EUROPEAN CHEMICALS AGENCY

Substance Name: Tris(4-nonylphenyl, branched and linear) phosphite (TNPP)

EC Number: -

CAS Number: -

MEMBER STATE COMMITTEE SUPPORT DOCUMENT FOR IDENTIFICATION OF

TRIS(4-NONYLPHENYL, BRANCHED AND LINEAR) PHOSPHITE (TNPP)

AS A SUBSTANCE OF VERY HIGH CONCERN BECAUSE OF ITS ENDOCRINE DISRUPTING PROPERTIES (ARTICLE 57(F) - ENVIRONMENT) PROPERTIES

Adopted on 22 November 2024

CONTENTS

TABLES

ABBREVIATIONS

4-bNP	*4-nonylphenol, branched*
ARN	*Assessment of Regulatory Needs*
BOD	*Biological oxygen demand*
CLI	*Classification and Labelling Inventory*
CLP	*Classification, labelling and packaging*
CMR	*Carcinogenic, Mutagenic and/or toxic for Reproduction*
DMF	*Dimethylformamide*
EC	*European Community*
ECHA	*European Chemicals Agency*
ED	*Endocrine disruption*
EU	*European Union*
EU RAR	*European Union Risk Assessment Report*
LOD	*Limit of detection*
LOEC	*Lowest observed effect concentration*
LOELR	*Lowest observed effect loading rate*
LOQ	*Limit of quantification*
NP	*Nonylphenol*
OECD	*Organisation for economic co-operation and development*
PBT	*Persistent, bioaccumulative and toxic*
RAR	*Risk assessment report*
REACH	*Regulation (EC) No 1907/2006 concerning registration, evaluation, authorisation, and restriction of chemicals*
SVHC	*Substances of very high concern*
TG	*Test guideline*
TNPP	*Tris(4-nonylphenyl, branched and linear) phosphite*
UVCB	*Unknown or variable composition, complex reaction products or of biological materials.*
vPvB	*Very persistent and very bioaccumulative*
WAF	*Water accommodated fraction*
WoE	*Weight of evidence*

IDENTIFICATION OF A SUBSTANCE OF VERY HIGH CONCERN ON THE BASIS OF THE CRITERIA SET OUT IN REACH ARTICLE 57

Substance name: Tris(4-nonylphenyl, branched and linear) phosphite (TNPP)

List number: -

EC number: -

CAS number: -

- Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) is identified as a substance of equivalent level of concern to those of other substances listed in points (a) to (e) of Article 57 of Regulation (EC) No 1907/2006 (REACH) according to Article 57(f) of REACH Regulation.

Summary of how the substance meets the criteria set out in Article 57 of the REACH Regulation

The name tris(4-nonylphenyl, branched and linear) phosphite and acronym TNPP describe a group of substances, including any of the individual branched or linear isomers and/or combinations thereof, that are identified as substances of very high concern in accordance with Article 57(f) of Regulation (EC) 1907/2006 (REACH) due to their degradation into 4-nonylphenol, branched and linear. 4-nonylphenol, branched and linear have been identified as a group of SVHC substances according to Article 57(f) REACH because of their endocrine disrupting properties for the environment which give rise to an equivalent level of concern to those other substances listed in points (a) to (e) of Article 57 of REACH.

The conclusion is based on a weight of evidence approach of the most relevant information on tris(4-nonylphenyl, branched) phosphite.

The strongest evidence comes from a hydrolysis study that demonstrates that under environmentally relevant pH and temperature, tris(4-nonylphenyl, branched) phosphite can degrade into 4-nonylphenol, branched.

Indeed, in the preliminary test conducted with the intent to solubilise tris(4-nonylphenyl, branched) phosphite in the frame of the hydrolysis study, a constant release of 4-nonylphenol, branched in amounts higher than the impurity (4-nonylphenol, branched) present in the original composition of the substance was measured. In this preliminary test, tris(4-nonylphenyl, branched) phosphite was added to two kinds of solid carriers (glass beads or C18 silica gel), which were then included in elution column. The preliminary studies with significant releases of 4-nonylphenol, branched were performed at 50°C and pH 4 for both carriers. Additionally, similar releases were observed at pH 6 and 20°C for glass beads. The results demonstrate that the release of 4-nonylphenol, branched comes from the hydrolysis of tris(4-nonylphenyl, branched) phosphite adsorbed on solid carriers in the elution column. Elution samples were then used to carry out a hydrolysis test according to the OECD TG 111 under environmentally relevant pH and temperature. Nevertheless, no measurement of tris(4-nonylphenyl, branched) phosphite was achieved in the elution samples used for the hydrolysis test. There is then no indication that tris(4-nonylphenyl, branched) phosphite was present in the definitive hydrolysis test. However, the same rates of release of 4-nonylphenol, branched were observed in the preparation of the samples for the definitive hydrolysis test as in the preliminary tests. In the preliminary tests, these release rates were constant in each successive fraction over the analysis period. The preliminary tests were performed over a short time (<20h) supporting that a higher release is expected in a hydrolysis study performed according to the OECD TG 111 over 5 days. Moreover, the elution/contact time is higher in an OECD TG 111 which should have lead to higher release of 4-nonylphenol, branched. In addition, the proportion of released 4-nonylphenol, branched are calculated considering the nominal quantity of tris(4-nonylphenyl, branched) phosphite in the column, whereas adsorption on preparation material is expected, leading to lower amounts of tris(4-nonylphenyl, branched) phosphite in the elution column and then underestimation of the proportion of released 4-nonylphenol, branched. The study therefore provides evidence that hydrolysis of 4-nonylphenol, branched can occur from tris(4-nonylphenyl, branched) phosphite adsorbed to glass beads and C18 silica gel. Although small quantities of 4-nonylphenol, branched were measured, these were constant in each successive fraction over the analysis period in the preliminary study (elution from a column) and very likely to underestimate what would have been observed in a longer standard guideline study.

Furthermore, 4-nonylphenol, branched was measured in a toxicity study with *Daphnia magna* at levels that support that degradation of tris(4-nonylphenyl, branched) phosphite leading to the formation of 4-nonylphenol, branched occurs.

Based on a weight-of-evidence assessment of all available relevant information, there is sufficient evidence that tris(4-nonylphenyl, branched) phosphite can be a source of 4-nonylphenol, branched in the environment through its degradation/transformation under environmentally relevant conditions. Therefore, tris(4-nonylphenyl, branched) phosphite is considered as an endocrine disruptor for the environment.

This conclusion can be extended to the substances belonging to the TNPP group, which differ only by the nature of their alkyl chain, (branched and/or linear), because hydrolysis is anticipated to take place at the phosphite group irrespective of the linear or branched structure of the nonylphenol chain. Indeed, linear alkyl chains are expected to have a lower steric hindrance compared to branched alkyl chains and are not expected to limit access to hydrolysis sites for TNPP-linear. Additionally, the identification of the group is deemed appropriate because it will allow harmonisation with the existing entry facilitating the practical applicability of the identification (e.g. verification of REACH obligations related to the presence of TNPP substances in articles).

Equivalent level of concern

The equivalent level of concern is based on the fact that TNPP can be a source of 4-nonylphenol, branched and linear in the environment. 4-nonylphenol, branched and linear were identified as SVHC under article 57f in particular on the basis of its potential to induce serious toxic effects. These effects include possible delayed and irreversible effects as well as inter-generational effects and have the potential to impair the environment at large.

Uncertainties in quantifying exposures and deriving safe concentration limits

Once released to surface water and distributed to sediment, degradation of TNPP may remain a long lasting and unpredictable source of 4-nonylphenol, branched and linear that may lead to subsequent irreversible effects on aquatic organisms and ecosystems due to its endocrine disruption properties.

From the available data on degradation, it is not possible to estimate accurately the extent of release of 4-nonylphenol, branched from tris(4-nonylphenyl, branched) phosphite or the contribution to the emissions in the environment. However, in general, it can be expected that continuous exposure from precursors occurs and may contribute to the presence of 4-nonylphenol, branched and linear over time, which increases the concern for aquatic organisms.

Societal concern

In spite of the efforts to reduce emissions of 4-nonylphenol, branched and linear in the environment, due to their endocrine disruptor properties to the environment, by strict regulatory measures including use restrictions since 2003, according to the available monitoring data 4-nonylphenol, branched is still present in the aquatic environment. The available information on tris(4-nonylphenyl, branched) phosphite shows that it can be a precursor of 4-nonylphenol, branched in the environment, that may subsequently lead to irreversible effects on aquatic organisms and contribute to wildlife population and biodiversity decline. Thus, efforts are still needed to reduce any emissions of 4-nonyphenol, branched and linear to the environment.

Consequently, TNPP represents a societal concern that requires immediate action to ensure a high level of protection of the environment. This regulatory action is in line with the goal of regulatory measures already undertaken for 4-nonyphenol, branched and linear and fits with the objectives of the Zero Pollution Ambition for a toxic-free environment.

In conclusion:

Overall, it is concluded that the tris(4-nonylphenyl, branched and linear) phosphite group, which includes any of the individual isomers and/or combinations thereof, meet the criteria of Article 57(f) of REACH, because, through their degradation, they are substances with endocrine disrupting properties for which there is scientific evidence of probable serious effects to the environment which give rise to an equivalent level of concern to those for other substances listed in paragraphs (a) to (e) of Article 57 of REACH Regulation.

Registration dossiers submitted for substance: tris(4-nonylphenyl, branched) phosphite (List number 701-028-2[1]).

[1] Explanation on the role of LIST numbers is provided in the ECHA website at: https://echa.europa.eu/information-on-chemicals/registered-substances/information

Justification

1. Identity of the substance and physical and chemical properties

1.1 Name and other identifiers of the substance

Table 1: Substance identity

EC number:	-
EC name:	-
CAS number (in the EC inventory):	-
CAS number:	-
No. List	-
Chemical name:	Tris(4-nonylphenyl, branched and linear) phosphite
Index number in Annex VI of the CLP Regulation	
Molecular formula:	C45H69O3P
Molecular weight range:	
Synonyms:	Other chemical names: • Phenol, nonyl-, phosphite (3:1) • tris(4-nonylphenol, branch) phosphorous acid ester • tris(4-nonylphenyl, branched) phosphite Acronyms: • TNPP Trade names: • ADK STAB 1178 • DOVERPHOS 4 • DOVERPHOS HIPURE 4 • Mark CH 55 • Markphos TNPP • Nauguard TNPP • Nauguard TNPP HR • Rostabil TNF • Rostabil TNF HR • tris(nonylphenyl) phosphite

Introduction and justification of the group

Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) can exist with linear and/or branched alkyl chains. The characteristics of the alkyl chains of 4-nonylphenol, either branched and/or linear is expected to reflect the characteristics of the alkyl chains of the corresponding TNPP. 4-nonylphenol, branched and linear can also be present in TNPP as an impurity.

4-nonylphenol, branched and linear has been identified as a group of SVHC substances according to Article 57(f) REACH of Regulation (EC) 1907/2006 (REACH) because of the endocrine properties for the environment.

TNPP with ≥ 0.1% w/w of 4-nonylphenol, branched and linear is in the candidate list due to the presence of 4-nonylphenol, branched and linear ≥ 0.1% w/w as impurity.

The current SVHC identification of TNPP under Article 57(f) of REACH Regulation 1907/2006 (REACH) is based on scientific data on tris(4-nonylphenyl, branched) phosphite (List number 701-028-2). The strongest evidence comes from a hydrolysis study that shows that under environmentally relevant conditions, tris(4-nonylphenyl, branched) phosphite can degrade into 4-nonylphenol, branched (see section 5.7).

Although the degradation pathway is unknown for tris(4-nonylphenyl, branched) phosphite due to lack of data, hydrolysis of tris(4-nonylphenyl, branched) phosphite is anticipated to take place at the phosphite group leading the release of 4-nonylphenol, branched.

In this regard, the substances belonging to the TNPP group, which differ only in the nature of the alkyl chain (branched or linear), are expected to have the same hydrolysis pathway. Regarding the possible influence of the alkyl chain in the nonylphenol group on hydrolysis, linear alkyl chains are expected to have a lower steric hindrance compared to branched alkyl chains and are not expected to limit access to hydrolysis sites for TNPP-linear. Consequently, for the substances of the TNPP group, the same hydrolysis pathway is expected irrespective of the nature of the alkyl chain structure, yielding the release of 4-nonylphenol, branched and linear.

Therefore, the current SVHC identification of TNPP under Article 57 (f) is independent of the initial presence of 4-nonylphenol, branched and linear in the composition of the substance. Additionally, the identification of the group is deemed appropriate because it will allow harmonisation with the existing entry facilitating the practical applicability of the identification (e.g. verification of REACH obligations related to the presence TNPP substances in articles).

The current Candidate List entry will be amended as follows:

- **Tris(4-nonylphenyl, branched and linear) phosphite (TNPP)**

A non-exhaustive list of TNPP identifiers used includes:

- Tris(nonylphenyl) phosphite with EC 247-759-6 and CAS 26523-78-4.
- Tris(4-nonylphenyl, branched) phosphite with List number 701-028-2, registered substance describing a substance with branched alkyl chains.
- Phenol, 4-nonyl, phosphite (3:1) with CAS 3050-88-2 describing a substance with linear alkyl chains. It was used for the pre-registration process.
- Phenol, *p*-isononyl-, phosphite (3:1) with CAS 31631-13-7.

- Phenol, *p-sec*-nonyl-, phosphite with CAS 106599-06-8 and describing a substance with secondary alkyl chains.

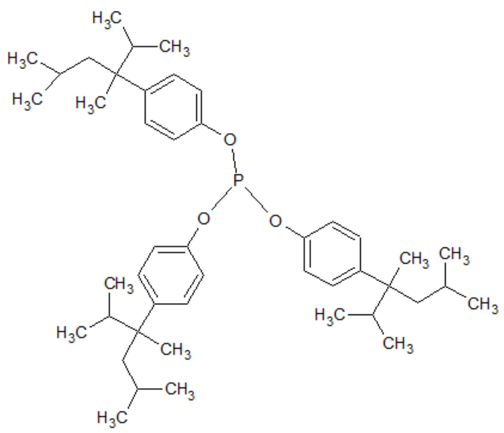
It should be noted that tris(nonylphenyl) phosphite (EC 247-759-6; CAS 26523-78-4) was initially registered as a mono-constituent substance. However, during the substance evaluation process, the identity and composition of the substance was further clarified. An update of the registration dossier regarding its substance identification (SID) confirmed that the registration refers to a substance with non-linear alkyl chains. ECHA requested the registrants to modify the identifiers of the registered substance to adequately reflect its composition. The substance identifiers were changed in March 2016 and the registered substance is now defined as an UVCB substance and identified as tris(4-nonylphenyl, branched) phosphite with the List number 701-028-2 and no specific CAS number.

