European Commission

Preparatory study and impact support study on tyres

Draft report
Task 5: Substances of concern

Written by: Yifaat Baron (Öko-Institut Consult GmbH)

May 2026

Öko-Institut Consult GmbH
vito
Trinomics
ecomatters

EUROPEAN COMMISSION

Directorate-General for Environment
Directorate B — Circular Economy
Unit B4 — Sustainable Products

E-mail: ENV-B04-ARES@ec.europa.eu

European Commission
B-1049 Brussels

Preparatory Study and Impact Assessment support study on tyres

Draft Report of
Substances of Concern
(Phase II)
Version 1.0

Yifaat Baron (Öko-Institut Consult GmbH)

Directorate-General for Environment
<Name of the programme/activity>

2026

EUR <number> EN

Submitted by:

In collaboration with:

Manuscript completed in May 2026

Draft edition

Luxembourg: Publications Office of the European Union, 2025

Print ISBN <xxx-xx-xx-xxxxx-x> ISSN <xxxx-xxxx> doi:10.<xxxx/xx...x> <xx-xx-xx-xxx-xx-x>
PDF ISBN <xxx-xx-xx-xxxxx-x> ISSN <xxxx-xxxx> doi:10.<xxxx/xx...x> <xx-xx-xx-xxx-xx-x>
EPUB ISBN <xxx-xx-xx-xxxxx-x> ISSN <xxxx-xxxx> doi:10.<xxxx/xx...x> <xx-xx-xx-xxx-xx-x>

Directorate-General for Environment
<Name of the programme/activity>

2026 EUR <number> EN

Project Information

Title	Preparatory study and impact assessment support study on tyres
Framework Contract No	ENV.B.4/FRA/2023/0018 Lot 1
Specific Contract No	2025/4500082801/ENV.B4/GROW
Service Request No	8
Project Duration	30 months
Starting Date	01/03/2025
Framework Contract Manager	
Name	Tatiana Pasquel Garcia
Organisation	VITO
Address	Boeretang 200, 2400 Mol (Belgium)
E-Mail	tatiana.pasquelgarcia@vito.be
Telephone	+32 14 33 58 86
Technical Team Leader	
Name	Yifaat Baron & Daniel Hincheliffe
Organisation	Oeko-Institut Consult GmbH
Address	Merzhauser Str. 173, 79100 Freiburg (Germany)
E-Mail	Y.Baron@oeko.de; D.Hinchliffe@oeko.de
Telephone	Germany +49 761 45 295 266; +49 30 405085-343

Partners

Organisation	Country
VITO	Belgium
Oeko-Institut	Germany
Ecomatters	The Netherlands
Trinomics	The Netherlands

Deliverable information

Deliverable No	D3
Version of Deliverable*	1.0
Task	2: Preparatory Study (PS) Phase II
Sub-task	2.3: PS Tasks 1-7 Task 5: Substances of Concern
Main author(s)	Yifaat Baron (Öko-Institut Consult GmbH)
Recipient(s)	Lie Heymans (DG-ENV-B4) & Alexander Campenhausen (DG-GROW-I2)
Reviewers	Wai Chung Lam & Nele Kelchtermans (VITO)
Nature	DR – Draft Report
Dissemination Level	RE – Restricted to a group specified by the EC (including EC)
Contractual Delivery Date	M5 (08/2025) – Revised: M17 (05/2026)

*Version	Date	Description
(D3-T5-SoC) 0.1	17/02/2026	Template for input
(D3-T5-SoC) 0.2	10/04/2026	Input provided - Version for internal review
(D3-T5-SoC) 0.3	10/04/2026	Version with QA – 1
(D3-T5-SoC) 0.4	25/04/2026	Reviewed version
(D3-T5-SoC) 0.5	27/04/2026	Version sent to EC
(D3-T5-SoC) 0.6	08/05/2026	Version 0.6 with EC feedback
(D3-T5-SoC) 0.7	13/05/2026	Revised version for internal review
(D3-T5-SoC) 0.8	18/05/2026	Version 0.8 with QA2
(D3-T5-SoC) 1.0	18/05/2026	Version 1.0 sent to Stakeholders for SHM2
(D3-T5-SoC) **2.0**		Revised version after SHM2 (updated figures and stakeholder feedback incorporated)

Contents

Table of tables

List of Abbreviations and definitions

CLP	The Classification, Labelling and Packaging of chemicals (CLP) Regulation (EC No 1272/2008)
ECHA	European Chemicals Agency
ELT	End-of-Life Tyres
ELV	End-of-Life Vehicles
EoL	End of Life
ESPR	Regulation (EU) 2024/1781 of 13 June 2024 establishing a framework for the setting of Ecodesign for Sustainable Products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC
IDIS	Dismantling Information System
PBT	In substance classification - persistent, bioaccumulative and/or toxic
POP	Persistent Organic Pollutant
POPs	Regulation EU 2019/1021 on Persistent Organic Pollutants
REACH	The Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH) (EC No 1907/2006)
SCCP	Short chain chlorinated paraffins
SDS	Safety data sheet
SoC	Substances of Concern
SRM	Secondary raw material
SVHC	Substances of very high concern
vPvB	In substance classification - very persistent and/or very bioaccumulative
WFD	Directive 2008/98/EC or Waste Framework Directive

1. Introduction

This preparatory study describes the results of the ESPR preparatory study on tyres, part of the regulatory process under the Ecodesign for Sustainable Products Regulation (ESPR). The structure of this report adheres to the JRC methodology developed for Task B5 (Pérez-Camacho, et al., 2025) as part of the ongoing 2024-2026 revision of the MEErP (Caldas et al., 2022). The aims and objectives of the project and a general methodological overview are detailed in the draft report on Task 1-4 of this preparatory study. This annex comprises part of the reporting for MEErP **Task 5 – Environment & Economics (Substances of Concern)**.

