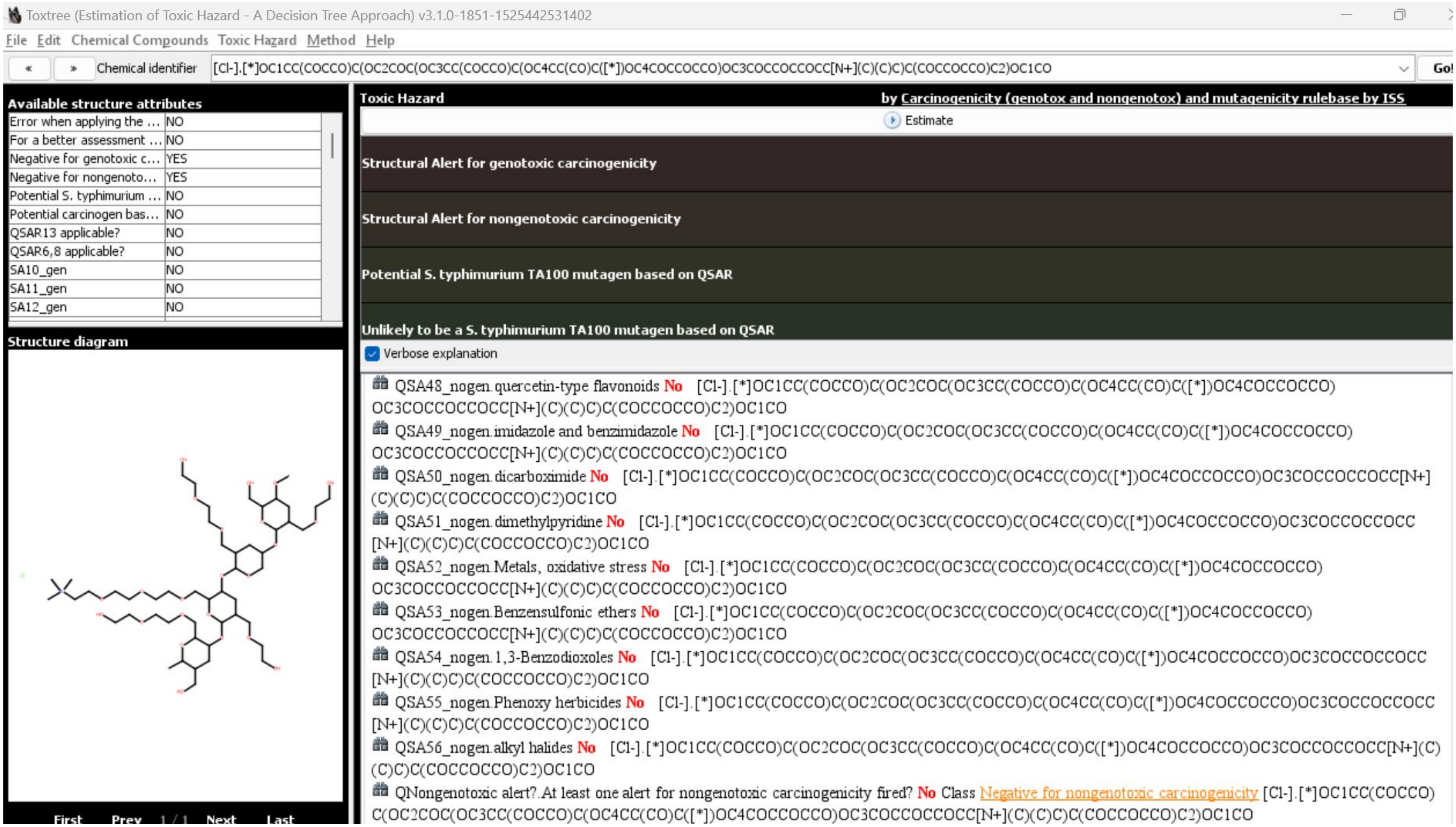
- California Safe Cosmetics Program - Reportable Ingredient List: CSCP - Reportable Ingredient List
- EC - CEPA DSL: DSL-all
- TSCA Chemical Substance Inventory (Active-Inactive): TSCA Commercially Active
- TSCA Chemical Substantial Risk Notices: TSCA - Substantial Risk Notices

Positive Lists (1)

- Cosmetic Ingredient Review (CIR): Safe as Used

APPENDIX D: Toxtree Carcinogenicity Results for Polyquaternium-10 (CAS #68610-92-4)




Toxtree (Estimation of Toxic Hazard - A Decision Tree Approach) v3.1.0-1851-1525442531402
File Edit Chemical Compounds Toxic Hazard Method Help
Chemical identifier [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
Go!
Available structure attributes
Error when applying the ... NO
For a better assessment ... NO
Negative for genotoxic c... YES
Negative for nongenoto... YES
Potential S. typhimurium ... NO
Potential carcinogen bas... NO
QSAR13 applicable? NO
QSAR6,8 applicable? NO
SA10_gen NO
SA11_gen NO
SA12_gen NO
Structure diagram
First Prev 1 / 1 Next Last
Toxic Hazard
by Carcinogenicity (genotox and nongenotox) and mutagenicity rulebase by ISS
Estimate
Structural Alert for genotoxic carcinogenicity
Structural Alert for nongenotoxic carcinogenicity
Potential S. typhimurium TA100 mutagen based on QSAR
Unlikely to be a S. typhimurium TA100 mutagen based on QSAR
Verbose explanation
QSA48_nogen.quercetin-type flavonoids No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA49_nogen.imidazole and benzimidazole No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA50_nogen.dicarboximide No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA51_nogen.dimethylpyridine No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA52_nogen.Metals, oxidative stress No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA53_nogen.Benzensulfonic ethers No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA54_nogen.1,3-Benzodioxoles No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA55_nogen.Phenoxy herbicides No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QSA56_nogen.alkyl halides No [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO
QNongenotoxic alert?.At least one alert for nongenotoxic carcinogenicity fired? No Class Negative for nongenotoxic carcinogenicity [Cl-].[*]OC1CC(COCCO)C(OC2COC(OC3CC(COCCO)C(OC4CC(CO)C([*])OC4COCCOCCO)OC3COCCOCCOCC[N+](C)(C)C)C(COCCOCCO)C2)OC1CO