It cannot be excluded that the identifiers "tris(nonylphenyl) phosphite, EC 247-759-6, CAS 26523-78-4 are still inappropriately used in other contexts than REACH registrations for describing compositions actually corresponding to tris(4-nonylphenyl, branched) phosphite.

It was observed that notifications of classification have also been received in the Classification and Labelling Inventory (CLI) for the identifiers tris(nonylphenyl) phosphite (EC 247-759-6; CAS 26523-78-4), before and after the identity and composition of the substance were further clarified.

Structural formula:

The structure below displays one of the isomers of the registered substance.



1.2 Composition of the substance

Name: Tris(4-nonylphenyl, branched and linear) phosphite (TNPP)

Description: group entry

Substance type: UVCB[2]

[2] Substances of Unknown or Variable composition, Complex reaction products or Biological materials

4-nonylphenol, branched and linear are the relevant transformation/degradation products for this dossier.

The following tables show the composition of the registered substance tris(4-nonylphenyl, branched) phosphite (List number 701-028-2):

Table 2: Constituents other than impurities/additives of tris(4-nonylphenyl, branched) phosphite (List number 701-028-2)

Type	Identity
Constituent	Tris(4-nonylphenol, branched) phosphorous acid ester List no.: 701-028-2 CAS no.: /

Table 3: Impurities of tris(4-nonylphenyl, branched) phosphite (List number 701-028-2)

Impurities
Phenol EC no.: 203-632-7 CAS no.: 108-95-2
Phenol, 4-nonyl-, branched EC no.: 284-325-5 CAS no.: 84852-15-3

1.3 Identity and composition of degradation products relevant for the SVHC assessment

Table 4: Degradation (transformation) product

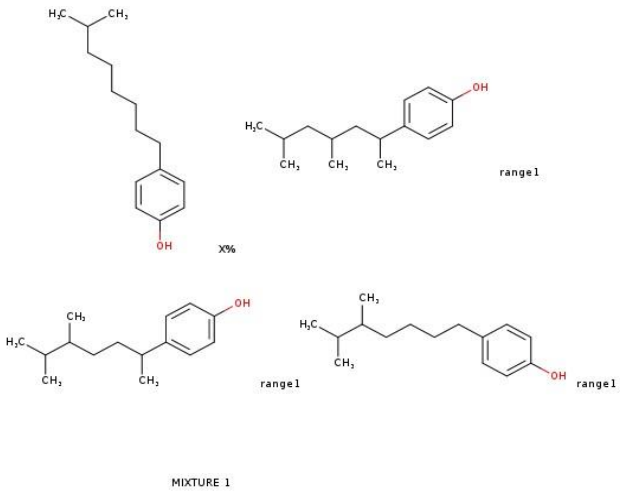
EC number:	
EC name:	Group member: 4-Nonylphenol, branched and linear
SMILES:	
CAS number (in the EC inventory):	
CAS number:	-
IUPAC name:	
Index number in Annex VI of the CLP Regulation	
Molecular formula:	
Molecular weight range:	
Synonyms:	Group members (non-exhaustive list): • *p-(1,1-dimethylheptyl)phenol* • *p-isononylphenol* • *p-nonylphenol* • *p-(1-methyloctyl)phenol* • *4-(1-Ethyl-1,3-dimethylpentyl)phenol* • *4-(1-Ethyl-1,4-dimethylpentyl)phenol* • *4-(1-ethyl-1-methylhexyl)phenol* • *Phenol, 4-nonyl-, branched* • *Phenol, nonyl-, branched* • *Isononylphenol* • *4-(1,1,5-Trimethylhexyl)phenol* • *Nonylphenol* • *4-(3-ethylheptan-2-yl)phenol* Trade names: • NONPH - NONYLPHENOL • NP • O3053 • Üveglakk 1:1 B komponens • etc

4-Nonylphenol, branched and linear corresponds to substances with a linear and/or branched alkyl chain with a carbon number of 9 covalently bound in position 4 to phenol, covering UVCB- and well-defined substances which include any of the individual isomers or a combination thereof.

A non-exhaustive list of relevant numerical identifiers for the Candidate List entry "4-Nonylphenol, branched and linear" is available on the ECHA's website https://echa.europa.eu/fr/substance-information/-/substanceinfo/100.239.149 including a support document to the corresponding entry in the candidate list.

Structural formula:

The following structural formulae are reported as examples and they show some of the isomers covered by the group name "4-nonylphenol, branched and linear".



Indication of the process by which the transformation takes place:

In general, phosphites can undergo hydrolysis when exposed to humidity with rates of hydrolysis depending on pH and molecular weight of the substance (ECHA, 2022[3]). Information on P-O bond cleavage by the action of enzymes is available for some substances with the phosphite moiety (see section 3.1.2.1.3). Moreover, some degradation and aquatic toxicity studies with tris(4-nonylphenyl, branched) phosphite (see sections 3.1.1 and 5.1) provide evidence of the hydrolysis of the substance and release of 4-nonylphenol, branched. In addition, the release of 4-nonylphenol, branched is observed in the preparation of samples for a hydrolysis study (see section 3.1.1.1).

[3] Assessment of regulatory needs group "Triphenylphosphites" (Triphenylphosphite and its derivatives) 36ac283b-41f1-1019-2a0a-33b88990af20 (europa.eu)

1.5 Physicochemical properties

For the registered substance tris(4-nonylphenyl, branched) phosphite (List number 701-028-2), which is covered by the group entry, physicochemical properties are given in Table 5 below:

Table 5: Overview of physicochemical properties

Property	Description of key information	Value [Unit]	Reference/ source of information
Physical state at 20°C and 101.3 kPa	*Clear liquid*		*ECHA dissemination web site*
Melting/freezing point	*Pour point has been determined by ASTM Method D97, as recommended in the OECD TG 102.*	Pour point: 6 ± 3 °C at 101.3 kPa	*ECHA dissemination web site*
Boiling point	*Boiling point has been determined according to OECD TG 103 (distillation method). TNPP degrades before boiling according to a thermal gravimetric analysis (TGA).*	Decomposition: 303 °C at 101.3 kPa	*Unnamed, 2001* *ECHA dissemination web site*
Vapour pressure	*The vapour pressure has been determined according to ASTM D2879 method (isoteniscope). The vapour pressure was measured under different temperatures and the values were extrapolated by linear extrapolation to estimate the vapour pressure at 25 °C.*	$8.54.10^{-4}$ Pa at 25 °C	*Unnamed, 1997* *ECHA dissemination web site*
Density	*The density has been determined according to the OECD TG 109*	0.98 at 20 °C	*Unnamed, 2004* *ECHA dissemination web site*
Water solubility	*The water solubility has been determined by the flask method according to the OECD guideline 105 (HPLC method). TNPP was not observed in the water sample at the limit of quantification (<0.6 mg/L).* *Subsequent studies have improved this limit of quantification to 0.05 mg/L (50 ppb). TNPP's solubtility is believed to be at or slightly below this improved limit of quantification.*	<0.05 mg/L at 24 °C	*Unnamed, 2001* *ECHA dissemination web site*
Partition coefficient n-octanol/water (log value)	*log Kow (log Pow) has been determined experimentally according to the OECD guideline 117 (HPLC method). Estimation were based on regression analysis of retention time and capacity factor of Butyl benzene, diethylhexyl phthalate (DEHP), diisononylphthalate (DINP) and diisodecylphthalate (DIDP) were used as standards with known Kow's.*	log Kow (log Pow)= 14 (estimation) at 25 °C and pH 7 for the UVCB substance	Unnamed, 2007 ECHA dissemination web site

2. Harmonised classification and labelling

Tris(nonylphenyl) phosphite (with the identifiers: EC number 247-759-6, CAS number 26523-78-4[4] has a harmonised classification and labelling (ATP03) (Index No 015-202-00-4) approved by the European Union. The substance is classified as: very toxic to aquatic life, very toxic to aquatic life with long lasting effects and may cause an allergic skin reaction.

- Skin Sens H317
- Aquatic Acute 1 H400
- Aquatic Chronic 1 H410 (no conclusion on M-factor)

The harmonised classification and labelling of the substance was published in 2010 (RAC opinion available at: https://echa.europa.eu/documents/10162/f279875c-84f3-e85f-455b-93f0bd92246a).

It is noted that due to the change in tris(nonylphenyl) phosphite identifiers after the decision on classification and labelling, tris(4-nonylphenyl, branched) phosphite with List number 701-028-2 is not explicitly included in the harmonised classification entry.

Table 6 : Classification according to Annex VI, Table 3 (list of harmonised classification and labelling of hazardous substances) of Regulation (EC) No 1272/2008

Index No	International Chemical Identification	EC No	CAS No	Classification		Labelling			Spec. Conc. Limits, M-factors	Notes
				Hazard Class and Category Code(s)	Hazard statement code(s)	Pictogram, Signal Word Code(s)	Hazard statement code(s)	Suppl. Hazard statement code(s)		
015-202-00-4	tris(nonylphenyl) phosphite	247-759-6	26523-78-4	Skin Sens. 1 Aquatic Acute 1 Aquatic Chronic 1	H317 H400 H410	GHS09 GHS07, Warning	H317 H410			

[4] Refer to Section 1.1 in relation to the historical use of these identifiers

3. Environmental fate properties

Information is only available for the registered substance tris(4-nonylphenyl, branched) phosphite (List number 701-028-2). In addition, it should be noted that most of the experimental environmental fate studies (Unpublished study 2001, Unpublished study 2004, Unpublished study 2007) were conducted before the change of identifiers of tris(4-nonylphenyl, branched) phosphite (List number 701-028-2). However, because the identifiers change was solely due to an adequate identification as an UVCB substance, the test material tris(nonylphenyl) phosphite reported in the studies corresponds to tris(4-nonylphenyl, branched) phosphite and the nonylphenol reported in the medium of some studies corresponds to 4- nonylphenol, branched (4-bNP).

3.1 Degradation

3.1.1 Abiotic degradation

3.1.1.1 Hydrolysis

The studies on hydrolysis are summarised in the following table:

Table 7 Overview of hydrolysis studies

Method	Results	Remarks	Reference
OECD TG 111 (Hydrolysis as a Function of pH) pH 4, 7 and 9 at <19h Test material: tris(nonylphenyl) phosphite	Half-life (DT50): Supposed to be: 13 — 14 h at 22 °C Transformation products after 24 h: not detected	Reliability score 3 (not reliable) disregarded study experimental result	Study report Unpublished study (2001)
OECD TG 111 (Hydrolysis as a Function of pH) pH 4, 7 and 9 at 24h Test material: tris(nonylphenyl) phosphite tris (nonylphenyl) phosphite water accommodated fractions (WAFs) were analysed for the formation of NP during a 24-hr period.	No formation of nonylphenol detected. No information on the method of analysis of nonylphenol.	Reliability score 3 (reliable with restrictions) disregarded study experimental result	Study report Unpublished study (2004)
Equivalent or similar to OECD TG 111 (Hydrolysis as a Function of pH) % Hydrolysis was defined as % NP No information on test conditions (pH, temperature) Test material: tris(nonylphenyl) phosphite Initial NP <0.1%.	Hydrolysis (in %): 0.1 after 242 h Transformation products: nonylphenol 0.1-0.15%	Reliability score 3 (not reliable) supporting study experimental result	Study report Unpublished study (2007)
OECD TG 111 (Hydrolysis as	No hydrolysis observed, but	Reliability score 2-	Study report

Method	**Results**	**Remarks**	**Reference**
a Function of pH) Preliminary study (OECD TG 105 Water Solubility): elution in column of tris(4-nonylphenyl, branched) phosphite adsorbed on two carriers, C18 silical gel (pH 4, 20 and 50 °C) or glass beads (pH 6, 20 and 50 °C) Definitive test with 2h elution fractions from column with glass beads (pH 4,7, 9, 19.4°C) Test material: tris(4-nonylphenyl, branched) phosphite <0.1% 4-bNP	presence of tris(4-nonylphenyl, branched) phosphite not confirmed. Significant release of 4-bNP in the preliminary study and the preparation of the samples for the hydrolysis study.	3 (hydrolysis study not reliable. Reliable results from the preliminary study and during the preparation of samples for the hydrolysis test) Study used in weight of evidence	Unpublished study 2021

The first hydrolysis studies provided do not allow concluding on hydrolysis (Unpublished study, 2001; Unpublished study, 2004; Unpublished study, 2007). In the Unpublished study, 2001, hydrolysis was significant according to the authors. Nevertheless, there is no information regarding the mass balance and it is therefore not excluded that the observed dissipation of the substance results from adsorption on the vessel. In this test, transformation products were not detected but the method of detection of nonylphenol (linear) was not appropriate for detection of the branched nonylphenol chains contained in the tested substance. Formation of nonylphenol was not detected but no information on analytical methods are available in Unpublished study (2004). It is therefore not possible to conclude that no release of 4-nonylphenol, branched occurred in this study. In the Unpublished study (2007), despite the presence of a hydrolysis stabilizer, nonylphenol was detected but the level of measured nonylphenol (0.1-0.15%, assumed to be 4-bNP) was only slightly above the amounts of nonylphenol present as impurity.

In addition, observations in two ecotoxicological tests (see sections 5.1.2.1 and 5.1.3) are in contradiction with the hydrolysis tests results. Occurrence of 3 % nonylphenol was measured in an acute toxicity test on daphnia carried out with tris(nonylphenyl) phosphite with <0.1% of nonylphenol and increase in algae density (>300%) exposed to tris(nonylphenyl) phosphite was observed, probably because of the release of phosphorus resulting from tris(nonylphenyl) phosphite hydrolysis.

Therefore, the results of these studies do not allow to conclude on hydrolysis rate and formation of 4-nonylphenol, branched. A similar conclusion is presented in the background document to the RAC opinion for the harmonised classification of tris(nonylphenyl) phosphite.

In the Assessment of Regulatory Needs (ARN[5]) conducted by ECHA on the Group "Triphenylphosphites and its derivates", it is considered that phosphites can undergo hydrolysis when exposed to humidity with rates of hydrolysis depending on pH and molecular weight of the substance, with release of alkylated phenols. Hydrolysis data on other triphenylphosphites are however limited in this document.