2. Substances of Concern

2.1. Introduction of Task

2.1.1. Objectives of this Task

This part of the Professional Tyres preparatory study focuses on identifying 'Substances of Concern' (SoC). These substances identified in accordance with Article 2(27) (a–d) of the ESPR, namely any substance that:

a) Appears in the Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH) (EC No 1907/2006) Annex XIV (Substances of Very High Concern, SVHC) Candidate List.

b) Falls under one or more hazard classes in Annex VI of the Classification, Labelling and Packaging of chemicals (CLP) Regulation (EC No 1272/2008):

- (i) carcinogenicity categories 1 and 2; [interpreted to reflect hazardous statement H350 and H351, respectively]
- (ii) germ cell mutagenicity categories 1 and 2; [interpreted to reflect hazardous statement H340 and H341, respectively]
- (iii) reproductive toxicity categories 1 and 2; [interpreted to reflect hazardous statement H360 and H361, respectively]
- (iv) endocrine disruption for human health categories 1 and 2;
- (v) endocrine disruption for the environment categories 1 and 2;
- (vi) persistent, mobile and toxic or very persistent, very mobile properties;
- (vii) persistent, bioaccumulative and toxic or very persistent, very bioaccumulative properties;
- (viii) respiratory sensitisation category 1;
- (ix) skin sensitisation category 1; [interpreted to reflect hazardous statement H317]

- (x) hazardous to the aquatic environment — categories chronic 1 to 4; [interpreted to reflect hazardous statements H400, H410 or H413]
- (xi) hazardous to the ozone layer; [interpreted to reflect hazardous statement H420]
- (xii) specific target organ toxicity — repeated exposure categories 1 and 2; [interpreted to reflect hazardous statement H372 and H373, respectively]
- (xiii) specific target organ toxicity — single exposure categories 1 and 2.

c) Is regulated as a Persistent Organic Pollutant (EU 2019/1021).

d) Negatively affects the reuse or recycling of materials in the product.

When such substances are present, information requirements are by default imposed (Art. 7(5) of ESPR legislation) and can require reporting of substance identity, location, concentration, safe-use instructions, and end-of-life guidance. Exemptions on information requirements could be justifiable in case there is solid evidence for issues around technical feasibility or relevance of tracking substances of concern, the existence of analytical methods to detect and quantify them, and/or the need to protect confidential business information.

For substances meeting criterion (d), performance requirements, such as maximum concentration limits or bans, may also be needed to safeguard circularity. Such requirements may be justified if the use of a substance impacts on any of the product aspects listed in Article 5(1) of the ESPR:

a) durability;
b) reliability;
c) reusability;
d) upgradability;
e) repairability;
f) the possibility of maintenance and refurbishment;
g) the presence of substances of concern;
h) energy use and energy efficiency;
i) water use and water efficiency;
j) resource use and resource efficiency;
k) recycled content;
l) the possibility of remanufacturing;
m) recyclability;
n) the possibility of recovery of materials;
o) environmental impacts, including carbon and environmental footprint;
p) expected generation of waste.

A ban or restriction of use is only possible if alternatives are available on the market that would not affect the functionality of the product, the health and safety of individuals, the affordability of the product for users, the competitiveness of economic operators or result in disproportionate administrative burdens for manufacturers or force them to use a proprietary technology.

This report examines literature and stakeholder perspectives, and the information collected from these sources and assesses whether the available data are sufficient to define information and/or performance requirements beyond existing obligations.

2.1.2. Tyre components and characteristics

Tyres are composed of a diversity of substances with up to 200 different raw materials being included in the manufacture of a single tyre. The single raw materials are mixtures of several intentionally added substances and impurities, meaning that a tyre may contain thousands of substances. As compositions of raw materials may vary, even for a single model, depending on the place and time of manufacture, slight variations in the exact recipe may also occur, due to differences in raw material sources and suppliers. This makes the task of eliciting the list of substances contained in a tyre a particularly complex one.

The substances contained in a tyre vary depending on the tyre component or material. The mass of a tyre is distributed among several functional zones or components and each of these affects the composition of its material due to its performance requirements.

The tread representing ca. 35-40% of the tyre weight is the main source of environmental emissions through abrasion see detail under 2.1.3). (Oponeo.pl S.A., 2019) The tread is composed of rubber (40–60%), reinforcing/filler agents 20–45%, and chemical additives (5–15%).(Giechaskiel et al., o. J.)

The sidewall connects the tread to the bead and provides lateral stability, protecting the tyre from impacts, and displaying tyre information and markings. (Bharadwaj, 2024) It is composed of rubber and thus of similar constituents as the tread.

The rubber components of a tyre such as the tread and side belt wall are composed of a combination of natural and synthetic rubber mixed with various additives to ensure necessary performance characteristics. Some data is given by Giechaskiel et. al as to the various constituents of tyre rubber:

- Substances used to vulcanise rubber and obtain a more elastic material include sulphur and other chemicals such as thiazoles, sulphenamides, selenium, tellurium, organic peroxides, nitro compounds, and azo compounds.
- To activate the vulcanisation process, zinc oxide as well as calcium, lead, or magnesium oxides are added as catalysts
- Carbon black is added as a filler to increase tyre resistance and has been partially replaced by silica to improve tyre rolling resistance. The addition of mineral oils increases tyre flexibility and modifies hardness (Giechaskiel et al., o. J.).

Bead wires are the part of the tyre in contact with the vehicle wheel rim. The bead ensures a secure fit to the wheel, to stabilise and support vehicle weight. (Bharadwaj, 2024) Kadhem et al. refer to the bead as a composite material of rubber matrix and steel wires. The wires are explained to be coated with copper or bronze to maintain an optimum adhesion to bead rubber. The following elements are mentioned among the constituents of the bead wire: Carbon, manganese, silicone, sulfur, phosphorus, nickel, copper, bronze (Kadhem et al., 2017). The tyre beads are usually constructed of coils of monofilament steel wire, and are wound as a cable, or positioned in several layers. They are typically made by winding layers of extruded rubber sheet containing wires on top of each another. This is then often wrapped with a textile fabric to stabilise the structure (Nideröst & Walters, 2000).

Inner (butyl) liner - The innermost layer of the tyre creates a barrier to keep the tyre inflated and prevent leakage of air (Bharadwaj, 2024). The liner is composed of a polymer of low air permeability with chlorobutyl or bromobutyl rubber often used for this purpose (Nideröst & Walters, 2000).

The textile carcass is a layer located beneath the tread to reinforce the tyre and enhance its strength while increasing resistance against puncture and impacts. (Bharadwaj, 2024) Typical materials used for the textile carcass included rayon, nylon, polyester and polyethylene terephthalate (PET) (Continental, o. J., n.d).

Steel belts, as their name suggests, are layers of steel that are also located beneath the tread and that provide similar functions to that of the steel carcass. (Bharadwaj, 2024)

2.1.3. Use phase context of tyres

To contextualise this Task, the use phase of tyres is described.