APPENDIX E: Tox 21 EDSP Data for Surrogates

Cetrimonium chloride:

EXPORT

Bioactivity Summary Grid

Filter out non-representative sample (Repr.) results. Filter out 'background' from Intended Target Family

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP ER														
TOX21_ERa_BLA_Antagonist_r	EDSP ER		NP_000116.2	ESR1	-	-			Active	0.9996	82.88	28.87	1.46	20.00	18
TOX21_ERa_BLA_Antagonist_v	EDSP ER cytotoxicity burst				263	1771			Active	0.9977	76.28	25.12	1.40	38.89	2
TOX21_ERa_LUC_VM7_Antag	EDSP ER		NP_000116.2	ESR1	-	-			Active	0.9948	44.35	44.11	1.64	24.50	4
TOX21_ERa_LUC_VM7_Agonis	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	2.33e-9	25.00	1.40	20.00	-
TOX21_ERa_LUC_VM7_Antag	cytotoxicity burst EDSP ER				263	1771			Inactive	0	9.44	46.99	1.67	24.57	-
TOX21_ERa_BLA_Agonist_rati	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	2.47e-10	20.00	1.30	20.00	-

EXPORT

Bioactivity Summary Grid

Filter out non-representative sample (Repr.) results. Filter out 'background' from Intended Target Family

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP AR														
TOX21_AR_LUC_MDAKB2_Ant	EDSP AR		P10275.3	AR	-	-			Active	0.9995	71.51	25.00	1.40	29.88	2
TOX21_AR_LUC_MDAKB2_Ant	cytotoxicity burst EDSP AR				263	1771			Active	1	65.95	40.13	1.60	20.00	3
TOX21_AR_BLA_Antagonist_ra	EDSP AR		P10275.3	AR	-	-			Active	1	103.60	7.89	0.90	26.09	4
TOX21_AR_BLA_Antagonist_v	cytotoxicity burst EDSP AR				263	1771			Active	1	71.92	23.13	1.36	23.06	16
TOX21_AR_LUC_MDAKB2_Ant	cytotoxicity burst EDSP AR				263	1771			Active	0.995	28.79	47.35	1.68	20.00	4
TOX21_AR_LUC_MDAKB2_Ant	EDSP AR		P10275.3	AR	-	-			Active	1	99.24	18.75	1.27	32.13	14
TOX21_AR_BLA_Agonist_ratio	EDSP AR		P10275.3	AR	23	25			Inactive	0	8.65e-9	20.00	1.30	20.00	-
TOX21_AR_LUC_MDAKB2_Ag	EDSP AR		P10275.3	AR	23	25			Inactive	0	2.51e-10	25.00	1.40	20.00	-

EXPORT

Bioactivity Summary Grid

Filter out non-representative sample (Repr.) results. Filter out 'background' from Intended Target Family

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(2) EDSP steroido														
TOX21_TRHR_HEK293_antagc	EDSP thyroid			TRHR	48	389			Active	0.9992	41.74	11.22	1.05	20.00	11
TOX21_TR_LUC_GH3_Antago	EDSP thyroid		NP_003242.1 NP_000452.2	THRA | THR B	-	-			Active	1	120.00	10.20	1.01	22.44	5
TOX21_TSHR_HTRF_Agonist_r	EDSP thyroid		P16473.2	TSHR	42 | 54 | 159	277			Active	0.9944	50.64	25.00	1.40	27.85	2
TOX21_Aromatase_Inhibition_	cytotoxicity burst EDSP steroidogenesis				25 | 263	36 | 1771			Active	0.9991	53.90	21.99	1.34	27.62	2
TOX21_TR_LUC_GH3_Antago	EDSP thyroid cytotoxicity burst				-	-			Active	1	85.99	13.21	1.12	40.08	12
TOX21_Aromatase_Inhibition	EDSP steroidogenesis		NP_000094.2	CYP19A1	25	36			Active	1	94.06	12.92	1.11	26.84	8
TOX21_TRHR_HEK293_agonis	EDSP thyroid			TRHR	48	389			Active	1	26.91	11.46	1.06	20.00	13
TOX21_TR_LUC_GH3_Agonist	EDSP thyroid		NP_003242.1 NP_000452.2	THRA | THR B	-	-			Inactive	0	5.90e-10	25.00	1.40	20.00	-
TOX21_TSHR_HTRF_Antagoni	EDSP thyroid		P16473.2	TSHR	42 | 54 | 159	277			Inactive	-	1.33	2.29e-4	-3.64	20.00	-
TOX21_TSHR_wt_Agonist_HTF	EDSP thyroid		P16473.2	TSHR	-	-			Inactive	0	3.77e-9	25.00	1.40	20.00	-

Laurtrimonium chloride:

EXPORT **Bioactivity Summary Grid**

Filter out non-representative sample (Repr.) results. Filter out 'background' from Intended Target Family