A new hydrolysis study (test method: EU c.7/OECD TG 111) was requested in the decision SEV-D-2114516891-47-01/F with the aim to clarify the formation of 4-nonylphenol,

[5] Assessment of Regulatory Needs, GMT 283, Triphenylphosphites (Triphenylphosphites and its derivatives), ECHA 2022: https://echa.europa.eu/fr/assessment-regulatory-needs/-/dislist/details/0b0236e1869c1861

branched. To increase the dispersion of tris(4-nonylphenyl, branched) phosphite, the use of sterile silica gel was recommended as a solid carrier, as described in ECHA guidance, chapter R.7b for biodegradation (R.7.9.4.1, Modified ready Biodegradation tests and Appendix R7.9-3) and ISO (1995). Indeed the solubility of tris(4-nonylphenyl, branched) phosphite is low (<0.1 mg/L), and this method has been already successfully applied to triphenyl phosphite (EC 202-908-4).

However, the study (Unpublished study, 2021) provided in response to this decision did not follow these recommendations. The registrant used other solid supports (glass beads or C18 silica gel instead of silica gel) without explanation for this change. Moreover, they first used a continuous flow system, similar to OECD TG 105, which is a water solubility guideline to solubilise tris(4-nonylphenyl, branched) phosphite. The contact time between water and the solid phase is then lower than in a batch study. An OECD TG 111 study was then performed with elution fractions but tris(4-nonylphenyl, branched) phosphite was not measured in the elution fractions. However, the results of the preliminary studies and the initial analysis of samples used for the hydrolysis study bring information on the hydrolysis of the substance despite the fact that it is not carried out with batch conditions as it is recommended in the OECD TG 111. As the study protocol is non-standard and the conclusion is mainly based on a weight of evidence from this study, methods and results are fully described below.

<u>Preliminary study, solubilisation of tris(4-nonylphenyl, branched) phosphite</u>

A preliminary study was carried out to generate concentrations of tris(4-nonylphenyl, branched) phosphite around its solubility limit, testing two different sorbent materials (glass beads or C18 silica gel). Tris(4-nonylphenyl, branched) phosphite (50 mg) was first solubilised in pentane and then added to a solid carrier. The solvent was evaporated overnight and then the solid carrier with tris(4-nonylphenyl, branched) phosphite was added to the column. No measurement of tris(4-nonylphenyl, branched) phosphite was carried out at this stage, therefore 50 mg is the nominal quantity of tris(4-nonylphenyl, branched) phosphite added to the column. Deposition/ adsorption of tris(4-nonylphenyl, branched) phosphite on to the vessel during preparation before the transfer to the elution column is expected, thus the initial quantity of the substance in the column could be lower.

The column was then filled with buffer aqueous media and the system was then equilibrated for 2 hours. The initial fraction after the 2 hours of equilibration was supposed to contain all 4-nonylphenol, branched present as impurity and was eliminated. Considering that tris(4-nonylphenyl, branched) phosphite with 0.03% of 4-bNP as impurity was used for the test, this first fraction should contain 15 µg of 4-bNP. However, no measurement was carried out on this fraction. It is assumed that no 4-nonylphenol, branched was then present as impurity in the column after this first 2 hours elution.

A water flow rate of 14 mL/hour was then applied and fractions of 1 hour were collected.

Several conditions were tested for each solid support. For C18 silica gel, pH 6 and 20°C, and pH 4 and 50°C were applied. For the glass beads, pH 4 and 20°C or 50°C and pH 6 and 20°C were applied. According to the report, for C18 silica gel, six eluted fractions were collected on the first day, flow was stopped during the night and 8 eluted fractions were collected on the second day. Data on the 6^{th} fraction is however missing and it is not clear if the 7^{th} fraction corresponds to the first one after the night stop. For glass beads, because of a technical issue, only the first five fractions were analysed for the pH 4 and 50°C. At 20°C, 19 fractions were collected, but there is no information regarding the timeline of sample collection. 4-nonylphenol, branched was then analysed. According to the study report, the samples were analysed for 4 nonylphenol branched by LC-MS/MS without specific preparation of the samples.

Results from C18 silica gel preliminary test

At pH 4 and 50°C an average concentration of 1.17 ±0.09 mg/L of 4-bNP was measured (excluding the first fraction where 0.48 mg/L 4-bNP was measured). The concentration in the 7^{th} fraction (assumed to be the first one after the night stop) was slightly higher (1.35 mg/L). Linear NP was below LOD.

Considering 14 fractions of 14 mL (total volume of 196 mL), an average concentration of 4-bNP of 1.17 mg/L in 13 fractions and 0.48 mg/L in the first fraction, the total mass of 4-bNP recovered is 219.7 µg of 4-bNP (in 14 hours). This amount is higher than the quantity of 4-bNP initially present as impurity in the column (15 µg).

The percentage of formation of degradation products is often derived from studies with a radiolabeled substance, the substance being radiolabeled once in most cases. As no radiolabeling was applied in this test, the percentage of 4-bNP formed is calculated by comparing the weight of released 4-bNP to the nominal weight of tris(4-nonylphenyl, branched) phosphite (50 mg). It should be reminded that 50 mg is the nominal quantity added to the C18 silica gel, but no measurement was carried out to ensure that this nominal quantity was achieved. Therefore the quantity of tris(4-nonylphenyl, branched) phosphite adsorbed onto support in the column could be lower and the percentage of hydrolysed tris(4-nonylphenyl, branched) phosphite higher. For this preliminary test, the percentage of formation of 4-bNP is 0.44% (on weight basis, i.e. dividing the mass of 4bNP released by the nominal mass of tris(4-nonylphenyl, branched) phosphite, assuming no presence of 4-bNP as impurity at this stage of the experiment). In that case the tris(4-nonylphenyl, branched) phosphite is considered fully hydrolysed, one mole of tris(4-nonylphenyl, branched) phosphite leading to the formation of 3 mol of 4-bNP/mol of tris(4-nonylphenyl, branched) phosphite. Nevertheless, while the exact stoichiometry of the reaction is not known, this study shows that 4-bNP is released from tris(4-nonylphenyl, branched) phosphite in water.

4-nonylphenol, branched was not detected in the C18 silica gel test at pH 6 and 20°C. It is not known if the hydrolysis of tris(4-nonylphenyl, branched) phosphite adsorbed on C18 silica gel is limited by the lower temperature or the higher pH.

Results from glass beads preliminary test

Glass beads, pH 4, 50°C

Lower concentrations of 4-bNP were measured with the glass beads material compared to C18 silica gel at same pH and temperature: an average concentration of 236 ±13 µg/L of 4-bNP was measured. The concentrations appear to be stable in the fractions, however only 5 fractions were collected in this preliminary test.

Considering 5 fractions of 14 mL (total volume of 70 mL), an average concentration of 4-bNP of 236 µg/L in each fraction, the total amount 4-bNP recovered in 5 h is 16.5 µg of 4-bNP. The percentage of mass of 4-bNP formed compared to the mass of tris(4-nonylphenyl, branched) phosphite is 0.033% w/w in 5 h.

Glass beads, pH 6, 20°C

Similar concentrations were measured at pH 6 (indicated as pH 3.93 in the study report - a mistake recognised by the registrant) and 19.4°C: an average concentration of 256 ± 53 µg/L of 4-bNP was measured.

The reason why the number of collected fractions is different depending on carrier, temperature and pH is not explained in the report. Considering 19 fractions of 14 mL (total volume of 266 mL), with an average concentration of 4-bNP of 256 µg/L in each fraction, the total amount of 4-bNP recovered in 19h is 68.1 µg of 4-bNP. The percentage of mass of 4-bNP formed compared to the mass of tris(4-nonylphenyl, branched) phosphite is 0.14% w/w in 19h.

Conclusion on the preliminary study

Although these tests are not usual hydrolysis studies, they show that in less than 24 hours 4-bNP can be released from tris(4-nonylphenyl, branched) phosphite in water in amounts (220 µg (C18 silica gel 50°C, 14h), 16.5 µg (glass beads 50°C, 5h); 68 µg (glass beads 20°C, 19h)) higher than the impurity initially present (15 µg, assumed to be removed in the first eluted fraction). It should be noted that with the column elution device, the amounts of released 4-bNP depend on the number of elution fractions collected. Indeed, the concentration of 4-bNP in the elution fraction is relatively constant (relative standard deviation RSD <10% at 50°C, 20% at 20°C), and it is assumed that higher elution time fractions would lead to higher amounts of released 4-bNP.

As indicated in the previous section, tris(4-nonylphenyl, branched) phosphite was not measured at any stage of the experiment, therefore it is not possible to state if tris(4-nonylphenyl, branched) phosphite was present or not in the column but also in the elution fractions. Thus, it cannot be completely excluded that hydrolysis could happen at any stage of the experiment including the preparation of the columns, or during sample preparation when 4-bNP was measured in the elution fractions if tris(4-nonylphenyl, branched) phosphite was present. However, there is currently no indications that hydrolysis of tris(4-nonylphenyl, branched) phosphite would have occurred in this study during sample preparation. In particular, presence of 4-bNP is not observed in all samples whereas it is assumed that sample preparation followed an identical method. Moreover, it should be noted that the study report indicates that the samples were analysed for 4-bNP by LC-MS/MS without any specific sample preparation. Furthermore, there are no indications that the conditions (e.g. pH and temperature) at any stages of the experiment including sample preparation would have deviated from the reported conditions in the elution column so that the observed release of 4-bNP would be due to deviating conditions more favourable for hydrolysis. Therefore, whatever the stage of the experiment where the release of 4-bNP took place, it is considered plausible that the release of 4-bNP can occur at the reported temperature and pH of the tests, including environmentally relevant pH (4-6) and temperature (20 °C).

The data support that the hydrolysis occurred from tris(4-nonylphenyl, branched) phosphite adsorbed on both tested carriers. Indeed, considering that the concentration of tris(4-nonylphenyl, branched) phosphite in water is the highest estimation of solubility of tris(4-nonylphenyl, branched) phosphite (50 µg/L, based on LOD) and that all the solubilised tris(4-nonylphenyl, branched) phosphite is fully hydrolysed into 4-bNP (one mole of tris(4-nonylphenyl, branched) phosphite hydrolyze into 3 moles of 4-bNP) the amount of released 4-bNP would be 9.4 µg (C18 silica gel 50°C), 3.4 µg (glass beads 50°C); 12.8 µg (glass beads 20°C). Higher amounts of 4-bNP are obtained through the elution column which indicate that hydrolysis of tris(4-nonylphenyl, branched) phosphite which is adsorbed on solid phase as C18 silica gel and glass beads occurred during these preliminary studies. Therefore, this study supports the release of 4-bNP from the hydrolysis of tris(4-nonylphenyl, branched) phosphite adsorbed on sediment.

These tests are not performed with a radiolabeled substance and it is not obvious to derive a percentage of 4-bNP formation. Nevertheless, whatever stage of hydrolysis (full or partial) is considered, both tests (with C18 silica gel or glass beads) show significant formation of 4-bNP. Moreover, these percentages are calculated considering the nominal quantity of tris(4-nonylphenyl, branched) phosphite in the column, despite no measurement of tris(4-nonylphenyl, branched) phosphite being performed. It is expected that adsorption on to the vessel occurred during the preparation and that the quantity of tris(4-nonylphenyl, branched) phosphite in the column was lower (and the derived percentage higher). The contact time of tris(4-nonylphenyl, branched) phosphite with water is lower than in a standard hydrolysis test carried out in batches (120h). Therefore, this test could be considered to underestimate the release of 4-bNP compared to the release within 120h of the batch hydrolysis study. One of the tests with glass beads has been performed at environmentally relevant temperature (20°C) and pH (6) and demonstrate significant release of 4-bNP. Moreover, it is demonstrated that the hydrolysis occurred from tris(4-nonylphenyl, branched) phosphite once it is adsorbed on a solid phase (see note 1 of the Table _). Both solid phases and high amounts of water are present for instance in the sediment in the environment where such releases of 4-bNP are therefore expected. It should be noted that glass beads have a lower specific surface area (0.5 m^2/g, Naderi et al 2012) than sediment (6-46 m^2/g, 60 UK sediment samples, Rawlings et al. 2010). Therefore, higher dispersion of tris(4-nonylphenyl, branched) phosphite and availability for hydrolysis could be expected with sediment.

Table 8 : Release of 4-bNP in the preliminary study

Sorbent	T°C	pH	Number of fractions /duration	Total volume (mL) (14mL / fraction	[mean 4-bNP] (µg/L)	Mass 4-bNP (µg)[1]	% released 4-bNP w/w[2]	% released 4-bNP mol/mol[3]
C18	50	4	13 +1	182 +14	1170 (one fraction at 480)	219.7	**0.44**	**1.37**
Glass beads	50	4	5	70	236	16.5	**0.033**	**0.1**
Glass beads	20	6	19	266	256	68.1	**0.14**	**0.42**

[1] To be compared to the quantity of 4-bNP initially present as impurity (<15µg considering 50 mg of nominal quantity of tris(4-nonylphenyl, branched) phosphite present in the column (see note 2), despite it being assumed to be removed), and to the amount of 4-bNP released from the total hydrolysis of potentially soluble tris(4-nonylphenyl, branched) phosphite (highest estimation 50 µg/L): 9.4 µg (C18 silica gel), 3.4 µg (glass beads 50°C); 12.8 µg (glass beads 20°C).

[2] percentage based on weight of 4-bNP measured compared to nominal weight of tris(4-nonylphenyl, branched) phosphite present in the column, considering the nominal quantity of tris(4-nonylphenyl, branched) phosphite in the column (50 mg) and that 4-bnP as impurity was no more present in the system. No measurement of tris(4-nonylphenyl, branched) phosphite was carried out at this stage. Deposition/ adsorption on to the vessel during preparation is not excluded and the quantity of tris(4-nonylphenyl, branched) phosphite in the column could be lower, and percentage of hydrolysis higher. In addition, it should be noted that this calculation does not take into account the difference of molecular mass between, tris(4-nonylphenyl, branched) phosphite and 4-nonylphenol, branched.

[3] percentage based on moles of 4-bNP measured compared to nominal moles of tris(4-nonylphenyl, branched) phosphite in the column derived from nominal quantity of tris(4-nonylphenyl, branched) phosphite (see also note 2 regarding the limitations concerning the estimation of tris(4-nonylphenyl, branched) phosphite actually present in the column) and considering that 4-bnP as impurity was no more present in the system. This calculation is closer to the method usually applied when the parent substance is radiolabeled than to a calculation based on mass of tris(4-nonylphenyl, branched) phosphite and 4-nonylphenol, branched. Nevertheless, this calculation assumed that one mole of tris(4-nonylphenyl, branched) phosphite releases one mole of 4-nonylphenol, branched, whereas each molecule of tris(4-nonylphenyl, branched) phosphite could theoretically release up to 3 molecules of 4-nonylphenol, branched.