During the use phase of a tyre, the tread which is in contact with the road is subjected to wear. The amount of wear or tyre abrasion depends on tyre composition and characteristics as well as on other parameters like driving style, vehicle type, road conditions, weather conditions, etc. This wear results in emissions of particulate matter and micro-plastics. A significant portion of tyre wear particles and microplastic emissions initially settles on the road surface and can be transported directly or indirectly into surface waters. Tyre composition can thus affect how flora and fauna residing in or approximate to surface waters are affected by such emissions. See also tasks 3 and 4 of this study (Baron et al., 2025).

According to Giechaskiel el al., “tyre wear is a major source of the unintentional release of primary microplastics into the environment”. Such particles and leachates can have various biological impacts on aquatic and terrestrial biota. However, the range of such impacts is not well understood. Tyre particles are generated either through abrasion of the tread and the road (tyre abrasion particle) or by volatilisation, which generates very small particles. The latter, which have nanoscale size, do not significantly contribute to the volume of emissions, but are highly relevant for human health. Estimations for the mass of tyre abrasion generated in the EU vary and refer to as little as 500 kt to 1327 kt in 2014. (Giechaskiel et al., o. J.)

Tyre wear particles can contain any of the substances and materials referred to in section 2.1.2 as well as various metals (Si, S, Zn, Ca, Al, and Fe), though the latter can also originate from road wear. In addition, tyre wear particles contain a large variety of organic chemicals, such as benzothiazoles, N-(1,3-dimethylbutyl)-N’-phenyl-1,4-phenylenediamine (6-PPD), 1,3-diphenylguanidine (DPG), and a wide variety of polycyclic aromatic hydrocarbons (PAHs). Various studies identified also substances like phenanthrene, pyrene, benzo(a)pyrene, benzo(g,h,i)perylene, and indeno-1,2,3(c,d)pyrene. “Zn can be toxic to living organisms, butadiene is considered carcinogenic to humans, benzothiazoles and derivatives are carcinogens and genotoxicants, and PAHs are toxic and carcinogenic. Recently, a transformation product of 6-PPD was linked to the acute mortality of coho salmon, and the same chemical was shown to shorten the lifespan and health span of Caenorhabditis elegans an in vitro study” (Giechaskiel et al., o. J.).

2.1.4. End-of-life context of tyres

To contextualise this Task, the end-of-life treatment of tyres is described.

Tyres are placed on the market either already incorporated into vehicles (termed OEM tyres as purchased by vehicle original equipment manufacturers) or for use as replacement tyres for worn out ones, which are installed in a vehicle after purchase. Similarly, end-of-life tyres can either be collected from vehicles, once the latter reaches its end of life and is subjected to waste management, or they are collected e.g., from garages or tyre repair operators when a worn tyre is replaced with a new one. In the waste management of vehicles, Directive 2000/53/EC on End-of-Life Vehicles (ELV) (EC No 2000/53 - ELV, 2000) requires that tyres are removed from vehicles and sent to separate treatment. Thus, the waste management of tyres covers both tyres collected from operators dealing with tyre replacement and tyres collected from EoL vehicle dismantlers. When a trye is collected in one of these routes, it is inspected to consider if it can be reused (more relevant when tyres are collected from ELVs) or retread. End-of-life tyres (ELT) are then either sent to reuse, retreading or to waste management.

In retreading, the remaining tread of a tyre will be buffed off to ensure a level surface and to prepare the surface for bonding with a new retread. Shavings removed in the buffing process are often collected and sent to a recycler. Though the composition of a tyre affects how it will be retreaded in terms of the choice of material for the new tread, stakeholders have not addressed problems with substances of concern in this respect.

As part of waste management and based on its characteristics (e.g., type, size, dimensions, composition) tyres can be subjected to a number of treatment routes including the following:

- Mechanical recycling;
- Chemical recycling (i.e. pyrolysis);
- Devulcanisation;
- Incineration in cement kilns;
- Other forms of recovery (e.g., civil engineering, public works and other forms of backfilling)
- Disposal or landfilling (generally prohibited in the EU)
- Export.

In the recycling of tyres (mechanical, chemical and devulcanisation), the first step is the shredding of the tyre. Various tyres that cannot be shredded will be excluded from this process once identified and sent to other routes. After shredding, the resulting material can be sent to various forms of recycling, affecting the outputs of the process and in particular their quality. Where sent to incineration in cement kilns, it is also currently the norm in the EU that the tyre shall first undergo shredding. Generally, steel, textile fibres (limited in use) and rubber (granulate, crumb, powder) are recycled and depending on the route, sometimes also carbon black is generated as well as pyrolysis oils and gas (see task 4 of this study (Baron et al., 2025) for further detail). The composition of the tyres is relevant at this stage as it influences the quality of the secondary materials that shall be generated from each recycling process as well as possible content of SVHCs. Having information on the composition of a tyre can thus help in the waste management, both allowing tyres with problematic substances to be sorted out as well as allowing operators to optimise batches of tyres that are destined to be treated together.

2.1.5. Reading guide

The report is structured in four parts to guide the reader through identifying and assessing the SoC in the tyre's product group. The first section covers the stakeholder consultation, which outlines how input from manufacturers, recyclers, and national representatives shaped the SoC inventory. Afterwards, the existing regulatory requirements are discussed. This section reviews REACH, CLP, Persistent Organic Pollutants (POP) Regulation and Waste Framework Directive (WFD), so that ESPR proposals align with, rather than duplicate, current reporting duties. Next, SoC in the product group presents the identified substances and highlights any recycling challenges based on that inventory. Finally, the section on information and performance requirements translates these findings into recommendations for the product group.

3. Stakeholder consultation

As a starting point for the SoC work, a stakeholder consultation was conducted to gather information. It aimed to support the creation of a SoC inventory and to identify specific requirements and potential exemptions for certain substances. The consultation was conducted from 2 June 2025 to 19 September 2025. A questionnaire originally developed by the JRC was modified to help identify both Intentionally Added Substances (IAS) and Non-Intentionally Added Substances (NIAS) and ask for other inputs. The consultation was made available to stakeholders registered on the platform used for previous consultations: https://ecodesign-tyres.eu/en/documents. The stakeholders engaged in this consultation include manufacturers, industry organisations for both manufacturing and recycling, as well as national representatives.