Assay Lists filter: (1) EDSP ER

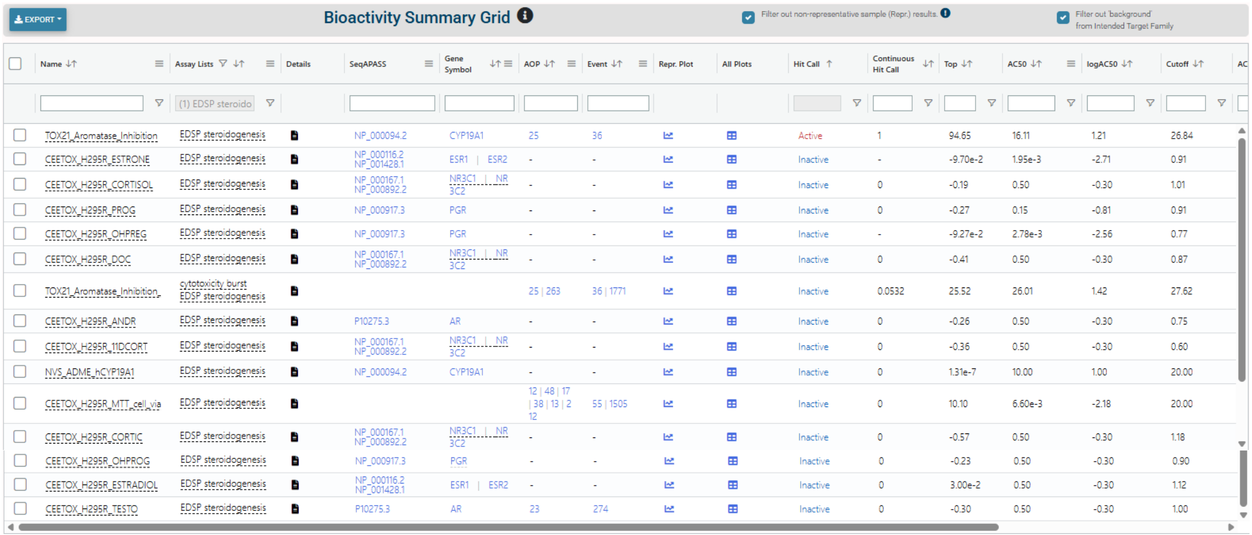
Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff
TOX21_ERa_BLA_Antagonist_	EDSP ER		NP_000116.2	ESR1	-	-			Active	1	56.68	18.05	1.26	20.00
TOX21_ERa_LUC_VM7_Antag	EDSP ER		NP_000116.2	ESR1	-	-			Active	1	109.75	24.25	1.38	24.50
TOX21_ERa_LUC_VM7_Antag	cytotoxicity burst EDSP ER				263	1771			Active	0.9997	63.47	70.51	1.85	24.57
ACEA_ER_AUC_viability	cytotoxicity burst EDSP ER				220 | 263	1394 | 1821			Active	0.9998	115.59	21.33	1.33	20.00
OT_ER_ERaERa_0480	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	4.73e-11	50.00	1.70	20.00
TOX21_ERa_BLA_Antagonist_	EDSP ER cytotoxicity burst				263	1771			Inactive	0.8175	51.46	40.00	1.60	38.89
ACEA_ER_80hr	EDSP ER		NP_000116.2	ESR1	220	1394			Inactive	0.0037	2.94e-7	50.00	1.70	25.49
TOX21_ERa_BLA_Agonist_rati	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	2.01	17.60	1.25	20.00
ATG_ERE_CIS	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	-0.27	8.17	0.91	0.50
NVS_NR_hER	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	1.43e-8	25.00	1.40	24.39
OT_ERa_GFPERaERE_0480	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	8.25	20.69	1.32	20.00
NVS_NR_mERa	EDSP ER		NP_031982.1	Esr1	-	-			Inactive	0.8516	28.10	1.81	0.26	25.96
ATG_ERa_TRANS	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	6.63e-12	35.00	1.54	1.10
OT_ERa_GFPERaERE_0120	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	3.11	3.00e-2	-1.52	20.00
NVS_NR_bER	EDSP ER		NP_001001443.1	ESR1	-	-			Inactive	0	1.17e-9	25.00	1.40	24.17
OT_ER_ERbERb_0480	EDSP ER		NP_001428.1	ESR2	-	-			Inactive	-	2.33	11.02	1.04	20.00
OT_ER_ERbERb_1440	EDSP ER		NP_001428.1	ESR2	-	-			Inactive	0	7.98e-9	50.00	1.70	20.00
OT_ER_ERaERa_1440	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	9.78e-11	50.00	1.70	20.00
OT_ER_ERaERb_0480	EDSP ER		NP_000116.2 NP_001428.1	ESR1 | ESR2	-	-			Inactive	0	1.92e-9	50.00	1.70	23.30
OT_ER_ERaERb_1440	EDSP ER		NP_000116.2 NP_001428.1	ESR1 | ESR2	-	-			Inactive	0	9.49	10.20	1.01	20.00
TOX21_ERa_LUC_VM7_Agoni	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	1.76e-9	45.00	1.65	20.00

EXPORT **Bioactivity Summary Grid**

Filter out non-representative sample (Repr.) results. Filter out 'background' from Intended Target Family

Assay Lists filter: (1) EDSP AR

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff
TOX21_AR_LUC_MDAKB2_Ant	cytotoxicity burst EDSP AR				263	1771			Active	0.9849	26.94	7.51	0.88	20.00
TOX21_AR_LUC_MDAKB2_Ant	EDSP AR		P10275.3	AR	-	-			Active	1	101.23	5.78	0.76	29.88
OT_AR_ARSRC1_0480	EDSP AR		P10275.3 NP_005408.1	AR | SRC	23	25			Active	1	57.09	23.00	1.36	20.00
TOX21_AR_LUC_MDAKB2_Ant	EDSP AR		P10275.3	AR	-	-			Active	1	107.59	4.92	0.69	32.13
TOX21_AR_BLA_Antagonist_v	cytotoxicity burst EDSP AR				263	1771			Active	1	65.52	35.73	1.55	23.06
OT_AR_ARSRC1_0960	EDSP AR		P10275.3 NP_005408.1	AR | SRC	23	25			Active	1	78.15	13.47	1.13	20.00
TOX21_AR_BLA_Antagonist_ra	EDSP AR		P10275.3	AR	-	-			Active	1	114.36	13.57	1.13	26.09
TOX21_AR_LUC_MDAKB2_Ant	cytotoxicity burst EDSP AR				263	1771			Active	1	62.52	16.97	1.23	20.00
OT_AR_ARELUC_AG_1440	EDSP AR		P10275.3	AR	23	25			Inactive	-	-	-	-	20.00
TOX21_AR_LUC_MDAKB2_Ag	EDSP AR		P10275.3	AR	23	25			Inactive	0	3.93e-10	45.00	1.65	20.00
ATG_AR_TRANS	EDSP AR		P10275.3	AR	-	-			Inactive	0.0001	1.60e-12	35.00	1.54	0.86
UPITT_HCI_U2OS_AR_TIF2_N	EDSP AR		P10275.3	AR	23	25			Inactive	0.0858	33.23	9.92	1.00	37.98
TOX21_AR_BLA_Agonist_ratio	EDSP AR		P10275.3	AR	23	25			Inactive	0	1.07e-9	40.00	1.60	20.00
UPITT_HCI_U2OS_AR_TIF2_N	EDSP AR		P10275.3	AR	23	25			Inactive	0.0457	11.83	50.00	1.70	20.00