Hydrolysis study

An OECD TG 111 study was then performed at pH 4, 7 and 9. The starting solutions of tris(4-nonylphenyl, branched) phosphite were prepared as in the preliminary study at 19.4°C, using the glass bead column despite this sorbing material showing the lowest release of 4-nonylphenol, branched. Between 56 and 61 mg of tris(4-nonylphenyl, branched) phosphite was added to glass beads at three different pH values , the solvent was evaporated during the night and the column was equilibrated for 2 hours.

After 2 hours, 24-44 mL were collected to remove 4-bNP present as impurity in tris(4-nonylphenyl, branched) phosphite (theoretically between 17 and 18 µg considering the nominal added tris(4-nonylphenyl, branched) phosphite in the column). After 2 additional hours, between 24 and 44 mL of elution solutions were collected and then used as starting solutions for the batch hydrolysis study according to the OECD TG 111. As in the preliminary study, this elution method was applied to solubilise tris(4-nonylphenyl, branched) phosphite. According to the study report, the analysis of tris(4-nonylphenyl, branched) phosphite was attempted but it could not be quantified in the collected fractions with the available analytical method. Therefore, there is no indication that tris(4-nonylphenyl, branched) phosphite was indeed present in the collected fractions used as starting solution for the hydrolysis study according to the OECD TG 111. During this batch hydrolysis study, only 4-bNP was measured at 6 time points for 120 hours. The average concentrations over 120h are reported for each pH in Table 9.

Table 9: Initial and average concentration of 4-bNP at 19.4 °C

pH	elution rate for the preparation of tested samples (mL/h)	Concentration, just after 2h of elution (µg/L)	Average concentration (n= 6) (µg/L)	SD (µg/L)	RSD (%)
4	19	272	250	12.2	4.9
7	22	198	187	22.8	12
9	12	171	200	24	12

The concentration of 4-bNP in the batch hydrolysis test according to the OECD TG 111 is stable during the 120 h of the test. As no tris(4-nonylphenyl, branched) phosphite was detected in the starting solutions, it is not possible to conclude whether the stable concentration of 4-bNP is explained by (1) the absence of degradation of tris(4-nonylphenyl, branched) phosphite into 4-bNP during the hydrolysis study or (2) by the absence at three different pH values, of tris(4-nonylphenyl, branched) phosphite in the starting solution or (3) a too low concentration of tris(4-nonylphenyl, branched) phosphite to lead to detectable changes in the initial concentration of 4-bNP Therefore, the determination of DT50 and hydrolysis rate constant are not possible from these hydrolysis studies.

However, the analyses of the elution samples from this study confirm that 4-bNP was released from tris(4-nonylphenyl, branched) phosphite before the hydrolysis test according to the OECD TG 111 during the preparation of the starting solutions by elutions through the column with the glass beads. During this preparation, the solution was eluted for only 2 hours (44 mL for the pH 7 column) leading to low release of 4-bNP (table 10). However, the preliminary test with glass beads at pH 6 shows a constant concentration of 4-bNP in each eluted fraction during 19 hours. Assuming a constant concentration, elution for 120 h (Hydrolysis OECD TG 111 duration) would have lead to a percentage of formation of 4-nonylphenol, branched of more than 0.8% w/w.

Table 10: Release of 4-nonylphenol, branched in samples prepared for the hydrolysis study at 19 °C

pH	Total volume (mL) for 2 h	[4-bNP] (µg/L) in the starting fraction	Mass 4-bNP (µg)	Nominal Mass of tris (4-nonylphenyl, branched) phosphite in column (mg)	% released 4-bNP 2h[1] w/w	% released 4-bNP 120h w/w	% released 4-bNP 120h [2] mol/mol
4	**38**	272	10.3	**56**	**0.018**	**1.11**	**3.46**
7	**44**	198	8.7	**61**	**0.014**	**0.86**	**2.67**
9	**24**	171	4.1	**56**	**0.007**	**0.44**	**1.37**

[1] percentage based on weight of 4-bNP measured compared to nominal weight of tris(4-nonylphenyl, branched) phosphite present in the column, considering the nominal quantity of tris(4-nonylphenyl, branched) phosphite in the column (50 mg). No measurement of tris(4-nonylphenyl, branched) phosphite was carried out at this stage. Deposition/adsorption on vessel during preparation is not excluded and the quantity of tris(4-nonylphenyl, branched) phosphite in the column could be lower, and percentage of hydrolysis higher. In addition, it should be noted that it does not take into account the difference of molecular mass between tris(4-nonylphenyl, branched) phosphite and 4-nonylphenol, branched.

[2] extrapolated percentage over 120h based on moles of 4-bNP measured compared to nominal moles of tris(4-nonylphenyl, branched) phosphite in the column derived from a nominal quantity of 4-nonylphenyl, branched) phosphite (see also note 1 regarding the limitations concerning the estimation of tris(4-nonylphenyl, branched) phosphite actually present in the column). This calculation is closer to the method usually applied when the parent substance is radiolabeled than to a calculation based on mass of tris(4-nonylphenyl, branched) phosphite and 4- nonylphenol, branched. Nevertheless, this calculation assumed that one mole of tris(4-nonylphenyl, branched) phosphite releases one mole of 4-nonylphenol branched, whereas each molecule of tris(4-nonylphenyl, branched) phosphite could theoretically release up to 3 molecules of 4-nonylphenol branched.

Conclusion

The concentration of 4-bNP does not vary with time during the batch hydrolysis studies according to the OECD TG 111 (5 days). However, tris(4-nonylphenyl, branched) phosphite was not measured in the starting solutions used for the hydrolysis test and may not have been present. It is therefore not possible to conclude on the hydrolysis of tris(4-nonylphenyl, branched) phosphite based on the test according to the OECD TG 111.

However, hydrolysis of tris(4-nonylphenyl, branched) phosphite with release of 4-bNP occurred in the preliminary study with release of 4-bNP >0.1% after 19h at 20°C and pH 6 from glass beads. It is demonstrated that this release of 4-bNP comes from the tris(4-nonylphenyl, branched) phosphite adsorbed on glass beads and not from solubilized tris(4-nonylphenyl, branched) phosphite. The fraction of released 4-bNP is calculated based on the nominal quantity of tris(4-nonylphenyl, branched) phosphite in the system. However, no measurement of tris(4-nonylphenyl, branched) phosphite was performed. Therefore, the loss of tris(4-nonylphenyl, branched) phosphite during preparation may not be excluded and the quantity of tris(4-nonylphenyl, branched) phosphite in the column could be lower, and percentage of hydrolysis higher. Since the temperature (20°C) and pH (6) in one of the test with glass beads are environmentally relevant, the results of this preliminary test thus supports that such hydrolysis is probable from tris(4-nonylphenyl, branched) phosphite adsorbed in sediment, allowing significant release of 4-bNP in the environment.

Similar results are obtained in the starting solution prepared for the hydrolysis study. As the volume of the collected fractions is lower than in the preliminary study, the amounts of released 4-bNP are also lower. However, at the three tested pH values, the concentrations of 4-bNP in the tested fractions are in the same range as in the preliminary study. Moreover, the concentrations over 19h of elution are quite stable in each fraction of the preliminary study. Therefore it is expected that higher elution times would lead to higher 4-bNP release. An estimation of the release expected for 120h indicated that the formation of more than 0.8% w/w of 4-bNP would have been measured.

It should be noted that the hydrolysis is observed with a continuous flow with a low contact time of water (between 12 and 22 mL /hour) with the adsorbed tris(4-nonylphenyl, branched) phosphite. Moreover, the low specific surface area of glass beads additionally limits the contact with water. Higher releases of 4-bNP could be expected in a batch study with longer contact time with water over 5 days.

The sorbing material was not silica gel as initially recommended. The dried silica gel is a porous solid phase with a large specific surface area (between 300 and 600 m^2/g) and a large number of silanols on its surface. This solid phase is therefore polar. The test substance would have interacted with this surface by an adsorption mechanism. Water is the solvent that has the strongest affinity with this material. During the hydrolysis test, the strong affinity of water for the silica gel should have allowed the desorption of the test substance (previously adsorbed on the silica surface) as well as the 4-bNP produced by hydrolysis) thus enabling the better dispersion of the test substance in the aqueous phase thanks to the inert carrier. This method was successfully used in a hydrolysis test with triphenyl phosphite[6].

Instead, the release of 4-bNP in environmental relevant temperature and pH is observed in the test using glass beads (specific surface area 0.5 m^2/g, Naderi et al. 2012). In contrast to the initially recommended carrier, glass beads (fused silica) are amorphous, non-porous compounds with significantly less silanol on the surface than silica. Apolar compounds such as tris(4-nonylphenyl, branched) phosphite can adsorb on its surface. However, in order to desorb them an organic solvent miscible with water (methanol, acetonitrile) is required, which was not used in the provided study. Therefore, considering the characteristics of the carriers, the dispersion of tris(4-nonylphenyl, branched) phosphite in water thanks to the inert carrier is expected to be less effective on glass beads. Therefore, higher release of 4-bNP could have been obtained with silica gel as a carrier as initially recommended. Moreover, higher dispersion and availability for hydrolysis could be expected from sediment in the environment. Indeed, literature data support that sediments have higher specific area (6-46 m^2/g, 60 UK sediment samples, Rawlings et al., 2010) than glass beads. The surface area of C18 silica gel is higher (400 m^2/g), however grafting alkyl octadecyl chains (C18) on silanols of silica leads to a hydrophobic material. In the environment, adsorption of 4-nonylphenol, branched to organic matter in the sediment is also expected. Nevertheless, irrespective of the final distribution among the environmental compartments, it is expected that hydrolysis of the substance in the environment would lead to the release of 4-nonylphenol, branched.

The results of this study are discussed based on weight of evidence in Section 5.7 below.

[6] https://echa.europa.eu/docume+nts/10162/fc02208b-9999-388f-440d-e25b7e03f591

3.1.1.2 Phototransformation/photolysis

3.1.1.2.1 Phototransformation in air

The studies on phototransformation in air are summarised in the following table:

Table 10 Overview of phototransformation studies

Method	Results	Remarks	Reference
(Q)SAR estimation EPIWIN model version 1.9. Test material: tris(nonylphenyl) phosphite	Half-life (DT50): 5.1 h	2 (reliable with restrictions) key study	Charles A. Staples, Ph.D (2001) Meylan, W. and PH Howard. 2000a. (2000)

Tris(nonylphenyl) phosphite released to the atmosphere is expected to degrade by reaction with hydroxyl radicals. A constant rate for degradation in air of 3.28 d^{-1} with a corresponding half-life of 5.1 hours was estimated (degradation rate constant with OH radicals: 50.6 cm^3 $molecule^{-1}$ s^{-1}).

3.1.1.2.2 Phototransformation in water

No data available.

3.1.1.2.3 Phototransformation in soil

No data available.

3.1.1.3 Summary on abiotic degradation

See section 3.1.2.3

3.1.2 Biodegradation

3.1.2.1 Biodegradation in aqueous media or aqueous environment

3.1.2.1.1 Estimated data

There is currently no software that gives valid results for the hydrolysis of phosphite derivates. CATALOGIC v5.16 models for hydrolysis do not cover the phosphite fragment in the structural domain. Hence, the substance is outside the applicability domain of the model. Due to the lack of this fragment in the training set of the model, the model cannot predict its eventual hydrolysis leading to the formation of phenols.

Nevertheless, CATALOGIC v5.16 model 301C v.13.18 was run to assess the formation of 4-nonylphenol, branched through biodegradation. In the CATALOGIC 301C model, two sub-models generate the predictions, one for BOD and one for the metabolic maps. The training set and applicability domain for these models are different.

The structural domain checked in CATALOGIC only calculates the applicability domain of the BOD model. Model 301C for ready biodegradation (BOD) contains four phosphites in the training set, and the model is considered applicable. The similar substances in the training set (CAS 2082-80-6, CAS 60626-17-3, CAS 1505-57-9, CAS 3050-88-2) are correctly identified as ready or not ready biodegradable. This supports the applicability of the BOD model for the substance.

Unfortunately, there is no data investigating phenol formation in the test with the four similar substances in the training set. Moreover, there are no phosphites in the list of substances with observed maps. There are some theoretical supports provided by the transformation reactions. On this basis, the software predicts the formation of the 4-nonylphenol, branched (4-bNP) with 40% mol/mol parent. However, the predicted amount is uncertain, as there is no information on formed phenols available from the substances in the 301C BOD training set, and no references are available for observed maps.

3.1.2.1.2 Screening tests

The studies on biodegradation in water (screening tests) are summarised in the following table:

Table 11 Overview of screening tests for biodegradation in water

Method	Results	Remarks	Reference
commercial bacterial preparation (Polyseed) Modified OECD TG 301 D (Ready Biodegradability: Closed Bottle Test) with inoculum deviating from the test guideline (this deviation is not one of the accepted modifications in ECHA guidance R.7b for modified ready biodegradability tests) Test material: tris(nonylphenyl) phosphite	Degradation of test substance: < 4% after 28 days	Reliability score 3 (not reliable) experimental result	Study report Unpublished study (2001a)
activated sludge (adaptation not specified) OECD TG 301 B (Ready Biodegradability: CO2 Evolution Test Test material: tris(nonylphenyl) phosphite	Degradation of test substance: 1% after 29 d	Reliability score 2 (reliable with restrictions) experimental result	Study report Unpublished study (1994)

The ready biodegradability of tris(nonylphenyl) phosphite was studied in a CO_2 test performed according to OECD TG 301B (Unpublished study, 1994).

In the OECD TG 301B study, tris(nonylphenyl) phosphite was tested at a concentration of 18.1 mg/L. The inoculum was constituted with activated sludge collected from the sewage treatment plant of Reinach (Switzerland). The pH after collection was 7.0. Before application, the inoculum was pre-acclimated to the test medium overnight. The test was performed at a temperature of 22 +/- 2°C with a carbon dioxide free air supply. To consider the very low solubility of the test substance, its preparation was as follows: a stock solution was prepared dissolving 1.36 g of test substance in 10 mL dichloromethane. From this stock solution, for each replicate, 27.2 mg (200 µL) were applied onto a filter paper as small drops. After the filter paper was completely dry (no remaining dichloromethane was present), it was cut into small pieces (10-15) and added to the test medium. Thereafter, the medium volume was completed to 1.5L with 300 mL water and the flasks were immediately connected to the CO_2 scrubber. Within a few hours the filter paper was homogeneously distributed in the test medium (so that it could not be seen anymore). Only 1% of tris(nonylphenyl) phosphite was biodegraded after 29 days of experiment. Few information is provided in the IUCLID on this study, which is therefore considered as supportive.