In addition to the SoC focused stakeholder consultation, some stakeholders provided comments related to SoC in other consultation exercises, including their comments to the first draft report for tasks 1-4 (Baron et al., 2025) and contributions to the stakeholder consultation held to collect information on task 6 design options which is still ongoing.

To collect additional data, some stakeholders were also consulted with directly through interviews related to the task 6 design options, through which data was also collected on SoCs.

3.1. Stakeholder perspectives and feedback

The consultation provided information on the substances present in the product group and stakeholders perspectives, specifically from industry representatives and manufacturers. These perspectives covered some shared points as highlighted in **Table 3-1**. It is noted that the points raised in the table below do not reflect views shared by all stakeholders but rather points raised by multiple stakeholders.

Table 3-1: Shared perspective across stakeholders.

Topic	Stakeholder feedback
Importance of SoC tracking	Information on substance content is important to ensure the quality of recycling outputs and their use, e.g., specification of TPO used for recycled plastic production. (1)
Tracking substances only in final product	Proposed to consider only substances which are intentionally added to (e.g., additives) and remain in the final tyre product. As many manufacturing processes for tyres are outside the EU and cannot be verified, this would contribute to a level playing field. (1,3,4)
Simplification of the definition of SoC	Substances falling solely under Article 2 (27) a), b) or c) are already addressed u nder chemical legislation. Such substances should be considered SoC under ESPR tyres legislation **only**, if they impede recycling and are thus covered also by Article 2 (27) d). (1,3) In addition, "substances hindering recycling" should be clearly defined. (1)
SoC threshold for tracking	A 0.1% threshold is proposed due to its alignment with existing European legislation reporting criteria, including the REACH Regulation and the Waste Framework Directive, which mandate similar limits for the notification and communication of SVHC. (4)
Periodical review of Article 2 (27) d) SoC	Whether a substance supports/ impedes/remains neutral to a recycling process depends on the recycling technology used, requirements for SRM (e.g., performance, durability), material innovation, and waste management. This can change over time, making it necessary to review substance identification as hindering recycling. (1)
Information requirements to align with other legislation	Information requirements for substances covered by Article 2(27) (a) - (c), should be aligned with existing requirements for SDS and SVHC in articles under REACH to limit burden of compliance. (1,3)
No chemical bans under ESPR	REACH should continue to serve as the only framework for regulating chemical safety in the EU, i.e., as far as bans or restrictions go. ESPR should focus regulating SoCs only where they impair sustainability aspects defined in ESPR Article 5. (2,3)

Note: Sources have been anonymised but are referenced to enable follow-up.

Beyond the shared perspectives there are other relevant aspects to highlight.

Though stakeholders generally agree that it is important to know what substances are contained in a tyre to support waste management, there are different views on the level of granularity needed in information on SoC content for this purpose. While industry parties propose various simplifications, other stakeholders view this with less tolerance. One stakeholder proposed to have no exemptions, explaining that the knowledge on how various substances affect health and the environment is still very limited. Whereas the stakeholder proposed setting thresholds for substances where the data on toxicity is comprehensive, for other substances the detection limit was proposed as the reporting threshold (5).

In respect of SoC, a few stakeholders have explained that in some cases the use of certain additives may introduce SoCs, nonetheless having a positive contribution to the sustainability of the tyre. In other cases, the use of a certain ingredient which is an SoC may directly affect the tyres sustainability (e.g., substances that are contained in tyre wear particulate matter). In other words, how a substance is to be reviewed needs to depend not just on their hazardous properties but also on the specific use case and supported functions of the substance within the tyre. This is particularly the case where a substance may contribute to important parameters

like durability of reduction of rolling resistance but may make recycling more challenging. It was thus recommended in the context of SoCs that ESPR measures addressing one sustainability aspect should not compromise the achievement of other ESPR sustainability targets or that a concept for trade-offs under ESPR be developed. (1,2,3)

It is noted that some of the aspects raised above concern definitions or the general approach towards SoC applied under ESPR. It is beyond the consultant's mandate to make adaptations that would not be in line with the legal text of ESPR.

4. Existing regulatory requirements on provision of SoC information

In the consultation, stakeholders noted that several existing laws already require information sharing on SoC for waste treatment. This section therefore examines legislative requirements beyond the ESPR, highlighting obligations that apply to this product group and identifying any existing thresholds for communicating SoC information (if present).

4.1. REACH regulation

Under Art. 33(1) of the REACH regulation (EC No 2006/1907 - REACH, 2006), any supplier of an article containing a Candidate List SVHC at a concentration above 0.1% w/w must provide, at or before the time of supply, sufficient information (at minimum the substance's name) to allow safe use of the article by their professional recipients. Furthermore, upon request by a consumer, the supplier must supply the same information free of charge within 45 days of that request. This information requirement applies to SoC that fall under ESPR Art. 2(27)(a).

Continuing from the requirements discussed above, Art. 31 also obliges any supplier of a substance or mixture to provide a safety data sheet (SDS) free of charge whenever it is classified as hazardous according to the CLP Regulation, is persistent, bioaccumulative or toxic (PBT/vPvB), appears on the Candidate List of SVHCs, or falls under EU workplace exposure limits. The supplier must supply an SDS upon the recipient's request if a non-classified mixture contains hazardous substances above certain thresholds—1% w/w for non-gaseous substances or 0.2% v/v for gases (general hazards), and 0.1% w/w for PBT/vPvB or Candidate List substances.

Substances that are listed in Annex XIV of the REACH Regulation may not be placed on the EU market for use or be used in an article unless an authorisation is listed in the annex for the particular use in questions.

Substances that are listed in Annex XVII of the REACH Regulation are subject to restrictions and may only be used in compliance with the listed restrictions.

4.2. CLP Regulation

According to the CLP Regulation (EC No 1272/2008 - CLP, 2008), before being placed on the EU market, any substance or mixture classified as hazardous must bear a label showing at minimum the product identifier; supplier name, address and phone number; hazard pictograms; a signal word; hazard statements; precautionary statements; and (where applicable) supplemental information (Art. 17–25). Labels must be applied and positioned in accordance with the general rules in Art. 31 and 32 of the CLP Regulation, and specific rules for outer, inner and single packaging in Art. 33. Moreover, suppliers are required to assemble and keep available all the information used for classification and labelling for at least ten years after the substance or mixture was last supplied, and to provide it on request (Art. 49).