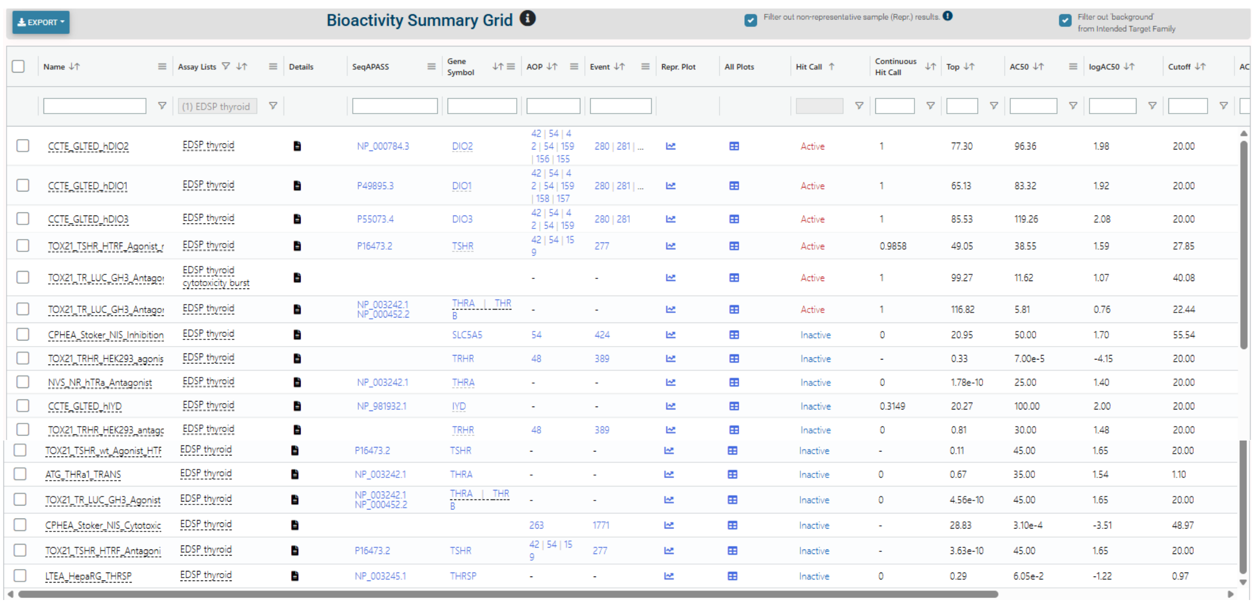
EXPORT

Bioactivity Summary Grid

Filter out non-representative sample (Repr.) results.

Filter out 'background' from Intended Target Family

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP steroido														
TOX21_Aromatase_Inhibition	EDSP steroidogenesis		NP_000094.2	CYP19A1	25	36			Active	1	94.65	16.11	1.21	26.84	
CEETOX_H295R_ESTRONE	EDSP steroidogenesis		NP_000116.2 NP_001428.1	ESR1 | ESR2	-	-			Inactive	-	-9.70e-2	1.95e-3	-2.71	0.91	
CEETOX_H295R_CORTISOL	EDSP steroidogenesis		NP_000167.1 NP_000892.2	NR3C1 | NR3C2	-	-			Inactive	0	-0.19	0.50	-0.30	1.01	
CEETOX_H295R_PROG	EDSP steroidogenesis		NP_000917.3	PGR	-	-			Inactive	0	-0.27	0.15	-0.81	0.91	
CEETOX_H295R_OHPREG	EDSP steroidogenesis		NP_000917.3	PGR	-	-			Inactive	-	-9.27e-2	2.78e-3	-2.56	0.77	
CEETOX_H295R_DOC	EDSP steroidogenesis		NP_000167.1 NP_000892.2	NR3C1 | NR3C2	-	-			Inactive	0	-0.41	0.50	-0.30	0.87	
TOX21_Aromatase_Inhibition_	cytotoxicity burst EDSP steroidogenesis				25 | 263	36 | 1771			Inactive	0.0532	25.52	26.01	1.42	27.62	
CEETOX_H295R_ANDR	EDSP steroidogenesis		P10275.3	AR	-	-			Inactive	0	-0.26	0.50	-0.30	0.75	
CEETOX_H295R_11DCORT	EDSP steroidogenesis		NP_000167.1 NP_000892.2	NR3C1 | NR3C2	-	-			Inactive	0	-0.36	0.50	-0.30	0.60	
NVS_ADME_hCYP19A1	EDSP steroidogenesis		NP_000094.2	CYP19A1	-	-			Inactive	0	1.31e-7	10.00	1.00	20.00	
CEETOX_H295R_MTT_cell_via	EDSP steroidogenesis				12 | 48 | 17 | 38 | 13 | 2 12	55 | 1505			Inactive	0	10.10	6.60e-3	-2.18	20.00	
CEETOX_H295R_CORTIC	EDSP steroidogenesis		NP_000167.1 NP_000892.2	NR3C1 | NR3C2	-	-			Inactive	0	-0.57	0.50	-0.30	1.18	
CEETOX_H295R_OHPROG	EDSP steroidogenesis		NP_000917.3	PGR	-	-			Inactive	0	-0.23	0.50	-0.30	0.90	
CEETOX_H295R_ESTRADIOL	EDSP steroidogenesis		NP_000116.2 NP_001428.1	ESR1 | ESR2	-	-			Inactive	0	3.00e-2	0.50	-0.30	1.12	
CEETOX_H295R_TESTO	EDSP steroidogenesis		P10275.3	AR	23	274			Inactive	0	-0.30	0.50	-0.30	1.00	



EXPORT

Bioactivity Summary Grid

Filter out non-representative sample (Repr.) results.