In addition, in a closed bottle test (modified OECD TG 301D study) (Unpublished study, 2001), OECD TG 301D study, tris(nonylphenyl) phosphite solutions were inoculated with a commercial bacterial preparation (Polyseed) and incubated at 20 ± 1°C. The study is not equivalent to a ready biodegradability test due to the inoculum deviating from the test guideline The biological oxygen demand (BOD) of the test substance was measured at 0, 7, 14, 21 and 28 days and compared to the theoretical oxygen demand ($ThODNO_3$) of the nominal concentration of tris(nonylphenyl) phosphite. Tris(nonylphenyl) phosphite concentration was 15.4 $mg.L^{-1}$ which theoretically corresponds to a Chemical Oxygen Demand of 13.2 mg. Besides the tris(nonylphenyl) phosphite solution, there were 3 controls: a test control (inoculated mineral medium), a procedure control (degradation of a reference substance) and a toxicity control (degradation of the reference substance in the presence of tris(nonylphenyl) phosphite). All controls passed the acceptability criteria of the test: oxygen depletion in the test control did not exceed 1.5 mg per liter after 28 days incubation, biodegradation of the sodium acetate reference substance met the criterion of > 60% of the $ThODNO_3$ within 14 days. Tris(nonylphenyl) phosphite is not assumed to be inhibitory in the test as the degradation in the toxicity control was not less than 25% after 14 days. Finally, the variance amongst duplicate test bottles was less than 20%. Less than 4% of tris(nonylphenyl) phosphite was biodegraded after 28 days experiment.

According to the OECD TG 301B study, tris(nonylphenyl) phosphite is considered as not readily biodegradable. The result of the modified OECD TG 301D study (not equivalent to a ready biodegradability test) is in line with this conclusion.

The identification of degradation products is often not performed in the ready biodegradation tests. However, the software Catalogic v5.16 provides degradation product predictions for a ready biodegradation test (301C). This software predicts the formation of 4-bNP. However, this result remains uncertain as the substance is not in the training set of the model.

3.1.2.1.3 Simulation tests

Simulation tests are not available in the registration dossier, a data waiving is notified for this endpoint. According to the Registrants, an OECD TG 309 water simulation study is not technically feasible given the extremely low water solubility of the substance.

Moreover, the Registrants consider that sediment is not anticipated to be a direct and indirect exposure route of concern, given limited release to the environment. However, widespread uses by professional workers, consumers and in article service life are identified for tris(4-nonylphenyl, branched) phosphite thus release to the environment cannot be excluded.

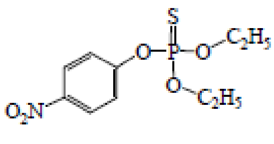
The biodegradation of tris(4-nonylphenyl, branched) phosphite could lead to the formation of 4-bNP. 4-bNP has been identified as an endocrine disruptor giving rise to equivalent level of concern. However, the waiving of an OECD TG 309 study was accepted due to the hydrolysis results supporting the release of 4-bNP that justifies regulatory action and due to technical difficulties (high insolubility, high adsorption) which could complicate the performance and the interpretation of a biodegradation test.

3.1.2.1.4 Other data regarding biodegradation

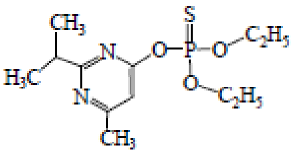
TNPP has structural similarities with phosphotriester pesticides which are highly toxic synthetic organophosphate compounds. The organophosphate insecticides are primarily phosphotriesters, thiophosphotriesters, or phosphorothiolesters as shown in examples below. Organophosphates have different atoms / substitutions or fragments than TNPP, some organosphophates contain sulfur instead of oxygen of alkylphenol, nitrophenol, or only alkyl chains instead of alkylphenol as TNPP.

Several examples of enzymes implicated in the P-O bond cleavage are reported in the literature. These enzymes differ widely in protein sequence and three-dimensional structure, as well as in catalytic mechanism, but they also share several common features. All the enzymes are metal-dependent hydrolases and contain a hydrophobic active site with three discrete binding pockets to accommodate the substrate ester groups.

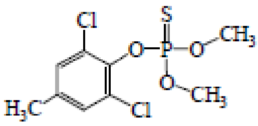
The P-O bond cleavage occurs after oxidation of sulfur when present. Such P-O bond cleavage leading to (nitro/methyl/chloro)phenol has been shown for parathion (Munnecke and Hsieh, 1976; University of Minnesota, 2021; Sethunathan and Yoshida, 1973), fenitrothion (Roy et al, 1996), diazinon, tolclofos-methyl and chlorpyrifos (Kodaka et al, 2003; Singh et al., 2006).



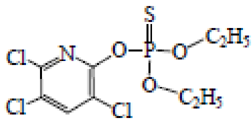
Parathion



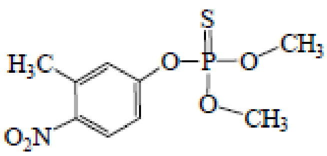
Diazinon



Tolclofos-methyl



Chlorpyrifos



Fenitrothion

Cytochrome CYP 450 enzymes could also be involved in hydrolytic P-O bond cleavage. This was for example demonstrated in the degradation of diazinon which was mediated by cytochrome P450 in the fungal model *Cunninghamella elegans* (Zhao et al., 2020).

There is at present no data regarding enzymes implicated in the P-O bond cleavage of TNPP but these examples show that the occurrence of such enzymes is not excluded.

3.1.3 Field data

No data available

3.1.4 Summary and discussion on (bio)degradation

The hydrolysis studies on their own do not allow to demonstrate the hydrolysis of tris(4-nonylphenyl, branched) phosphite because of strong deviations (presence of hydrolysis stabiliser, no adequate analytical method, no measurement of initial concentration of tris(4-nonylphenyl, branched) phosphite in the test). Nevertheless, preliminary studies carried out to solubilise tris(4-nonylphenyl, branched) phosphite show continuous release of 4-nonylphenol branched from two carriers. These studies were carried out in a column containing either glass beads or C18 silica gel. For two of these studies, duration of the test was long enough (14h and 19h) to observe a release of 4-nonylphenol, branched in higher quantity (70 – 230 µg) than the initial quantity of 4-nonylphenol, branched as impurity (< 15 µg). Moreover, the 4-nonylphenol, branched as impurity has been theoretically removed by the elimination of the first elution fraction). In addition, the quantity of released 4-nonylphenol, branched is also higher than the amount of 4-bNP released from the total hydrolysis of potentially soluble tris(4-nonylphenyl, branched) phosphite (~ 10 µg) considering the highest estimation of solubility of tris(4-nonylphenyl, branched) phosphite (50 µg/L)). These results support that the hydrolysis occurred from tris(4-nonylphenyl, branched) phosphite adsorbed on both tested carriers. One of the preliminary studies was carried out in environmentally relevant conditions (pH 6 and 20°C) and showed release of 4-nonylphenol, branched > 0.1% (0.14% w/w). The same method was used to prepare the samples for the hydrolysis study including 3 different pH levels covering the range of environmental pH. The sorbing phase (glass beads) with the lowest release of 4-nonylphenol, branched was used and the elution duration was low (2h). Nevertheless, the rate of 4–nonylphenol, branched release was similar to those observed in the preliminary studies. Assuming the same degradation rate over the duration of an hydrolysis study according to OECD TG 111 (5d) leads to an estimation of 4-nonylphenol, branched >0.1% (0.4 – 1.1% w/w). It should be noted that these calculations are based on nominal quantity of tris(4-nonylphenyl, branched) phosphite added in the column, whereas lower quantity and then higher percentage of release of 4-nonylphenol, branched could be expected considering the properties of tris(4-nonylphenyl, branched) phosphite. In addition, the sorbing phase used in the hydrolysis tests has a lower specific area than natural sediments. Therefore, higher release of 4-bNP is expected from sediment in the environment.

The ready biodegradability of tris(4-nonylphenyl, branched) phosphite was studied in a CO2 test performed according to OECD TG 301B (Unpublished study, 1994). Tris(4-nonylphenyl, branched) phosphite was not found to be readily biodegradable (1% of TNPP degraded after 29 days).

The data on ready biodegradation have shown that tris(4-nonylphenyl, branched) phosphite is not readily biodegradable, therefore tris(4-nonylphenyl, branched) phosphite is potentially P/vP. Nevertheless, a negative ready biodegradation test does not exclude potential biodegradation in the environment. Moreover, the lack of simulation tests to clarify the P/vP properties does not allow excluding the release of 4-bNP through biodegradation.

In addition, TNPP has some similarities with phosphotriester pesticides which are a class of highly toxic synthetic organophosphate compounds. Nevertheless, they differ in the oxidation level of phosphorus. Organothiophosphates have chemical differences to TNPP, including presence of sulfur instead of oxygen of alkylphenol. Some organosphophates contain also nitrophenol, or only alkyl chains instead of alkylphenol as with TNPP. Several examples of enzymes implicated in the P-O bond cleavage of organophosphate compounds are reported in the literature. There is at present no data regarding enzymes implicated in the P-O bond cleavage of TNPP but the occurrence of such enzymes is not excluded.

3.2 Environmental distribution

3.2.1 Adsorption/desorption

The studies on adsorption/desorption are summarised in the following table:

Table 12: Overview on adsorption/desorption data

Method	Results	Remarks	Reference
Study type: model results Model results using KOCWIN 2.00. Test material: tris(nonylphenyl) phosphite	Adsorption coefficient: log Koc: 10 — 17 at 25 °C (Results from two models)	Reliability score 3 (not reliable) supporting information estimated by calculation	US EPA (2010)

The estimated Koc values for tris(nonylphenyl) phosphite are far above the range of validity or validated set (log Koc = 0-7). Moreover, molecular weight of tris(nonylphenyl) phosphite (689 g mol^{-1}) is above the validated domain of applicability of the models developed in KOCWIN (minimum molecular weight = 73 g mol^{-1}; maximum molecular weight = 504 g mol^{-1}). Therefore, these calculated values can only be considered as supportive data which nevertheless estimate highly adsorptive properties.

3.2.2 Volatilisation

No information on volatilisation is available in the registration dossiers. In the Annex XV CLH report of tris(nonylphenyl)phosphite[7] (CAS 26523-78-4)[8], a Henry's law constant of 66.1 $Pa.m^3.mol^{-1}$ is reported using EPIWIN v. 3.10. Another estimation is reported from the ratio of the vapour pressure to the water solubility. Using a vapour pressure of 0.058 Pa, a molecular weight of 689 g.mol-1 and a water solubility of <0.05 $mg.L^{-1,}$ the Henry's law constant would be >799 $Pa.m^3.mol^{-}$. The report also points out: "*considering the hydrophobicity and the strong adsorption potential of the substance, volatilisation of TNPP from water is not expected to be a major phenomenon".*

3.2.3 Distribution modelling

This endpoint has not been assessed in detail in the frame of the SVHC identification but information from the registration dossiers are provided for contextual information.

The registration dossiers show distribution modelling of tris(nonylphenyl) phosphite based on calculations according to Mackay, Level III. The ECHA dissemination website reports the following information*: The following measured data were reported and used in the fugacity-based distribution modeling. TNPP undergoes hydrolysis with half-lives of 13 to 14 hours at pH values of 4 to 9 (at 22 °C) (Unpublished study 2001a), has a melting point averaging 6 °C (Unpublished study, 2001b), and a water solubility of < 0.6 mg/L (24 °C) (Unpublished study, 2001c). In addition, an expert statement with a calculated log Kow value of 21.6 was provided (Unpublished study, 2001d). Using the EPIWIN models additional parameters were estimated. They include a water solubility of 1.3 E-15 mg/L, a vapor pressure of 5 E-12 Pa, an atmospheric half-life of 5.07 hours, water and soil biodegradation half-lives of 900 hours, and a sediment half-life of 3600 hours. Except of the water and soil biodegradation half-lives, these values were all used in the distribution*

[7] https://www.echa.europa.eu/documents/10162/13630/trd_rar_env_france_tnpp_en.pdf/3c52a33e-5c4b-4640-b863-94198d406924

[8] Refer to Section 1.1 in relation to the historical use of these identifiers

modeling. Hydrolysis is the dominant fate process in water and would be equally so in soil, therefore a 14 hour half-life was used in those compartments. The results of the distribution modeling (assuming equal emissions to air, water, and soil) are provided in Table 13.

Table 13: Predicted environmental distribution

Fraction of emission directed to:	**%**
Air	1.4
Water	4.5
Soil	5.6
Sediment	88.6

3.2.4 Field data

No data available

3.2.5 Summary and discussion of environmental distribution

Tris(4-nonylphenyl, branched) phosphite is expected to have strong adsorptive properties, therefore when released to the environment it will tend to distribute primarily to sediment

3.3 Data indicating potential for long-range transport

No data available.

3.4 Bioaccumulation

This endpoint has not been assessed in the frame of the SVHC identification.

4. Human health hazard assessment

Not relevant for the identification of the substance as SVHC in accordance with Article 57 (f) of REACH Regulation.

5. Environmental hazard assessment

The following sections summarise available ecotoxicity information, the studies were conducted before the change of identifiers of tris(4-nonylphenyl, branched) phosphite, thus the test material tris(nonylphenyl) phosphite reported in the studies corresponds to tris(4-nonylphenyl, branched) phosphite and the nonylphenol reported corresponds to 4-nonylphenol, branched (4-bNP).

Information showing that the degradation product 4-nonylphenol, branched is a substance of very high concern, due to its endocrine disrupting properties which cause probable serious effects in the environment, is summarised in the SVHC supporting document[9] for 4-nonylphenol, branched (European Chemicals Agency, 2012).