4.3. POPs regulations

For Persistent Organic Pollutants (POPs) placed on the EU market as articles, POPs regulation (EU No 2019/1021 - POPs, 2019) sets specific concentration limits in Annex I (as amended by Delegated regulation (EU 2020/784). Concentration thresholds are substance specific and articles containing POPs at or above that concentration may not be placed on the EU market and must be reported or managed in accordance with the regulation unless they are derogated. A cumulative limit on the concentration (amount of mg/kg) in mixtures or articles is set or a specific limit on their presence in substances. This type of restrictions is associated with SoC's that fall under ESPR Art. 2(27)(c).

The POPs Regulation does not place general obligations on suppliers of articles on sharing information to downstream parties, however for several of the POPs listed in Annex I, a labelling requirement applies to products that contain the substance in question.

Article 7 of the POPs Regulation addresses waste management and requires producers and holders of waste to avoid contamination of other fractions with substances listed in Annex IV of the regulation. It also requires the waste management of wastes consisting of or containing the substances listed in the same annex "to ensure that the POP content is destroyed or irreversibly transformed so that the remaining waste and releases do not exhibit the characteristics of POPs". Seeing as once a substance is added to the POPs Regulation Annex I it shall not be used in products placed on the market, unless exemptions exist, suggests that the requirements on waste management are mainly retroactive. Though for most products information on the contents of substances they contain may be partial or missing, for tyres the consultants understand that manufacturers will usually have a documentation of the recipes in each tyre, supporting the retroactive provision of information should a substance used in a tyre be listed in Annex IV of the POPs Regulation.

4.4. Waste Framework Directive

The SCIP (Substances of Concern In articles as such or in complex objects (Products)) database, was established by ECHA under Art. 9(2) of the Waste Framework Directive (EC No 2008/98

WFD, 2008). It serves to collect and disseminate detailed information on Candidate List SVHCs present in articles and complex products throughout their entire lifecycle to drive substitution of hazardous substances, prevent the generation of contaminated waste and enhance transparency for waste operators.

Establishing the SCIP database was intended for transferring Art. 33(1) REACH information, that would otherwise not reach waste treatment operators. It is however noted in an evaluation of SCIP for ECHA (PWC, 2022) that: "While the reliability and quality of the information is not in question, its accessibility and practical use cases for waste operators and consumers remain limited for the moment, according to the consulted stakeholder organisations. Equally, some Companies are uncertain about the usefulness of the information they provide to SCIP for other stakeholders".

4.5. ELV Directive

The ELV Directive (EC No 2000/53 - ELV, 2000) regulates the waste management of end-of-life vehicles once they have reached the end of their lifetime. Among others, in its Article 4(2) it prohibits the use of the hazardous substance's cadmium, hexavalent chromium, lead and mercury in vehicles above a threshold of 0.1% by weight in the homogeneous material (or 0.01% in the case of cadmium) to protect the environment, including ensuring the environmentally sound recovery and disposal of ELVs. The Directive and consequently the prohibitions aim at preventing the disposal of waste and supporting a more environmental waste management of vehicles. As such the specified substances can be understood to be in the scope of ESPR SoC Article 27(2)(d). In support of these objectives Art. 4(2)(b) of the directive requires the Commission to review and, if necessary, amend the list of specific materials and components of vehicles benefitting from exemptions from the substance prohibitions. When evaluating the use of substances in specific components of materials, the Commission must consider whether their use in vehicles is avoidable or not. Exemptions to the substance prohibitions are detailed in Annex II of the Directive which is reviewed from time to time. Though the annex refers to a few exemptions for using lead in "vulcanising agents and stabilisers" (exemption 7(a) and 7(b)) and in "bonding agents for elastomers" (exemption 7(c)) neither of these is still valid for newly type approved vehicles nor are tyre applications referred to in their scope. At the time of writing (February 2026) no further exemptions are listed in the Annex of relevance for tyres. With this in mind, the consultants conclude that neither of the ELV prohibited substances is used in tyres in a concentration above the ELV substance thresholds as this would require an exemption to be listed and still valid.

Article 9 of the ELV Directive specifies that Member States shall require relevant economic operators to publish information among others on "the design of vehicles and their components with a view to their recoverability and recyclability". From the consultant's knowledge, some information is made available in this respect through the International Dismantling Information System (IDIS) Platform, which is accessible to vehicle dismantlers, however such information mainly covers prohibited substances in components that are to be depolluted during the waste management of vehicles. For example, for vehicles included in the data base, the location of mercury-based lamps and of batteries (some containing lead) is specified. Though tyres are specified as a separate component in the platform, data on tyre composition is not detailed

beyond the general composition of rubber. In addition, as the IDIS data base specifies the location of batteries in the vehicle, in cases in which a tyre pressure management system (TPMS) has been included by the vehicle producer, the system specifies the content of a TPMS battery (usually one per wheel), referring to lithium and other materials in terms of battery composition. (*IDIS*, 2026)

4.6. Summary of existing regulatory framework

The following existing information requirements are present in legislation:

- REACH requires suppliers to disclose any Candidate List SVHCs (Annex XIV) above 0.1% w/w and provide Safety Data Sheets for hazardous or PBT/vPvB substances;
- CLP requires clear hazard labelling and record-keeping for classification data;
- POPs above specific limits are banned, though POP rules don't mandate downstream information sharing in general. Nonetheless, several substances a labelling requirement applies for products containing the substance. In addition, the waste management of substances listed in Annex IV of the Regulation or products in which they are contained must "ensure that the POP content is destroyed or irreversibly transformed so that the remaining waste and releases do not exhibit the characteristics of POPs". To be able to comply with these requirements, it stands to reason that information on the content of such POPs would be available as a minimum to waste management operators of relevant products;
- The Waste Framework Directive's SCIP database collects SVHC data to aid waste operators;
- ELV prohibits certain hazardous substances in vehicles, with periodic reviews to safeguard the environment and facilitate the environmentally sound waste management of vehicles. In addition, the Directive includes requirements on the removal of certain components (e.g., tyres and batteries) and depollution of various materials and substances. To this end, vehicle producers need to provide waste management operators with data that support depollution and removal and have developed the IDIS platform which gives some data on the original tyres included in a vehicle, and where relevant in the inclusion of a TPMS battery (i.e., usually in the tyre's proximity).

5. Substance of Concern in the product group

This section will dive into the substances identified to be present in the product group to facilitate further evaluation of the need for SoC information or performance requirements.