Filter out 'background' from Intended Target Family

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP thyroid														
CCTE_GLTED_hDIO2	EDSP thyroid		NP_000784.3	DIO2	42 | 54 | 42 | 54 | 159 | 156 | 155	280 | 281 | ...			Active	1	77.30	96.36	1.98	20.00	
CCTE_GLTED_hDIO1	EDSP thyroid		P49895.3	DIO1	42 | 54 | 42 | 54 | 159 | 158 | 157	280 | 281 | ...			Active	1	65.13	83.32	1.92	20.00	
CCTE_GLTED_hDIO3	EDSP thyroid		P55073.4	DIO3	42 | 54 | 42 | 54 | 159	280 | 281			Active	1	85.53	119.26	2.08	20.00	
TOX21_TSHR_HTRF_Agonist_r	EDSP thyroid		P16473.2	TSHR	42 | 54 | 159	277			Active	0.9858	49.05	38.55	1.59	27.85	
TOX21_TR_LUC_GH3_Antagoı	EDSP thyroid cytotoxicity burst				-	-			Active	1	99.27	11.62	1.07	40.08	
TOX21_TR_LUC_GH3_Antagoı	EDSP thyroid		NP_003242.1 NP_000452.2	THRA | THRB	-	-			Active	1	116.82	5.81	0.76	22.44	
CPHEA_Stoker_NIS_Inhibition	EDSP thyroid			SLC5A5	54	424			Inactive	0	20.95	50.00	1.70	55.54	
TOX21_TRHR_HEK293_agonis	EDSP thyroid			TRHR	48	389			Inactive	-	0.33	7.00e-5	-4.15	20.00	
NVS_NR_hTRa_Antagonist	EDSP thyroid		NP_003242.1	THRA	-	-			Inactive	0	1.78e-10	25.00	1.40	20.00	
CCTE_GLTED_hIYD	EDSP thyroid		NP_981932.1	IYD	-	-			Inactive	0.3149	20.27	100.00	2.00	20.00	
TOX21_TRHR_HEK293_antagc	EDSP thyroid			TRHR	48	389			Inactive	0	0.81	30.00	1.48	20.00	
TOX21_TSHR_wt_Agonist_HTF	EDSP thyroid		P16473.2	TSHR	-	-			Inactive	-	0.11	45.00	1.65	20.00	
ATG_THRa1_TRANS	EDSP thyroid		NP_003242.1	THRA	-	-			Inactive	0	0.67	35.00	1.54	1.10	
TOX21_TR_LUC_GH3_Agonist	EDSP thyroid		NP_003242.1 NP_000452.2	THRA | THRB	-	-			Inactive	0	4.56e-10	45.00	1.65	20.00	
CPHEA_Stoker_NIS_Cytotoxic	EDSP thyroid				263	1771			Inactive	-	28.83	3.10e-4	-3.51	48.97	
TOX21_TSHR_HTRF_Antagoni	EDSP thyroid		P16473.2	TSHR	42 | 54 | 159	277			Inactive	-	3.63e-10	45.00	1.65	20.00	
LTEA_HepaRG_THRSP	EDSP thyroid		NP_003245.1	THRSP	-	-			Inactive	0	0.29	6.05e-2	-1.22	0.97	

Cetrimonium bromide

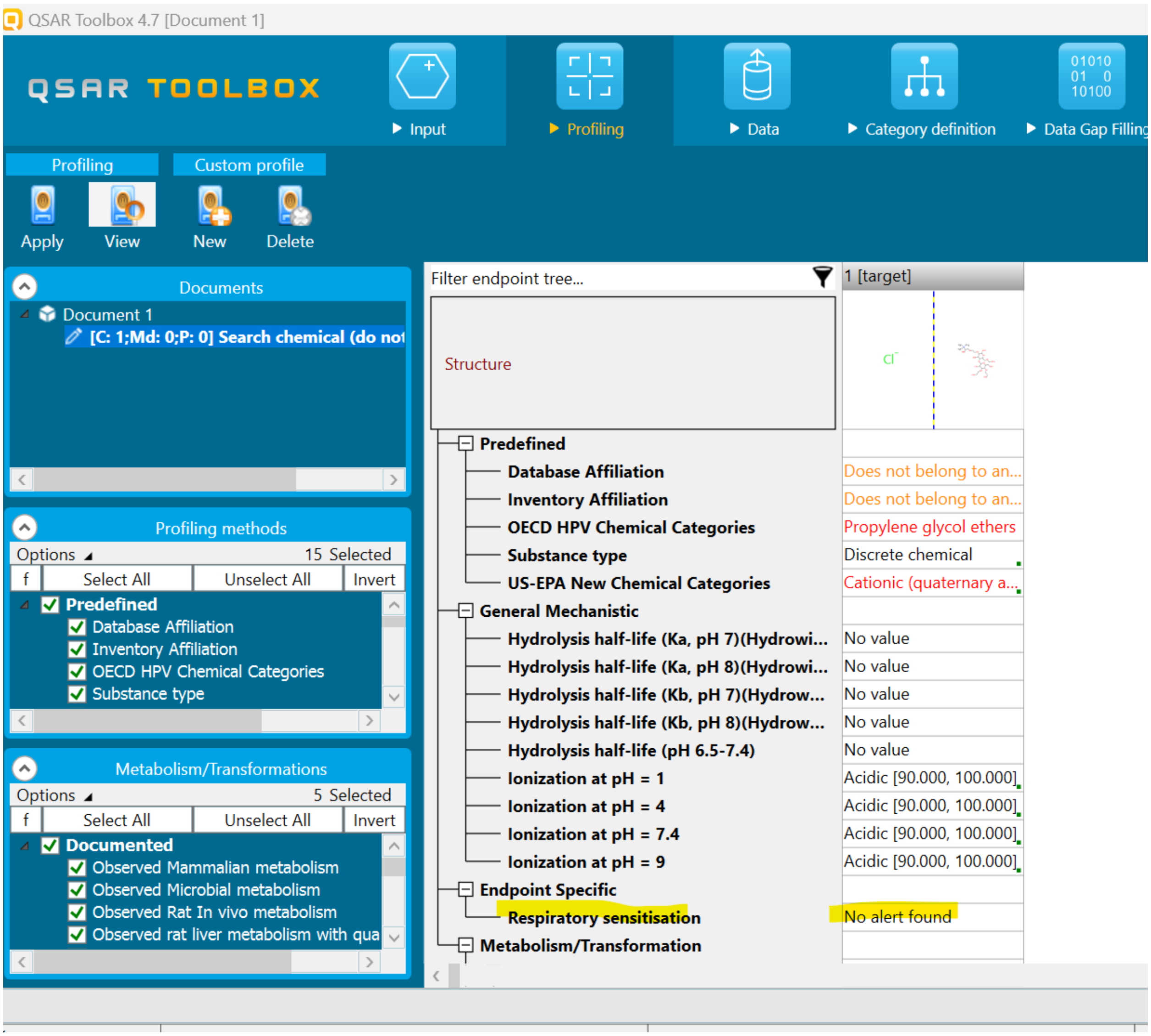
Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP ER														
OT_ER_ERaERa_1440	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	3.27e-10	50.00	1.70	20.00	
TOX21_ERa_LUC_VM7_Antag	EDSP ER		NP_000116.2	ESR1	-	-			Active	0.9986	54.70	31.59	1.50	24.50	
NVS_NR_hER	EDSP ER		NP_000116.2	ESR1	-	-			Active	0.997	85.51	47.06	1.67	24.39	
OT_ER_ERaERa_0480	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	-	5.93e-2	50.00	1.70	20.00	
OT_ER_ERbERb_1440	EDSP ER		NP_001428.1	ESR2	-	-			Inactive	-	2.99	1.03e-2	-1.99	20.00	
OT_ER_ERbERb_0480	EDSP ER		NP_001428.1	ESR2	-	-			Inactive	0	2.78e-10	50.00	1.70	20.00	
OT_ER_ERaERb_1440	EDSP ER		NP_000116.2 NP_001428.1	ESR1 | ESR2	-	-			Inactive	0	5.78e-9	50.00	1.70	20.00	
OT_ER_ERaERb_0480	EDSP ER		NP_000116.2 NP_001428.1	ESR1 | ESR2	-	-			Inactive	0	6.66e-10	50.00	1.70	23.30	
TOX21_ERa_BLA_Agonist_rati	EDSP ER		NP_000116.2	ESR1	-	-			Active	1	44.84	7.17	0.86	20.00	
OT_ERa_GFPERaERE_0120	EDSP ER		NP_000116.2	ESR1	-	-			Active	1	79.98	49.06	1.69	20.00	
TOX21_ERa_BLA_Antagonist_	EDSP ER cytotoxicity burst				263	1771			Active	0.9997	88.57	29.31	1.47	38.89	
TOX21_ERa_LUC_VM7_Antag	cytotoxicity burst EDSP ER				263	1771			Inactive	0.0032	17.76	45.00	1.65	24.57	
ATG_ERE_CIS	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	4.17e-3	100.00	2.00	0.50	
ACEA_ER_80hr	EDSP ER		NP_000116.2	ESR1	220	1394			Inactive	0	1.62e-7	50.00	1.70	25.49	
TOX21_ERa_LUC_VM7_Agoni	EDSP ER		NP_000116.2	ESR1	-	-			Active	1	70.69	0.64	-0.19	20.00	
ATG_ERa_TRANS	EDSP ER		NP_000116.2	ESR1	-	-			Inactive	0	1.06e-2	100.00	2.00	1.10	
NVS_NR_bER	EDSP ER		NP_001001443.1	ESR1	-	-			Inactive	0.0002	13.28	25.00	1.40	24.17	
NVS_NR_mERa	EDSP ER		NP_031982.1	Esr1	-	-			Active	1	83.58	7.96	0.90	25.96	
OT_ERa_GFPERaERE_0480	EDSP ER		NP_000116.2	ESR1	-	-			Active	1	87.36	50.00	1.70	20.00	
ACEA_ER_AUC_viability	cytotoxicity burst EDSP ER				220 | 263	1394 | 1821			Active	1	114.57	7.47	0.87	20.00	
TOX21_ERa_BLA_Antagonist_	EDSP ER		NP_000116.2	ESR1	-	-			Active	0.9999	69.34	33.03	1.52	20.00	