5.1 Aquatic compartment (including sediment)

5.1.1 Fish

5.1.1.1 Short-term toxicity to fish

The test results on aquatic toxicity of tris(nonylphenyl) phosphite are summarised in the following table:

Table 14: Overview of short-term data on fish

Method	Results	Remarks	Reference
Oncorhynchus mykiss static OECD TG 203 (Fish, Acute Toxicity Test) Test material: tris(nonylphenyl) phosphite Nominal tested concentrations: 0, 1.6, 3.1, 6.3, 12.5, 25.0, 50.0, and 100.0 mg/L	LL50 (96 h): > 100 mg/L (meas. (not specified)) based on: mortality	Reliability score 2 (reliable with restrictions) key study experimental result	Study report Unpublished study (2001b)
Leuciscus idus static DIN-Vorschrift 38412-L15 Test material: tris(nonylphenyl) phosphite; no further information available Nominal tested concentrations: 5.8, 10, 18, 32, 58 and 100 mg/L	LC50 (48 h): 7.1 mg/L (nominal)	Reliability score 3 (not reliable) disregarded study experimental result	Study report Unpublished study (1988)
Brachydanio rerio (new name: Danio rerio) static EU Method C.1 (Acute Toxicity for Fish) (Cited as Directive 84/449/EEC, C.1 ("Acute toxicity for fish")) Test material: tris(nonylphenyl) phosphite Nominal tested concentrations: 10, 18, 32, 58 and 100 mg/l	LC50 (96 h): < 10 mg/L LC50 (48 hr) (96 h): 16 mg/L LC50 (24hr) (96 h): 29 mg/L	Reliability score 3 (not reliable) disregarded study experimental result	Study report Unpublished study (1992b)

[9] https://echa.europa.eu/documents/10162/182ad178-5b9c-cae4-3701-3f618995d6dc

Three acute toxicity studies on fish were provided. Two were considered as not reliable. All fish died in the study with *Brachydanio rerio* whereas an LC50 of 7.1 mg/L (nominal) was determined in the study with *Leuciscus idus*. In both studies, tested concentrations (> 5 mg/L, nominal) were far above the limit of solubility of tris(nonylphenyl) phosphite and no equilibration time was carried out to allow at least partial dissolution of tris(nonylphenyl) phosphite. It is therefore not clear if the maximum solubility was achieved in the test medium. In the test with *Brachydanio rerio*, undissolved tris(nonylphenyl) phosphite was observed in all tested concentrations. In the study with *Leuciscus idus* a very high concentration of solvent (up to 950 mg/L of DMF for the highest tested concentration) was used and there is no clear report on the effect of the solvent on fish. Additionally, no direct or indirect measures of the test concentrations were reported and it is not clear if fish were exposed to tris(nonylphenyl) phosphite. Moreover, the potential presence of nonylphenol as an impurity of the test substance does not allow excluding that the observed effects result from nonylphenol toxicity, considering toxicity reported in the EU RAR for nonylphenol (LC50 = 0.128 mg/L).

High concentrations were tested in the key study (100 mg/L, nominal). Nevertheless, the stock solution was equilibrated for 78h and decanted before dilutions for the tests. No toxicity was observed. No measurement of the tested substance was carried out. The purity of tested substance was high and the content of 4-bNP as impurity should have been low. The occurrence of 4-bNP as hydrolysis product was investigated and no 4-bNP was detected (detection limit of 0.2 mg/L). However, information about the analytical methods are limited. This key study indicated that no toxicity of TNPP to fish is expected at its water solubility limit.

Overall, tris(4-nonylphenyl, branched) phosphite is not expected to be toxic to fish in short-term (96 h) studies at its limit of water solubility.

5.1.1.2 Long-term toxicity to fish

No information is available in the registration dossier, the registrants waived the study on the basis that there are no effects in fish in short-term studies at concentrations well in excess of the tris(4-nonylphenyl, branched) phosphite water solubility limit. For the Registrants, fish are not anticipated to be the most sensitive species for long-term aquatic toxicity testing. Valid WAF acute toxicity studies support that invertebrates are the most sensitive trophic level. Nevertheless, long term studies are usually required for poorly water soluble substances.

5.1.2 Aquatic invertebrates

5.1.2.1 Short-term toxicity to aquatic invertebrates

The results are summarised in the following table:

Table 15: Overview of short-term data on aquatic invertebrates

Method	Results	Remarks	Reference
Daphnia magna freshwater static OECD TG 202 (Daphnia sp. Acute Immobilisation Test)	EL50 (48 h): 0.3 mg/L (nominal)	Reliability score 2 (reliable with restrictions) key study experimental result	Study report Unpublished study (2001c)

Method	Results	Remarks	Reference
Test material (EC name): tris(nonylphenyl) phosphite Tested loads (see text): 5.00, 2.50,1.25, 0.63, 0.31, 0.16, 0.08, and 0.04 mg/L			
Daphnia magna static EU Method C.2 (Acute Toxicity for Daphnia) (Cited as Directive 84/449/EEC, C.2 (Acute toxicity for Daphnia)) Test material (EC name): tris(nonylphenyl) phosphite Nominal tested concentrations 0.058, 0.1, 0.18, 0.32, 0.58 and 1.0 mg/L	EC50 (48 h): 0.42 mg/L (nominal)	Reliability score 3 (not reliable) disregarded study	Study report Unpublished study (1992c)

The key study was run at loading levels well above the water solubility limit of tris(nonylphenyl) phosphite. The stock solution was stirred for 78 hours prior to testing in order to adequately mix and "age" the test solution and to allow for the solubilisation/formation of the hydrolysis products (water accommodated fraction). The load of the stock solution was 100 mg/L. After equilibration, the solution was decanted and the supernatant was diluted several times to obtain tested concentrations. The concentrations are expressed as nominal values taking into account the initial load of the stock solution. Detectable levels of nonylphenol (NP, 0.3 mg/L) were observed in the stock solution (10 mg/L, nominal load) which leads to the conclusion that degradation of the tris(nonylphenyl) phosphite had indeed occurred, as the test substance was >99.9% pure (expected maximal concentration of 0.01 mg/L of NP as impurity in the stock solution). The same proportion of NP was expected to occur in the other tested concentrations but was not detected. At 48h, an EC50 of 0.3 mg/L of solubilised/ hydrolysed tris(nonylphenyl) phosphite (nominal load) was determined, which would correspond to a concentration of nonylphenol of 0.009 mg/L. This concentration is above the limit of solubility of tris(nonylphenyl) phosphite in water. Nevertheless, it is expressed as nominal load and it should be kept in mind that actual concentrations in the test were probably lower. In addtion, the influence of nonylphenol in the observed toxicity is not completely elucidated. Indeed, the EC50 of nonylphenol in the RAR (2002)[10] is higher (EC50 = 0.085 mg/L), than the expected concentration of nonylphenol leading to 50% of immobilisation in the key test.

A similar result is reported for tris(nonylphenyl) phosphite in the supporting study which is however considered as RI3. Indeed, tested concentrations were far above the limit of solubility of tris(nonylphenyl) phosphite in water, no equilibration time was applied, and no analytical verification of concentrations was performed neither for tris(nonylphenyl) phosphite nor for its degradation product (nonylphenol). It is therefore not clear if the maximum solubility in the test medium was achieved. Moreover, the report mentions that undissolved substance was observed at all test concentrations. In addition, due to the low purity of the tested tris(nonylphenyl) phosphite grade, the effects might also be attributed to nonylphenol present as impurity additionally to its presence as potential hydrolysis product.

[10] https://echa.europa.eu/documents/10162/43080e23-3646-4ddf-836b-a248bd4225c6

Overall, in a test performed with an approach similar to the water accommodated fraction, an EC50 of 0.3 mg/L was determined (nominal, based on initial load of the stock solution). Nonetheless, the value remains above the limit of solubility of tris(nonylphenyl) phosphite in water. The stock solution was decanted before the test to allow solubilisation/hydrolysis of the substance but no measurement of tris(nonylphenyl) phosphite was performed. Therefore, actual concentrations in the test were probably lower. Additionally, degradation of pure tris(nonylphenyl) phosphite to NP was demonstrated and the influence of nonylphenol in the observed toxicity is not clear. This test supports that tris(nonylphenyl) phosphite degrades in water and leads to the formation of nonylphenol.

5.1.2.2 Long-term toxicity to aquatic invertebrates

The results are summarised in the following table:

Table 16: Overview of long-term studies with aquatic invertebrates

Method	Results	Remarks	Reference
Daphnia magna freshwater static, daily renewal OECD TG 211 (Daphnia magna Reproduction Test) Test material: tris(nonylphenyl) phosphite Single nominal concentration (0.1 mg/L)	LL50 (21 d): > 0.1 mg/L test mat. (nominal load) based on: reproduction (and survival) (100% WAF) NOELR (21 d): >= 0.1 mg/L test mat. (nominal) based on: reproduction (survival, and growth) (100% WAF) LOELR (21 d): > 0.1 mg/L test mat. (nominal) based on: reproduction (survival, and growth) (100% WAF)	Reliability score 3 (not reliable) supporting study experimental result	Study report Unpublished study (2009)

In a limit chronic test study, tris(nonylphenyl) phosphite was first dissolved in acetone (stock solution). The tested solution was renewed each day. For this purpose, the stock solution was dissolved and the test solution was mixed for 20 to 26 hours, and the water soluble fraction was removed and used for the test. No toxicity was observed. Nevertheless, no analytical measure was carried out and it is not demonstrated that dissolution of tris(nonylphenyl) phosphite (and potential hydrolysis to NP) occurred. Additionally, feeding of daphnia occurred just after the renewal of the solution, which could have limited bioavailability of solubilised tris(nonylphenyl) phosphite due to adsorption of tris(nonylphenyl) phosphite to the food. Therefore, it is unclear if organisms were exposed to tris(nonylphenyl) phosphite through water or through water and food. Overall, it is considered that the provided chronic study on invertebrates is not reliable.

5.1.3 Algae and aquatic plants

The results are summarised in the following table:

Table 17: Overview of studies with algae

Method	Results	Remarks	Reference
other algae: Green algae (Raphidocelis subcapitata, formerly Selenastrum capricornutum) (algae) freshwater static OECD TG 201 (Alga, Growth Inhibition Test) Test material: tris(nonylphenyl) phosphite Tested load (see text): 100, 50.0, 25.0, 12.5, 6.3, 3.1, and 1.6 mg/L	NOEC (72 h): 100 mg/L (meas. (not specified)) based on: growth rate LOEC (72 h): > 100 mg/L (meas. (not specified)) based on: growth rate	Reliability score 2 (reliable with restrictions) key study experimental result	Study report Unpublished study (2001d)
Scenedesmus subspicatus (new name: Desmodesmus subspicatus) (algae) freshwater static EU Method C.3 (Algal Inhibition test) (Cited as Directive 87/302/EEC, part C, p. 89 (Algal inhibition test)) Test material: tris(nonylphenyl) phosphite Nominal tested concentrations of 0, 1.23, 3.7, 11, 33 and 100 mg/L	EC50 (72 h): > 100 mg/L based on: biomass NOEC (72 h): 100 mg/L based on: biomass	Reliability score 3 (not reliable) disregarded study	Study report Unpublished study (1992a)

Two studies were provided. The study on *Desmodesmus subspicatus* (Unpublished study, 1992a) was considered not reliable. Indeed, no significant effects upon biomass were observed at any test concentration. However, the solutions were prepared without equilibration time, no analytical measurements of tris(nonylphenyl) phosphite or nonylphenol in the treatments were reported and the presence or actual concentrations are unknown. In addition, the purity of the tested tris(nonylphenyl) phosphite was low.

The key study (Unpublished study, 2001d) was run at loading levels well above the water solubility limit of tris(nonylphenyl) phosphite and the stock solution was stirred for 78 hours prior to testing in order to adequately mix and "age" the test solution and to allow for the solubilisation of tris(nonylphenyl) phosphite and formation of hydrolysis products (water accommodated fraction). The load of the stock solution was 100 mg/L. After equilibration, the solution was decanted and the supernatant was diluted several times to obtain tested concentrations. There was no measure of tris(nonylphenyl) phosphite in the test solutions. Nonylphenol was measured but not detected, probably due to the high LOD of the analytical method employed in the study. Nonetheless, the growth of algae when exposed to test solutions was significantly higher than growth of algae in the control solution (>300% for biomass, 38% increase for growth rate), which indicates that degradation could have occurred with release of phosphorus. As no measure of tris(nonylphenyl) phosphite concentration was carried out, it can only be considered that no toxicity of tris(nonylphenyl) phosphite occurred at its limit of solubility.

Overall, tris(4-nonylphenyl, branched) phosphite is not expected to be toxic to algae at its water solubility limit. The large increase in growth rate observed for algae supports the degradation of tris(4-nonylphenyl, branched) phosphite and release of phosphorus (phosphorous acid).

5.1.4 Sediment organisms

This endpoint has not been assessed by the dossier submitter in the frame of the SVHC identification.

5.1.5 Other aquatic organisms

No available information in the registration dossier.

5.2 Terrestrial compartment

No available information in the registration dossier.

5.3 Atmospheric compartment

No available information in the registration dossier.

5.4 Microbiological activity in sewage treatment systems

This endpoint has not been assessed by the dossier submitter in the frame of the SVHC identification.

5.5 Toxicity to birds

No available information.

5.6 Mammalian wildlife

No available information.

5.7 Endocrine disruption (Environment)

The assessment of endocrine disruptor properties of the group is based on data available for the registered substance tris(4-nonylphenyl, branched) phosphite (List number 701-028-2)

Evidence related to endocrine disruptor properties of tris(4-nonylphenyl, branched) phosphite

No relevant data is available in the registration dossier to investigate endocrine properties of tris(4-nonylphenyl, branched) phosphite for the environment. A search of the literature was conducted up to 3 April 2024. The literature search was performed in PubMed and Scopus databases without limitations on the year of publication (see Annex I). In both of these literature searches, a single concept strategy search was applied to retrieve all relevant information on tris(4-nonylphenyl, branched) phosphite by using its scientific chemical names, common names and previous chemical identifiers (CAS number and chemical name).

The literature search yielded only one study that investigates the endocrine disruptor properties of tris(4-nonylphenyl, branched) phosphite (Ogawa et al., 2007). In this study, the authors observed an estrogenic activity of tris(nonylphenyl)phosphite (CAS 26523-78-4)[11] in an *in vitro* assay (yeast two-hybrid cells assay). However, the results of the study should be taken with caution because no information about the identity (type of alkyl chain linear or branched), degree of purity and nonylphenol levels are available in the study. Thus, it is not possible to conclude if the estrogenic activity observed was exerted by the substance or the impurity of the substance (nonylphenol).

In conclusion, it is not possible to characterise the endocrine disruptor properties of tris(4-nonylphenyl, branched) phosphite due to the limited information available.

Evidence related to endocrine disruptor properties of tris(4-nonylphenyl, branched) phosphite based on its degradation to an endocrine disruptor substance

General approach

The assessment focuses on the question whether or not tris(4-nonylphenyl, branched) phosphite can be considered as an endocrine disruptor due to its degradation to 4-nonylphenol, branched. 4-nonylphenol, branched is a substance of very high concern included in the Candidate List (Decision ED/169/2012 of 18 December 2012) due to the endocrine disrupting properties which cause probable serious effects to the environment.

To answer the question, degradation and aquatic toxicity studies are considered which provide indications of degradation of the substance to 4-nonylphenol, branched (sections 3.1.1 and 5.1) and a weight-of-evidence approach is applied for the assessment.