5.1. Substances of Concern inventory

The inventory of Substances of Concern (**Table 5-1**) is developed using stakeholder input and literature for tyres. IAS and NIAS substances are included, based on data available from these sources.

Based on the methodology (Pérez-Camacho, et al., 2025) for each component (e.g., tread, sidewall, belt), any added substances should be listed separately. However, most of the data made available by stakeholders or available in the literature does not refer to a specific component, though these have been completed based on supplemental information as afar as possible. This may also have to do with the fact that most specified substances are used in the production of rubber material and components and would be used in multiple components in different amounts. Thus, in the following inventory the reference to components for most substances is simplified. Where data has been found, more detail is provided.

Though the SoC methodology prescribes the definition of a base-case product (e.g. a tyre) for which the inventory should be developed, in the case of tyres, this approach has not been implemented for several reasons. To begin with, finding detailed information on the substance content of a single tyre model is not straightforward due to the proprietary nature of tyre recipes. Furthermore, limiting this exercise to a single tyre model (an actual model or a theoretical model representing the average tyre on the market) would most probably result in omitting multiple substances that may be contained in other tyres though not necessarily in the average tyre. Exchanges with stakeholders representing the tyre waste management sector suggest that it is more important to have data on the SoC that could be potentially contained in each tyre rather than to have data that represents the average composition. This should support the development of information requirements with the prospect of future (automated) sorting in mind. The latter is to help on the one hand with the removal of tyres with problematic substances and on the other hand shall support optimised tyre batching for each recycling route to provide more consistency in the recipes of recycling outputs. This exercise has thus been focused on identifying SoCs that may potentially be contained in a tyre to ensure a comprehensive reporting in the future.

Specified substances are listed with their CAS numbers. Substances that meet the ESPR Art. 2(27) criteria are flagged to serve as the basis for identifying what substances could be considered for information requirements and performance requirements in the next sections.

Where possible, the likely function of each substance within its component is inferred from stakeholder or literature descriptions. It also indicates the life cycle stage at which each substance is used or appears

Stakeholder-supplied concentration ranges strongly suggest that this information was obtained via REACH Art. 33(1) disclosure, since several substances exceed the 0.1% w/w trigger threshold. Under REACH Art. 33(1), suppliers must inform downstream parties if an article contains any substance of very high concern (Article 57) identified under Article 59(1) at concentrations above 0.1% w/w; at minimum, providing the substance name to ensure safe use.

Substances related to emissions during use are based on data available about microplastic emissions occurring from tyre abrasion which are understood to be the main source of tyre emissions during the use phase.

Substances contained (intentionally or not) in tyre treads applied to casings in the process of retreading are not specifically indicated, given that the same materials are used as those applied for manufacturing the original tread of a tyre.

Beyond the manufacture and use phase, end-of-life (EoL) phase is represented through reference to substances present in recycling outputs. Such data may coincide with SoC referred to for the manufacturing and use phase seeing as contained substances at this stage are generally a result of substances used in the use phase.

The list of substances specified in **Table 5-1** only contains substances for which information was available and is considered non-exhaustive.

Questions or stakeholders

1. Please specify additional substances of relevance to the substance inventory for tyres that are not yet specified.
2. Please check the substances listed in **Table 5-1** and contribute information to complete missing information or comment where information is incorrect or unprecise.

444 **Table 5-1: Substances of Concern Inventory.**

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Intentionally added substances (IAS)									
Self sealing tyres	unknown	Sealing material	Unidentified	Unidentified			Waste treatment process disturbing	Manufacturing	d
Noise cancelation tyres	polyurethane foams	Noise reduction material	polyurethane	9009-54-5			Recycling quality disturbing	Manufacturing	d
Noise cancelation tyres	Adhesives used with polyurethane foams	Adhesive	Unidentified	Unidentified				Manufacturing	d
Rubber components: e.g., tread, sidewall	Tyre tread	Basic material: natural rubber	Polyisoprene $[C_5H_8]_n$)	9006-04-6	15-25% w/w%			Manufacturing	
Rubber components: e.g., tread, sidewall	Tyre tread	Basic material: synthetic rubber	Styrene butadiene	9003-55-8	25-45% w/w%			Manufacturing	
Rubber components: e.g., tread, sidewall	Tyre tread	Main constituent in synthetic rubber	Butadiene (1,3 - Butadiene)	106-99-0				Manufacturing	