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP AR														
OT_AR_ARELUC_AG_1440	EDSP AR		P10275.3	AR	23	25			Inactive	-	-	-	-	20.00	
UPITT_HCI_U2OS_AR_TIF2_N	EDSP AR		P10275.3	AR	23	25			Active	0.971	52.92	2.73	0.44	37.98	
TOX21_AR_LUC_MDAKB2_Ant	EDSP AR		P10275.3	AR	-	-			Active	1	113.99	25.27	1.40	29.88	
OT_AR_ARSRC1_0960	EDSP AR		P10275.3 NP_005408.1	AR | SRC	23	25			Active	1	51.52	4.37	0.64	20.00	
OT_AR_ARSRC1_0480	EDSP AR		P10275.3 NP_005408.1	AR | SRC	23	25			Active	1	55.47	25.31	1.40	20.00	
TOX21_AR_LUC_MDAKB2_Ant	cytotoxicity burst EDSP AR				263	1771			Active	1	69.50	37.40	1.57	20.00	
UPITT_HCI_U2OS_AR_TIF2_N	EDSP AR		P10275.3	AR	23	25			Active	0.9975	34.59	13.02	1.11	20.00	
TOX21_AR_BLA_Antagonist_v	cytotoxicity burst EDSP AR				263	1771			Active	1	96.10	34.18	1.53	23.06	
TOX21_AR_LUC_MDAKB2_Ant	cytotoxicity burst EDSP AR				263	1771			Active	0.9997	54.83	41.10	1.61	20.00	
ATG_AR_TRANS	EDSP AR		P10275.3	AR	-	-			Inactive	0.0004	0.44	7.09	0.85	0.86	
TOX21_AR_LUC_MDAKB2_Ag	EDSP AR		P10275.3	AR	23	25			Inactive	0	3.49e-10	25.00	1.40	20.00	
TOX21_AR_BLA_Agonist_ratio	EDSP AR		P10275.3	AR	23	25			Inactive	0.1261	17.95	38.04	1.58	20.00	
TOX21_AR_BLA_Antagonist_r	EDSP AR		P10275.3	AR	-	-			Active	1	82.08	10.59	1.02	26.09	
TOX21_AR_LUC_MDAKB2_Ant	EDSP AR		P10275.3	AR	-	-			Active	1	105.21	15.67	1.19	32.13	

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP steroido														
TOX21_Aromatase_Inhibition	EDSP steroidogenesis		NP_000094.2	CYP19A1	25	36			Active	1	89.07	13.90	1.14	26.84	1(
TOX21_Aromatase_Inhibition_	cytotoxicity burst EDSP steroidogenesis				25 | 263	36 | 1771			Active	0.9998	57.56	20.06	1.30	27.62	1!