The following information was identified as the most relevant to the overall analysis:

Experimental studies on degradation

- A hydrolysis study according to OECD TG 111 (Unpublished study, 2001) shows hydrolysis of tris(4-nonylphenyl, branched) phosphite without detection of 4-nonylphenol, branched. However, the results are questioned (reliability score 3) because no information regarding the mass balance is available and it is therefore not excluded that the observed dissipation of tris(4-nonylphenyl, branched) phosphite results from adsorption on the vessel. In addition, transformation products were not detected but the method of detection of nonylphenol (linear) was not suitable for detection of the branched nonylphenol-chains contained in the tested substance. The study report is poorly documented regarding the analytical methods and results. The results of the study provides a low strength of evidence in the assessment.
- In the hydrolysis study (Unpublished, 2004), formation of nonylphenol was not detected over 24h, however the study was poorly documented, e.g., there was no information on analytical methods used in the test. Therefore, it is not possible to conclude that no release of 4-nonylphenol, branched occurred in this study. This

[11] Refer to Section 1.1 in relation to the historical use of these identifiers

study is assessed to have a reliability score of 3 (not reliable) and it provides a low strength of evidence in the assessment.

- In a hydrolysis study similar to OECD TG 111 (Unpublished study, 2007) with tris (nonylphenyl) phosphite (containing <0.1% nonylphenol) limited hydrolysis was observed., despite the addition of a hydrolysis stabiliser. The level of measured nonylphenol was slightly above (0.1-0.15%) the level of nonylphenol present as impurity. This study is assessed to have a reliability score of 3 (not reliable), because the study was conducted in the presence of a hydrolytic stabiliser. As NP is present slightly above its maximum expected presence as an impurity, it provides a low strength of evidence on the formation of NP from tris (nonylphenyl) phosphite as the detected concentration was close to its possible presence as an impurity.
- A preliminary study (Unpublished study, 2021) (further details in section 3.1.1.1) with the intent to solubilise tris(4-nonylphenyl, branched) phosphite (containing 0.03% of 4- nonylphenol, branched) in a continuous flow system using two different sorbent materials (glass beads or C18 silica gel) shows a constant release of 4-nonylphenol, branched during 19 hours in amounts higher than the impurity. The results of the study demonstrate that this release comes from the hydrolysis of tris(4-nonylphenyl, branched) phosphite adsorbed on glass beads (at 50°C and pH 4 and at 20°C and pH 6) or C18 silica (at 50°C). The level of 4-nonylphenol, branched detected were formed under less favourable conditions than in a hydrolysis study (quantities of water employed and time of elution lower than contact time in an hydrolysis study) and they were constant during 19 hours. Moreover, these amounts were calculated based on the nominal concentration in the system without analytical confirmation. It is therefore reasonable to assume that higher amounts of 4-nonylphenol, branched would be released and a higher % of tris(4-nonylphenyl, branched) phosphite hydrolysed in a standard hydrolysis study. The preliminary study is assessed as having a reliability score of 2 (reliable with restriction) and it provides a high strength of evidence in the assessment.

- The hydrolysis study (Unpublished study, 2021) (further details in section 3.1.1.1) conducted with solutions of tris(4-nonylphenyl, branched) phosphite (containing 0.03% of 4-nonylphenol, branched) prepared as in the preliminary test but only with glass beads as sorbent material, shows a stable concentration of 4-nonylphenol, branched during the test in batch performed according to the OECD TG 111 (5 days). As no tris(4-nonylphenyl, branched) phosphite was measured in the starting solutions obtained through the elution in glass beads column, it is therefore not possible to determine a DT50 and a hydrolysis rate constant. However, the study confirms the finding of the preliminary test regarding the release of 4-nonylphenol branched during the preparation of the starting solutions with glass beads at pH 4, 7 and 9. Although the amounts of 4-nonylphenol, branched detected were formed even under less favourable conditions than in the preliminary test (one fraction recovered after 2 hours of elution), it is also reasonable to assume that higher amounts of 4-nonylphenol, branched would be released in a standard hydrolysis study. Moreover, the specific surface area of the carrier used for the preparation of the samples for the hydrolysis study is more than 10 times lower than in natural sediment, from which higher dispersion and availability of the substance for hydrolysis can thus be expected. This study is assessed as having a reliability score of 3 (not reliable) because the presence of tris(4-nonylphenyl, branched) phosphite is not analytically verified in the initial solution and no DT50 can be derived for the parent substance. However, the presence of 4-nonylphenol, branched in the samples prepared for the test at three different pH values relevant for the environment provides medium strength of evidence in the assessment.

Predicted information on degradation

- No software that gives valid results for the hydrolysis of phosphite derivates is available. CATALOGIC v5.16 models for hydrolysis do not cover the phosphite fragment in the structural domain. CATALOGIC v5.16 model 301C v.13.18 provides degradation product predictions for a ready biodegradation test (301C) (further details in section 3.1.2.1.1). Based on theoretical consideration of transformation reactions, the software predicts the formation of the 4-nonylphenol, branched (4-bNP) with 40% mol/mol parent. However, this result remains uncertain as there is no information on formation of phenols from tris(4-nonylphenyl, branched) phosphite in the 301C BOD training set. Information from this model prediction provides a low strength of evidence in the assessment.

Aquatic toxicity data

Some evidence on the formation of 4-nonylphenol, branched from the degradation of tris(4-nonylphenyl, branched) phosphite was also identified from two ecotoxicity studies: In the other ecotoxicity studies available, NP was not measured.

- A short term study with *Daphnia magna* according to OECD TG 202 (Unpublished study (2001c)) with tris(nonylphenyl) phosphite and using the water-accommodated fraction (WAF) approach for the preparation of exposure systems, shows detectable concentrations of 4-nonylphenol, branched (0.3 mg/L) in the medium in the highest test concentration (10 mg/L, nominal load) (further details in section 5.1.2.1). This concentration is higher than the maximum concentration of 4-nonylphenol, branched present as impurity. Consequently, degradation of tris(4-nonylphenyl, branched) phosphite leading to a release of 4-nonylphenol, branched in the medium occurs. This study is assessed as having a reliability score of 2 (reliable with restrictions). The presence of 4-bNP in the media above the expected concentration as an impurity (maximum 0.01 mg/L) provides a high strength of evidence in the assessment.

- In an algae test performed according to OECD TG 201 (Unpublished study (2001d)) with tris(nonylphenyl) phosphite using water-accommodated fraction (WAF) (further details in section 5.1.3), a significant increase in algal growth was observed after exposition to test solutions (>300% compared to the control). No measurements of tris(4-nonylphenyl, branched) phosphite were performed in the study and 4-nonylphenol, branched was not detected in the medium tested. The large increase in growth rate for algae exposed to tris(nonylphenyl) phosphite could be explained by phosphorus release to the medium. This study provides a low strength of evidence in the assessment, because, although degradation of the substance seems to occur, the chemical analysis did not confirm the presence of 4-nonylphenol, branched in the medium, probably due to the high LOD of the analytical method employed in the study.

Supporting data

- tris(4-nonylphenyl, branched) phosphite has structural similarities with phosphotriester pesticides despite a different oxidation level of phosphorus. Several examples of enzymes implicated in the P-O bond cleavage are reported in the literature (See section 3.1.2.1.3). Taking the example of parathion, a P-O bond cleavage is observed for this substance leading to (nitro/methyl/chloro) phenol. This information provides a low strength of evidence in the assessment, because the literature information does not make a clear reference to tris(4-nonylphenyl, branched) phosphite, or to a substance with a similar number of phenyls and as long carbon chain lengths on phenyls as TNPP. Nevertheless, it supports the occurrence of enzymes capable of cleaving the P-O bond.

Table 18: Summary of the lines of evidence and associated weight of evidence (WoE)* analysis

Type of evidence	Consistency and specificity	Likelihood	Strength of Evidence	Remaining uncertainty
Experimental degradation studies				
Hydrolysis study (Unpublished study, 2001)	Consistent Hydrolysis observed but not possible to confirm formation of 4-nonylphenol, branched	Plausible	Low strength of evidence	High
Hydrolysis study, Unpublished study (2004)	Not consistent Experimental conditions and analysis poorly documented	Plausible	Low strength of evidence	High
Hydrolysis study (Unpublished study, 2007)	Consistent	Not plausible	Low strength of evidence	High
Preliminary study – Solubilisation of TNPP Unpublished study, 2021	Consistent	Plausible	High strength of evidence	Low
Hydrolysis study Unpublished study, 2021	Consistent with the results of the preliminary test	Plausible	Medium strength of evidence	Medium
Predicted information on degradation				
CATALOGIC Biotic	Prediction consistent with general knowledge about degradation of phosphotriesters	Plausible	Low strength of evidence	High
Other information on degradation				
Literature on degradation of phosphotriesters	General publicatons on P-O clivage of organic compounds without clear reference to TNPP	Plausible	Low strength of evidence	High
Aquatic toxicity data				
Daphnia magna (OECD TG 222)	Consistent with the results of preliminary test of Unpublished study, 2021	Plausible	High strength of evidence	Low

Algae test (OECD TG 201)	Consistent	Plausible	Low strength of evidence	High

* Table adapted from "Weight of Evidence/Uncertainty Analysis Template[12] "

Conclusion from overall lines of evidence

The available lines of evidence allow to conclude that degradation of tris(nonylphenyl) phosphite can occur under environmentally relevant conditions leading to the formation of 4-nonylphenol, branched. This conclusion is mainly substantiated by the findings of the preliminary test and ecotoxicity information on *Dapnnia magna*. Both data provide high strength of evidence that degradation of the parent substance leads to the formation of 4-nonylphenol, branched.

The only available model prediction CATALOGIC v5.16 indicates the formation of the 4-nonylphenol, branched with 40% mol/mol parent. However, these results should be treated with caution, because no information on formed phenols is available from the substances in the training set of the model.

The growth boost observed in the algae test after exposure to tris(4-nonylphenyl branched) phosphite may indicate that P-O bond cleavage occurs on tris(4-nonylphenyl branched) phosphite, potentially leading to a release of phosphorus compounds and their alkylphenol group, as has been observed for substances belonging to the family of phosphotriesters.

Although it is not possible from the preliminary test and hydrolysis study to determine a rate of degradation and an accurate calculation of the extent of degradation of tris(4-nonylphenyl, branched) phosphite, the available information indicates that hydrolysis can occur from tris(4-nonylphenyl, branched) phosphite adsorbed to glass beads and C18 silica gel. In addition, it should be noted that, although small quantities of 4-nonylphenol, branched are estimated, these were constant over the analysis period. Moreover, 4-nonylphenol, branched is formed under conditions supporting an underestimation of 4-nonylphenol, branched release compared to an OECD TG 111 (lower time and volume contact than in a batch hydrolysis study according to OECD TG 111, calculation based on nominal quantity of tris(4-nonylphenyl, branched) phosphite despite expected loss of material during the preparation). In the environment, once released to surface water and distributed to sediment, degradation of tris(4-nonylphenyl, branched) phosphite may remain a long lasting source of 4-nonylphenol, branched.

5.7.5 Overall conclusion on endocrine disruption with regards to environment

As discussed above, based on the weight-of-evidence assessment of all available lines of evidence it is concluded that degradation of tris(4-nonylphenyl, branched) phosphite can occur under environmentally relevant conditions leading to the release of 4-nonylphenol, branched.

[12] https://echa.europa.eu/documents/10162/17169198/template_for_weight_of_evidence_en.docx/eb183c2e-c360- cbce-7a58-ad2d1270e5bd

4-nonylphenol, branched and linear is identified as a group of SVHC substances according to Article 57(f) of Regulation (EC) 1907/2006 (REACH) because of their endocrine disrupting properties for the environment.

Consequently, tris(4-nonylphenyl, branched) phosphite can be considered as endocrine disruptor for the environment.

Although the degradation pathways are unknown for tris(4-nonylphenyl, branched) phosphite due to the lack of data, hydrolysis of tris(4-nonylphenyl, branched) phosphite is anticipated to take place at the phosphite group, leading to the release of 4-nonylphenol, branched.

In this regard, the substances belonging to tris(4-nonylphenyl, branched and linear) phosphite group (TNPP), which differ only on the nature of the alkyl chain (branched or linear), the same hydrolysis pathway is expected. With respect to the possible influence of the alkyl chain of the nonylphenyl group on hydrolysis, linear alkyl chains are expected to have a lower steric hindrance compared to branched alkyl chains, and are not expected to limit access to hydrolysis sites for TNPP-linear. Consequently, the hydrolysis of substances of the tris(4-nonylphenyl, branched and linear) phosphite group (TNPP), irrespective of the nature of the alkyl chain structure, would lead to the release of 4-nonylpheno, branched and linear.

Additional arguments in relation to the SVHC identification relevant for all the substances belonging to the TNPP group, are also discussed below and in detail in sub-section 1.1 corresponding to the "Introduction and justification of group."

Therefore, tris(4-nonylphenyl, branched and linear) phosphite should be considered as endocrine disrupting substances for the environment.

6. Conclusions on the SVHC Properties

6.1 CMR assessment

Not relevant for the identification of the substance as SVHC in accordance with Article 57 (f) of REACH Regulation.

6.2 PBT and vPvB assessment

Not relevant for the identification of the substance as SVHC in accordance with Article 57 (f) of REACH Regulation.

6.3 Assessment under Article 57(f)

6.3.1 Summary of the data on the intrinsic/hazardous properties (providing scientific evidence of probable serious effects to the environment)

4-Nonylphenol, branched was identified as substance of very high concern and included in the Candidate List (Decision ED/169/2012 of 18 December 2012) due to the endocrine disrupting properties which cause probable serious effects to the environment.

Based on a weight-of-evidence assessment of all available relevant information, there is sufficient evidence that tris(4-nonylphenyl, branched) phosphite can be a source of 4-nonylphenol, branched in the environment through its degradation/transformation under environmentally relevant conditions. Thus, tris(4-nonylphenyl, branched) phosphite can be considered as an endocrine disruptor substance for the environment.

The hydrolysis of tris(4-nonylphenyl, branched) phosphite is anticipated to take place at phosphite group leading the release of 4-nonylphenol, branched. For the substances belonging to the TNPP group, which differ only regarding the nature of the alkyl chain (branched or linear), the same hydrolysis pathway is expected. With respect to the possible influence of the alkyl chain of the nonylphenyl group on hydrolysis, linear alkyl chains are expected to have a lower steric hindrance compared to branched alkyl chains and are not expected to limit access to hydrolysis sites for TNPP-linear. Consequently, for the substances of the TNPP group, the same hydrolysis pathway is expected, irrespective of the alkyl chain structure, leading to the release of 4-nonylphenol, branched and linear. Therefore, TNPP should be considered as endocrine disrupting substances for the environment.

Based on the above conclusion, TNPP is considered to be an SVHC under REACH article 57(f), independently of the initial presence of 4-nonylphenol, branched and linear in the composition of the substance. Additionally, the identification of the group is deemed appropriate because it will allow harmonisation with the existing entry, facilitating the practical applicability of the identification (e.g. verification of REACH obligations related to the presence of TNPP substances in articles).