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Tyre tread	Constituent of rubber compounds	Polybutadiene	9003-17-2	10-15% w/w%			Manufacturing	
Inner liner	Inner liner rubber	Maintaining the low gas permeability	Chlorobutyl Rubber	68081-82-3	3-5% w/w%		Can cause extensive damage via corrosion during the pyrolysis process and during the use of TPO as a feedstock for material re-use; Affects the quality of TPO and ist use as a feedstock for material re-use.	Manufacturing	d
Inner liner	Inner liner rubber	Maintaining the low gas permeability	Bromobutyl Rubber	68441-14-5	3-5% w/w%		Can cause extensive damage via corrosion during the pyrolysis process and during the use of TPO as a feedstock for material re-use; Affects the quality of TPO and ist use as a feedstock for material re-use.	Manufacturing	
Rubber components: e.g., tread, sidewall	Rubber components	Co-polymeriser in manufacture of synthetic rubber	Styrene	100-42-5				Manufacturing	b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Rubber components	Co-polymeriser in manufacture of synthetic rubber	Acrylonitrile	107-13-1				Manufacturing	b
Rubber components: e.g., tread, sidewall	Rubber components	Extender oil	Polycyclic-aromatic hydrocarbons (PAH)	218-01-0 207-08-9	11-21 mg/kg	21 mg/kg	PAH has been restricted in extender oils since 2010 through the REACH regulation, Annex XVII, entry 50. However, tyres produced before 2010 may still contain higher levels of PAH, hence limiting the reusability as new tyres or articles to the general public.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Styrene Butadiene Rubber Components	Plasticiser - phthalate	Dibutyl phthalate (DBP)	84-74-2			Multi-toxin: carcinogen, teratogen. Harmful to aquatic organisms.	Manufacturing	a
Rubber components: e.g., tread, sidewall	Styrene Butadiene Rubber Components	Plasticiser - phthalate	Diisobutyl phthalate	84-69-5	> 0.1% w/w and ≤ 100% w/w			Manufacturing	a,b
Rubber components: e.g., tread, sidewall	Styrene-butadiene rubber	Plasticiser - phthalate	Benzyl butyl phthalate (BBP)	85-68-7	> 0.1% w/w and ≤ 100% w/w			Manufacturing	a,b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Styrene-butadiene rubber	Plasticiser - phthalate	Bis (2-ethylhexyl)phthalate (DEHP)	117-81-7	> 0.1% w/w and ≤ 100% w/w			Manufacturing	a,b
Rubber components: e.g., tread, sidewall	Styrene Butadiene Rubber Components	Plasticisers	Short chain chlorinated paraffins (SCCP)	85535-84-8	> 0.1% w/w and ≤ 100% w/w		Persistent, toxic and bioaccumulative; Recycling quality disturbing	Manufacturing	a,c,d
	Component	Multiple = Constituents of many additives, and steel alloy	Collective inorganic substances (magnesium, silicon, copper, calcium, lead, zinc, iron, and other heavy metals).	N/A	0-20%	Forms up to 20% by weight in carbon black produced by tyre pyrolysis	Recycling quality disturbing; The large quantity of Inorganic substances in tyres pass through the pyrolysis process and accumulate in the resulting carbon black making the re-use of carbon black unsuitable. Recycled carbon black has up to 20% ash, whereas for making tyres carbon black needs below 0.5% ash. This then requires extra processing and extra resources and energy to upgrade, if it is even possible.	Manufacturing	d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Component	Multiple. In many types of additive…see next lines..., blowing agent, from brass - steel alloy.	Zinc	7440-66-6	About 2 to 5 wt%	5 wt%	Zinc partitions into various hazardous forms and products during thermal treatment (incineration, cement kiln combustion, and pyrolysis), creating hazardous materials and emissions. During pyrolysis, zinc partitions into oil and char, thereby impairing the use of pyrolysis tyre-derived recyclate; Zinc leaches out into the environment from recycled tyre products such as playground mats and artificial turf	Manufacturing	d
Rubber components: e.g., tread, sidewall	Final product	Accelerator for the vulcanisation process; cross linking accelerator; filler, activator of rubber compounds	Zinc oxide (zinc)	1314-13-2	1.5%-1.7%	1.70%	Same as for zinc	Manufacturing	b,d
Rubber components: e.g., tread, sidewall	Component	Vulcanizing retarder	Zinc laurate	2452-01-9			Same as for zinc	Manufacturing	b,d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Component	Vulcanizing retarder	Zinc stearate	557-05-1			Same as for zinc	Manufacturing	d
Rubber components: e.g., tread, sidewall	Component	Anti-degradant	2-mercaptobenzimidazole	583-39			Same as for zinc	Manufacturing	d
Rubber components: e.g., tread, sidewall	Component	Filler, pigments, plasticiser	Zinc borate	1332-07-6 |			Same as for zinc	Manufacturing	d
Rubber components: e.g., tread, sidewall	Component	Processing agent - peptiser	Zinc salt of pentachlorothiophenol	117-97-5			Same as for zinc	Manufacturing	d
Rubber components: e.g., tread, sidewall	Component	Dispersing agent	Zinc soap	557-05-1			Same as for zinc	Manufacturing	d
Rubber components: e.g., tread, sidewall	Pneumatic tyres, of rubber	Impurity of zinc oxide.	Cadmium oxide	1306-19-0			Recycling quality disturbing;	Manufacturing	a,b,d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	pneumatic tyres, of rubber, valve cap, brass bar in quick couplings, tyre filer, TYRE INFLATION HOSE	Possibly as PbCO3 or PbO for cross-linking, and an attendant substance of zinc oxide.	Lead	7439-92-1			Recycling quality disturbing; The large quantity of Inorganic substances in tyres pass through the pyrolysis process and accumulate in the resultant carbon black making the re-use of carbon black unsuitable. Recycled carbon black has up to 20% ash, whereas for making tyres carbon black needs 0.1% to 0.2% ash.This then requires extra processing and extra resources and energy to upgrade, if it is even possible.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	pneumatic tyres, of rubber, valve cap, brass bar in quick couplings, tyre filer, TYRE INFLATION HOSE	Cross linking agent /impurity in ZnO	Lead oxide (PbO)	68411-78-9			Same as for lead	Manufacturing	d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	pneumatic tyres, of rubber, valve cap, brass bar in quick couplings, tyre filer, TYRE INFLATION HOSE	Cross linking agent /impurity in ZnO	Lead carbonate (PbCO3)	598-63-0			Same as for lead	Manufacturing	d
Rubber components: e.g., tread, sidewall	Material	Vulcanisation accelerator and activator, cross-linking agent, filler	Magnesium	7439-95-4			Recycling quality disturbing; Same as for lead	Manufacturing	d
Rubber components: e.g., tread, sidewall	Material	Vulcanisation activator, filler	Calcium	7440-70-2			Recycling quality disturbing; Same as for lead	Manufacturing	d
Rubber components: e.g., tread, sidewall	Material	Filler	Silicon	7440-21-3			Recycling quality disturbing; Same as for lead	Manufacturing	d
Rubber components: e.g., tread, sidewall		Activator	Stearic acid	57-11-4		1.20%		Manufacturing	