Name	Assay Lists	Details	SeqAPASS	Gene Symbol	AOP	Event	Repr. Plot	All Plots	Hit Call	Continuous Hit Call	Top	AC50	logAC50	Cutoff	AC
	(1) EDSP thyroid														
CCTE_Simmons_QuantiLum_i	EDSP thyroid				159 | 42	279			Active	0.999	32.28	87.28	1.94	20.00	
CPHEA_Stoker_NIS_Inhibition	EDSP thyroid			SLC5A5	54	424			Active	0.9887	83.29	10.24	1.01	55.54	
ATG_THRa1_TRANS	EDSP thyroid		NP_003242.1	THRA	-	-			Inactive	0.5334	1.15	20.17	1.30	1.10	
CCTE_Simmons_CellTiterGLO	EDSP thyroid				263	1771			Active	1	97.78	10.66	1.03	20.00	
TOX21_TR_LUC_GH3_Agonist	EDSP thyroid		NP_003242.1 NP_000452.2	THRA | THRB	-	-			Inactive	0	1.51e-10	25.00	1.40	20.00	
CCTE_GLTED_hDIO3	EDSP thyroid		P55073.4	DIO3	42 | 54 | 42 | 54 | 159	280 | 281			Active	1	97.88	1.56	0.19	20.00	
TOX21_TR_LUC_GH3_Antago	EDSP thyroid cytotoxicity burst				-	-			Active	1	92.49	9.07	0.96	40.08	
TOX21_TSHR_wt_Agonist_HTF	EDSP thyroid		P16473.2	TSHR	-	-			Inactive	-	1.06	6.00e-5	-4.22	20.00	
CCTE_GLTED_hIYD	EDSP thyroid		NP_981932.1	IYD	-	-			Active	1	103.21	36.89	1.57	20.00	
TOX21_TSHR_HTRF_Antagoni	EDSP thyroid		P16473.2	TSHR	42 | 54 | 159	277			Inactive	-	2.83	9.85e-5	-4.01	20.00	
CCTE_GLTED_hDIO1	EDSP thyroid		P49895.3	DIO1	42 | 54 | 42 | 54 | 159 | 158 | 157	280 | 281 | ...			Active	1	98.09	13.57	1.13	20.00	
TOX21_TR_LUC_GH3_Antago	EDSP thyroid		NP_003242.1 NP_000452.2	THRA | THRB	-	-			Active	1	112.04	6.96	0.84	22.44	
TOX21_TSHR_HTRF_Agonist_r	EDSP thyroid		P16473.2	TSHR	42 | 54 | 159	277			Active	0.9986	62.12	45.00	1.65	27.85	
TOX21_TRHR_HEK293_agonis	EDSP thyroid			TRHR	48	389			Active	1	56.72	35.38	1.55	20.00	
NVS_GPCR_rTRH	EDSP thyroid		NP_037179.1	Trhr	-	-			Inactive	0	0.23	25.00	1.40	29.50	
CCTE_GLTED_hDIO2	EDSP thyroid		NP_000784.3	DIO2	42 | 54 | 42 | 54 | 159 | 156 | 155	280 | 281 | ...			Active	1	96.21	19.77	1.30	20.00	
CPHEA_Stoker_NIS_Cytotoxic	EDSP thyroid				263	1771			Inactive	0.6794	56.73	80.73	1.91	48.97	
TOX21_TRHR_HEK293_antagc	EDSP thyroid			TRHR	48	389			Active	1	71.68	30.00	1.48	20.00	
CCTE_Simmons_AUR_TPO	EDSP thyroid		NP_062226.2	Tpo	159 | 42	279			Active	1	77.10	49.78	[illegible]	[illegible]	

APPENDIX F: OECD Toolbox Profiling Results for Polyquaternium-10 (CAS #68610-92-4)



APPENDIX G: Known Structural Alerts for Reactivity

Explosivity – Abbreviated List

Explosivity – reactive groups

- Not classified if no chemical groups associated with explosivity, e.g.

Structural feature	Chemical classes
C–C unsaturation (not aromatic rings)	Acetylenes, acetylides, 1,2-dienes
C–metal, N–metal	Grignard reagents, organolithium compounds
Contiguous oxygen	Peroxides, ozonides
N–O bonds	Hydroxylamines, nitrates, nitro compounds, nitroso compounds, N-oxides, 1,2-oxazoles
N–halogen	Chloramines, fluoramines
O–halogen	Chlorates, perchlorates, iodosyl compounds
Contiguous nitrogen atoms	Azides, azo compounds, diazo compounds, hydrazines
Strained ring structure	Cyclopropanes, aziridines, oxiranes, cubanes

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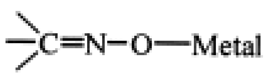
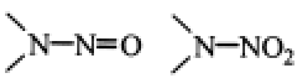
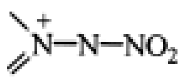
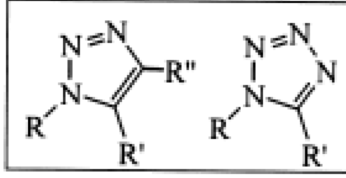
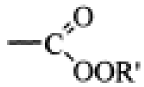
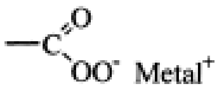
Explosivity – Full List