6.3.2 Equivalent level of concern assessment

As described in section 5.7, tris(4-nonylphenyl, branched) phosphite can be a source of 4-nonylphenol, branched in the environment due to its degradation to 4-nonylphenol, branched. For the substances belonging to the TNPP group, which differ only regarding the nature of the alkyl chain (branched or linear), the release of 4-nonylphenol (branched or linear) is also expected.

4-nonylphenol, branched and linear, were identified as a group of substances with endocrine disrupting properties for which there is scientific evidence of probable serious effects to the environment which gives rise to an equivalent level of concern to those of other substances listed in points (a) to (e) of Article 57 REACH.

Uncertainties in quantifying exposures and deriving safe concentration limits

Because of the high hydrophobicity, low water solubility and high adsorption potential, tris(4-nonylpheny branched) phosphite, when released into surface water, is expected to distribute mainly in the sediment compartment. In this respect, the results of the preliminary test in the last hydrolysis study (unpublished study, 2021) provide an insight into the possible fate of the substance in the aquatic environment. Indeed, in this laboratory test, it was shown that under restricted conditions, constant amounts of 4-nonylphenol, branched are released from tris(4-nonylpheny branched) phosphite adsorbed to a solid carrier (glass beads and C18 sillica gel). In the environment, higher release of 4-nonylphenol, branched compared to the laboratory conditions can be expected from tris(4-nonylphenyl branched) phosphite adsorbed to sediment. This means that tris(4-nonylphenyl, branched) phosphite adsorbed to sediment can be a long lasting and unpredictable source of 4-nonylphenol, branched in the aquatic environment.

Release of 4-nonylphenol, branched and linear can lead to harmful effects on aquatic organisms and ecosystems. A large amount of information has confirmed that exposure to 4-nonylphenol, branched exerts adverse effects on endocrine processes and functions. The support document for the identification of 4-nonylphenol, branched and linear as SVHC[13], clearly states: "*effects observed after exposure to 4-nonylphenols are considered to impair population stability and recruitment. They may occur even after short term exposure and*

[13] https://echa.europa.eu/documents/10162/bc140e0b-b407-fd1c-f750-6d43c99f82a4

thus may result in impairments in regions other than those where exposure occurred. Effects persist even after exposure has ceased and may influence population level on a long term basis e.g. due to transgenerational effects and/or changes in the gene pool. Effects may influence a wide range of taxa and it is difficult to estimate a safe level of exposure to 4-nonylphenols"

Potential for continuous exposures

From the available data on degradation, it is not possible to estimate accurately the extent of release of 4-nonylphenol, branched and linear from TNPP or their contribution to the emissions in the environment. However, it can be expected that continuous exposure from precursors occurs and may contribute to the presence of 4-nonylphenol, branched and linear over time, which increases the concern for aquatic organisms.

Societal concern

Due to endocrine disruptor properties to the environment, 4-nonylphenol, branched and linear are on the REACH Candidate List and are already subject to specific restrictions on their marketing and use under REACH (Annex XVII). The substances are on the Annex X that lists priority substances (Decision 2455/2001/EC) under the Water Framework Directive 2000/60/EC (WFD). In spite of the efforts to reduce emissions of 4-nonylphenol, branched and linear in the environment by strict regulatory measures including use restrictions since 2003, the substances are still present in the aquatic environment. In the NORMAN Empodat database, some data on levels of 4-nonylphenol, branched are available for German river sediment samples (2017-2019, total measurements=101). Around 80% of the samples showed levels higher than the LOQ (50 µg/L) from 52 µg/kg d.w up to 270 µg/kg d.w). For freshwater samples, the levels of 4-nonylphenol, branched have been detected on the Elbe river up to 0.16 µg/L and 0.24 µg/L in 2019 and 2020 respectively. In France, higher levels have been detected in river samples up to 2 µg/L and 1.7 µg/L in 2019 and 2020 respectively. In addition, the French database on surface water quality (Naiades), reports further monitoring data on French freshwater and freshwater sediment samples: for the period 2021-2022 (total measurements=1136) in almost all the sediment samples, detected levels of 4-nonylphenol, branched were from LOQ (50 µg/kg d.w) up to 2496 µg/kg d.w. The data available for freshwater samples for the same period (total measurements=13203) shows that around 1.4% of the samples exhibit detectable levels of 4-nonylphenol, branched from LOQ (0.02-0.03 µg/L) up to 1.3 µg/L. Thus, efforts are still needed to reduce any emissions of 4-nonyphenol, branched to the environment.

In addition, the Water Framework Directive (2000/60/EC) stipulates that *"Member States shall implement the necessary measures in accordance with Article 16(1) and (8), with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances".* Based on the available information on tris(4-nonylphenyl, branched) phosphite, the substances from the TNPP group can be considered as precursors of 4-nonylphenol, branched and linear in the environment, leading subsequently to irreversible effects on aquatic organisms, which may contribute to population and biodiversity decline.

Consequently, TNPP represents a societal concern that requires immediate action to ensure a high level of protection to the environment. Regulatory action is in line with the goal of regulatory measures already undertaken for 4-nonyphenol, branched and linear and fits with the objectives of the Zero Pollution Ambition for a toxic-free environment.

6.3.2.3 Summary of the ELoC assessment

The equivalent level of concern is based on the fact that through its degradation/transformation under relevant environmental conditions, TNPP can be a source of 4-nonylphenol, branched and linear, which is an endocrine disrupting substance identified as SVHC. In spite of the efforts to reduce emissions of 4-nonylphenol, branched and linear in the environment since 2003, the substance is still present in the aquatic environment and release of 4-nonylphenol, branched and linear in the environment is of very high concern.

The following table lists the main elements used for assessing the level of concern resulting from hazard properties of TNPP.

Table 18: Overview of the relevant components of the ELoC assessment

	Conclusion
Type of effects	TNPP can be a source of 4-nonylphenol, branched and linear in the environment. 4-nonylphenol, branched and linear was identified as SVHC under article 57f in particular on the basis of its capacity to induce probable serious effects to the environment. These include possible delayed and irreversible effects, as well as inter-generational effects and have the potential to impair the environment at large.
Uncertainties in quantifying exposures with sufficient certainty	Not possible to determine accurately the extent of degradation to 4-nonylphenol, branched and linear. The available information indicates that degradation can occur from tris(4-nonylphenyl, branched) phosphite adsorbed on solid carriers, leading to release of 4-nonylphenol, branched. In the environment, once released to surface water and distributed to sediment, degradation of tris(4-nonylphenyl, branched) phosphite may remain a long lasting and unpredictable source of 4-nonylphenol, branched.
Uncertainties in deriving safe concentration limits	Not possible to derive a safe concentration limit from the degradation of tris(4-nonylphenyl, branched) phosphite to 4-nonylphenol, branched.
Potential to continuous increase of exposures	Monitoring data show that 4-nonylphenol, branched is still present in the aquatic environment. Substances belonging to the TNPP group may potentially contribute to the levels of 4-nonyphenol, branched and linear in surface water and sediments.
Societal concern	4-nonylphenol is included in Annex X of priority substances of the Water Framework Directive (2000/60/EC). The Water Framework Directive (2000/60/EC) stipulates that *"Member States shall implement the necessary measures in accordance with Article 16(1) and (8), with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances".* The available information shows that tris(4-nonylphenyl, branched) phosphite can be a precursor of 4-nonylphenol, branched in the environment, leading to irreversible effects on aquatic organisms, which may contribute to population and biodiversity decline. Consequently, tris(4-

	nonylphenyl, branched) phosphite represents a societal concern that requires immediate action to ensure a high level of protection to the environment.

6.3.3 Conclusion on the Article 57(f) assessment

The name tris(4-nonylphenyl, branched and linear) phosphite and acronym TNPP describe a group of substances, including any of the individual branched or linear isomers and/or combinations thereof, that are identified as substances of very high concern in accordance with Article 57(f) of Regulation (EC) 1907/2006 (REACH) due to their degradation into 4-nonylphenol, branched and linear. 4-nonylphenol, branched and linear have been identified as a group of SVHC substances according to Article 57(f) REACH because of their endocrine disrupting properties for the environment which give rise to an equivalent level of concern to those other substances listed in points (a) to (e) of Article 57 of REACH.

The conclusion is based on a weight of evidence approach of the most relevant information on tris(4-nonylphenyl, branched) phosphite.

The strongest evidence comes from a hydrolysis study that demonstrates that under environmentally relevant pH and temperature, tris(4-nonylphenyl, branched) phosphite can degrade into 4-nonylphenol, branched.

Indeed, in the preliminary test conducted with the intent to solubilise tris(4-nonylphenyl, branched) phosphite in the frame of the hydrolysis study, a constant release of 4-nonylphenol, branched in amounts higher than the impurity (4-nonylphenol, branched) present in the original composition of the substance was measured. In this preliminary test, tris(4-nonylphenyl, branched) phosphite was added to two kinds of solid carriers (glass beads or C18 silica gel), which were then included in elution column. The preliminary studies with significant releases of 4-nonylphenol, branched were performed at 50°C and pH 4 for both carriers. Additionally, similar releases were observed at pH 6 and 20°C for glass beads. The results demonstrate that the release of 4-nonylphenol, branched comes from the hydrolysis of tris(4-nonylphenyl, branched) phosphite adsorbed on solid carriers in the elution column. Elution samples were then used to carry out a hydrolysis test according to the OECD TG 111 under environmentally relevant pH and temperature. Nevertheless, no measurement of tris(4-nonylphenyl, branched) phosphite was achieved in the elution samples used for the hydrolysis test. There is then no indication that tris(4-nonylphenyl, branched) phosphite was present in the definitive hydrolysis test. However, the same rates of release of 4-nonylphenol, branched were observed in the preparation of the samples for the definitive hydrolysis test as in the preliminary tests. In the preliminary tests, these release rates were constant in each successive fraction over the analysis period. The preliminary tests were performed over a short time (<20h) supporting that a higher release is expected in a hydrolysis study performed according to the OECD TG 111 over 5 days. Moreover, the elution/contact time is higher in a OECD TG 111 which should have lead to higher release of 4-nonylphenol, branched. In addition, the proportion of released 4-nonylphenol, branched are calculated considering the nominal quantity of tris(4-nonylphenyl, branched) phosphite in the column, whereas adsorption on preparation material is expected, leading to lower amounts of tris(4-nonylphenyl, branched) phosphite in the elution column and then underestimation of the proportion of released 4-nonylphenol, branched. The study therefore provides evidence that hydrolysis of 4-nonylphenol, branched can occur from tris(4-nonylphenyl, branched) phosphite adsorbed to glass beads and C18 silica gel. Although small quantities of 4-nonylphenol, branched were measured, these were constant in each successive fraction over the analysis period in the preliminary study (elution from a column) and very likely to underestimate what would have been observed in a longer standard guideline study.

Furthermore, 4-nonylphenol, branched was measured in a toxicity study with *Daphnia magna* at levels that support that degradation of tris(4-nonylphenyl, branched) phosphite leading to the formation of 4-nonylphenol, branched occurs.

Based on a weight-of-evidence assessment of all available relevant information, there is sufficient evidence that tris(4-nonylphenyl, branched) phosphite can be a source of 4-nonylphenol, branched in the environment through its degradation/transformation under environmentally relevant conditions. Therefore, tris(4-nonylphenyl, branched) phosphite is considered as an endocrine disruptor for the environment.

This conclusion can be extended to the substances belonging to the TNPP group, which differ only by the nature of their alkyl chain, (branched and/or linear), because hydrolysis is anticipated to take place at the phosphite group irrespective of the linear or branched structure of the C9 alkyl chain. Indeed, linear alkyl chains are expected to have a lower steric hindrance compared to branched alkyl chains and are not expected to limit access to hydrolysis sites for TNPP-linear. Additionally, the identification of the group is deemed appropriate because it will allow harmonisation with the existing entry facilitating the practical applicability of the identification (e.g. verification of REACH obligations related to the presence of TNPP substances in articles).

Equivalent level of concern

The equivalent level of concern is based on the fact that TNPP can be a source of 4-nonylphenol, branched and linear in the environment. 4-nonylphenol, branched and linear were identified as SVHC under article 57f in particular on the basis of its potential to induce serious toxic effects. These effects include possible delayed and irreversible effects as well as inter-generational effects and have the potential to impair the environment at large.

Uncertainties in quantifying exposures and deriving safe concentration limits

Once released to surface water and distributed to sediment, degradation of TNPP may remain a long lasting and unpredictable source of 4-nonylphenol, branched and linear that may lead to subsequent irreversible effects on aquatic organisms and ecosystems due to its endocrine disruption properties.

From the available data on degradation, it is not possible to estimate accurately the extent of release of 4-nonylphenol, branched from tris(4-nonylphenyl, branched) phosphite or the contribution to the emissions in the environment. However, in general, it can be expected that continuous exposure from precursors occurs and may contribute to the presence of 4-nonylphenol, branched and linear over time, which increases the concern for aquatic organisms.

Societal concern

In spite of the efforts to reduce emissions of 4-nonylphenol, branched and linear in the environment, due to their endocrine disruptor properties to the environment, by strict regulatory measures including use restrictions since 2003, according to the available monitoring data 4-nonylphenol, branched is still present in the aquatic environment. The available information on tris(4-nonylphenyl, branched) phosphite shows that it can be a precursor of 4-nonylphenol, branched in the environment, that may subsequently lead to irreversible effects on aquatic organisms and contribute to wildlife population and biodiversity decline. Thus, efforts are still needed to reduce any emissions of 4-nonyphenol, branched and linear to the environment.

Consequently, TNPP represents a societal concern that requires immediate action to ensure a high level of protection of the environment. This regulatory action is in line with the goal of regulatory measures already undertaken for 4-nonyphenol, branched and linear and fits with the objectives of the Zero Pollution Ambition for a toxic-free environment.

<u>In conclusion</u>:

Overall, it is concluded that the tris(4-nonylphenyl, branched and linear) phosphite group, which includes any of the individual isomers and/or combinations thereof, meet the criteria of Article 57(f) of REACH, because, through their degradation, they are substances with endocrine disrupting properties for which there is scientific evidence of probable serious effects to the environment which give rise to an equivalent level of concern to those for other substances listed in paragraphs (a) to (e) of Article 57 of REACH Regulation.

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Annex I: Search of literature

Scope search of literature: Identify published scientific information related to the endocrine disruptor properties of tris(4-nonylphenyl, branched) phosphite.

Databases consulted: PubMed and Scopus

Search equation: (((tris nonylphenyl phosphite)) OR (TNPP)) OR (26523-78-4)) OR ((DOVERPHOS 4))

Total records identified=176

The following flow diagram summarises the screening process for the selection of articles compatible with the scope of the research.