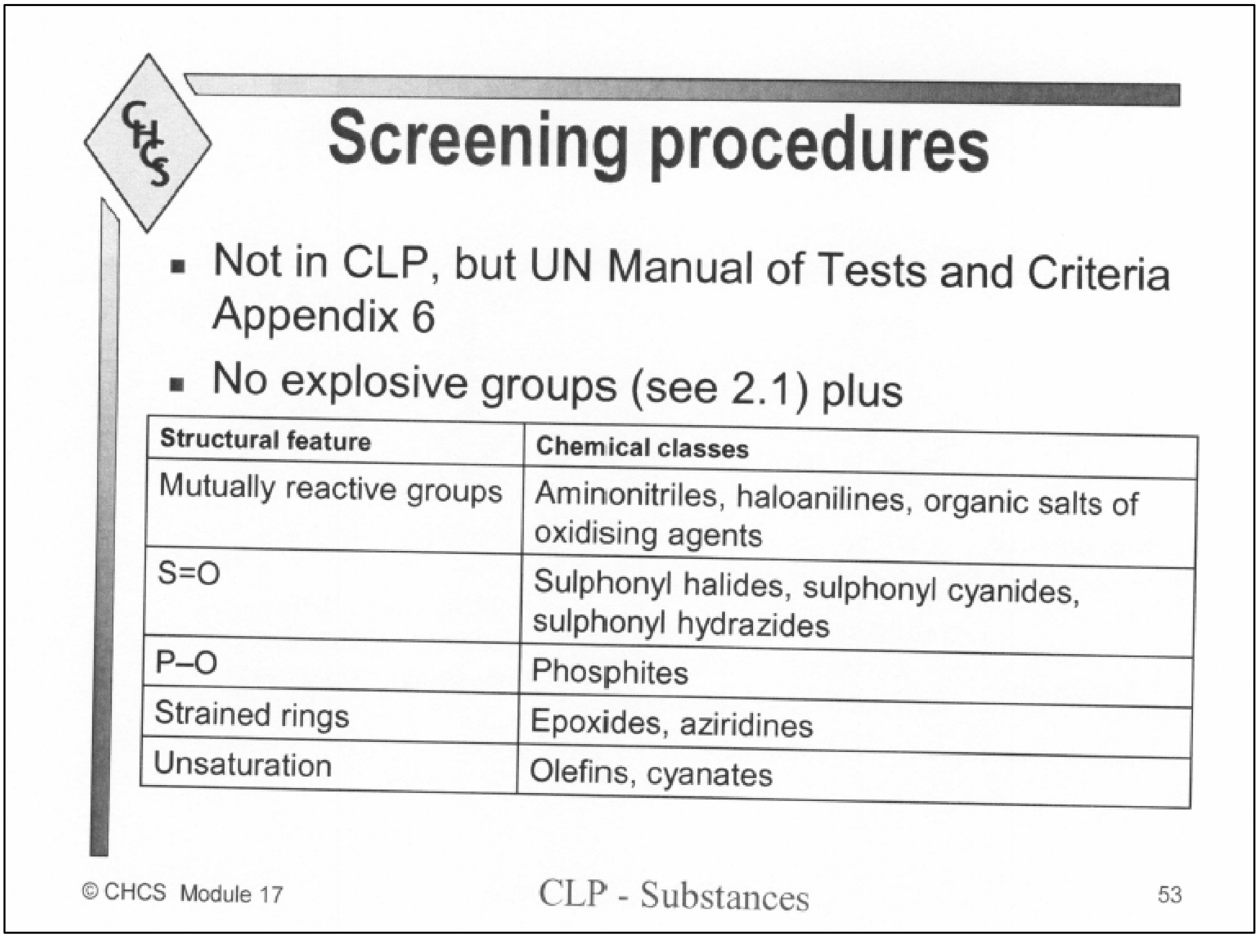
Table R.7.1-28 Chemical groups associated with explosive properties

Chemical group	**Chemical Class**
-C≡C- -C≡C-Metal -C≡C-Halogen	Acetylenic Compounds Metal Acetylides Haloacetylene Derivatives
	Diazo Compounds
-N=O -NO_2	Nitroso and Nitro Compounds,
R-O-N=O R-O-NO_2	Acyl or Alkyl Nitrites and Nitrates
	1,2-Epoxides
	Metal Fulminates or *aci*-Nitro Salts
	N-Metal Derivatives (especially heavy metals)
	N-Nitroso and N-Nitro Compounds
	N-Azolium Nitroimidates
	Azo Compounds
Ar-N=N-O-Ar	Arene Diazoates
$(ArN{=}N)_2O$, $(ArN{=}N)_2S$	Bis-Arenediazo Oxides and Sulfides
RN=N-NR'R''	Triazines
	High-nitrogen Compounds: e.g. Triazoles, Tetrazoles

Chemical group	Chemical Class
[1] ROOR', [2] 	Peroxy Compounds: [1] Alkyl hydroperoxides (R'=H), Peroxides (R'=organic); [2] Peroxo acids (R'=H), Peroxyesters (R'=organic)
[1] ROOMetal, [2] 	Metal peroxides, Peroxoacids salts
$-N_3$	Azides e.g. PbN_6, CH_3N_3
$^{-}O—C–N_2^{+}$	Arenediazonium oxides i.e. inner diazonium salts in which the counter ion is an oxide
Ar-N=N-S- Ar-N=N-S-Ar	Diazonium sulfides and derivatives, Arenediazo Aryl Sulfides
XO_n	Halogen Oxide: e.g. percholrates, bromates, etc
NX_3 e.g. $NC1_3$, $RNC1_2$	N-Halogen Compounds

Adapted from Bretherick (Bretherick's Handbook of Reactive Chemical Hazards 6th Ed., 1999. Butterworths, London)

Self-Reactive Substances



Screening procedures

- Not in CLP, but UN Manual of Tests and Criteria Appendix 6
- No explosive groups (see 2.1) plus

Structural feature	Chemical classes
Mutually reactive groups	Aminonitriles, haloanilines, organic salts of oxidising agents
S=O	Sulphonyl halides, sulphonyl cyanides, sulphonyl hydrazides
P–O	Phosphites
Strained rings	Epoxides, aziridines
Unsaturation	Olefins, cyanates

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APPENDIX H: Change in Benchmark Score

Table 5 provides a summary of changes to the GreenScreen® Benchmark™ for polyquaternium-10. This is a new GreenScreen® assessment.

Table 5: Change in GreenScreen® Benchmark™ for Polyquaternium-10			
Date	**GreenScreen® Benchmark™**	**GreenScreen® Version**	**Comment**
March 26, 2025	BM-1	v. 1.4	Original GreenScreen® assessment.
July 9, 2025	BM-1	v. 1.4	Minor edits made to justify original scores. No change in BM score.

Licensed GreenScreen® Profilers

Polyquaternium-10 GreenScreen® Evaluation Prepared by:

SIGNATURE BLOCK

Nancy Linde, M.S.,
Senior Toxicologist
ToxServices LLC

Polyquaternium-10 GreenScreen® Evaluation QC'd by:

SIGNATURE BLOCK

Bingxuan Wang, Ph.D., D.A.B.T.
Senior Toxicologist
ToxServices LLC