Rubber components: e.g., tread, sidewall	Component	Plasticiser	Mineral oil: Various subgroups characterised by various percentages of paraffinic, naphthenic and aromatic carbon atoms. Aromatic oils predominate in tyres.	68937-63-3	5% to 50%	50%	Contains polycyclic aromatic hydrocarbons which are restricted under REACH. PAHs are known to be present in, and leach out of, recycled tyre material such as playground mats and artificial turf; Recycling quality disturbing; When tyres are subjected to end-of-life pyrolysis, the hydrocarbons in mineral oil, along with hydrocarbons in the elastomer itself, form more heavy and toxic PAHs. The toxicity of these substances and the high content of PAHs in pyrolysis oil (of tyres) makes the oil unfit for use without extensive upgrading (necessitating further energy- and resource-intensive purification stages), also making the oil a hazardous substance. Due to the high concentrations of nitrogen and sulphur in tyres, this creates N-PAHs and S-PAHs, which are some of the most toxic forms. The PAHs also transfer into	Manufacturing	d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
							recycled carbon black which is one reason why recycled carbon black from pyrolysis of tyres cannot be used.		
Rubber components: e.g., tread, sidewall	Component	Cross-linking agent	Sulphur / sulfur	7704-34-9	1%- 2.5%	2.50%	Recycling quality disturbing; Results in SOx emissions when tyres are burned in cement kilns and where tyres form a component of solid recovered fuel in incineration. When tyres are pyrolysed, the high sulphur content of the oil and the char makes these products unfit for use, necessitating further energy- and resource-intensive purification stages.	Manufacturing	d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Unknown	Cross-linking agent, chlorinated paraffin plasticiser, anti-degradant.	Chlorine	7782-50-5			Waste treatement process disturbing; Transfers into products such as pyrolysis oils and pyrolysis process wastewater. Also results in the formation of chlorinated dioxins, furans and other POPs, along with the formation of corrosive, water-soluble compound HCl during all thermal treatment.	Manufacturing manufacturing	d
Rubber components: e.g., tread, sidewall	Rubber components	Vulcanising agents in rubber products	Nitrites	14797-65-0				Manufacturing	
Rubber components: e.g., tread, sidewall	Rubber components	Vulcanisation accelerator	N,N-dicyclohexylbenzothiazole-2-sulphenamide (DCBS)	4979-32-2			Toxic and harmful to aquatic organisms.	Manufacturing	
Rubber components: e.g., tread, sidewall	Rubber components	Vulcanising agent	2-Mercaptobenzothiazole (MBT)	149-30-4			Toxic and harmful to aquatic organisms.	Manufacturing	b
Rubber components: e.g., tread, sidewall	Rubber components	Vulcanisation accelerator for rubber	Thioperoxydicarbonic diamide ([(H2N)C(S)]2S2), tetramethyl-	137-26-8				Manufacturing	b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Component - sidewall and tread	Anti-ozonant and anti-oxidant	N-(1,3-dimethylbutyl)-N'-phenyl-1,4-benzenediamine (6PPD)	793-24-8			Harmful to aquatic organisms.	Manufacturing	
Rubber components: e.g., tread, sidewall	Component - sidewal	Anti-ozonant	N-isopropyl-N'-phenyl-1,4-phenylenediamine (IPPD)	*101-72-4*			Harmful to aquatic organisms.	Manufacturing	b
Rubber components: e.g., tread, sidewall	Component - sidewal	Anti-ozonant	N,N'-diphenyl-p-phenylenedi-amine (DPPD)	74-31-7			Harmful to aquatic organisms.	Manufacturing	b
Rubber components: e.g., tread, sidewall	Component - sidewal	Anti-ozonant	N-(1,4-dimethylpentyl)-N'-phenylbenzene-1,4-diamine (7PPD)	3081-01-4			Harmful to aquatic organisms.	Manufacturing	
Rubber components: e.g., tread, sidewall	Component - sidewal	Anti-ozonant	1,4-benzenediamine, N,N'-mixed Ph and tolyl derivs. (BENPAT)	68953-84-4			Skin irritant. Reproductive toxicity. Harmful to aquatic organisms.	Manufacturing	b
Rubber components: e.g., tread, sidewall	Component - sidewal	Anti-ozonant	N,N'-di-sec-butyl-p-phenylenediamine (44PD)	101-96-2			Harmful to aquatic organisms.	Manufacturing	
Rubber components: e.g., tread, sidewall	Component	Anti-degradant	1H-Benzotriazole (BTA)	95-14-7			Harmful to aquatic organisms.	Manufacturing	b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Component	Flame retardant and plasticiser	Triphenylphosphate (TPP)	115-86-6				Manufacturing	a
Rubber components: e.g., tread, sidewall	Material	High Performance Tackifier for the Rubber Industry	Koresin®	28514-92-3				Manufacturing	
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[a]pyrene (BaP) Polycyclic-aromatic hydrocarbons (PAH)	50-32-8			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[e]pyrene (BeP) Polycyclic-aromatic hydrocarbons (PAH)	192-97-2	11-21 mg/kg	21 mg/kg	Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[a]anthracene (BaA) Polycyclic-aromatic hydrocarbons (PAH)	56-55-3			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Material	Extender oils	Chrysen (CHR)	218-01-9			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[b]fluoranthene (BbFA) Polycyclic-aromatic hydrocarbons (PAH)	205-99-2			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[j]fluoranthene (BjFA)	205-82-3			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	b,d
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[k]fluoranthene (BkFA) Polycyclic-aromatic hydrocarbons (PAH)	207-08-9			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Material	Extender oils	Dibenzo[a,h]anthracene (DBAhA) Polycyclic-aromatic hydrocarbons (PAH)	53-70-3			Some PAHs might also be NIAS and are contained in used soot or are produced in the vulcanisation process of the tire.	Manufacturing	a,b,d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Component - sidewall and tread	Antioxidant; Antiozonant	N-1,3-dimethylbutyl-N'-phenyl-p-phenylenediamine (6PPD)	793-24-8	0.4-2%	2%	Should the amount of 6-PPD and it 's conversion product 6-PPDQ be too high, there may be concerns of the environmental impact of products produced with recycled rubber	Manufacturing	b,d
Rubber components: e.g., tread, sidewall	Component - sidewall	Antioxidant	1,4-Benzenediamine, N,N'-mixed phenyl and tolyl derivatives (BENPAT)	68953-84-4			The harmonised classification of the substance might hinder recycling	Manufacturing	b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Dibenzo[a,h]pyren (Dibenzo[b,def]chrysene)	189-64-0			The harmonised classification of the substance might hinder recycling	Manufacturing	b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Dibenzo[a,i]pyren (Benzo(r,s,t)pentaphene)	189-55-9			The harmonised classification of the substance might hinder recycling	Manufacturing	b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Dibenzo[a,l]pyren (Dibenzo[def,p]chrysene)	191-30-0			The harmonised classification of the substance might hinder recycling	Manufacturing	b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Naphthalene	91-20-3			The harmonised classification of the substance might hinder recycling	Manufacturing	b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Material	Extender oils	Anthracene	120-12-7			The substance is on the candidate list due to its PBT properties and restricted according to Annex XVII entry 50a REACH. This might have a negative impact on recycling.	Manufacturing	a,b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Benzo[g,h,i]perylene	191-24-2			The substance is on the candidate list due to its PBT and vPvB properties and restricted according to Annex XVII entry 50a REACH. This might have a negative impact on recycling.	Manufacturing	a,b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Fluoranthene	206-44-0			The substance is on the candidate list due to its PBT and vPvB properties and restricted according to Annex XVII entry 50a REACH. This might have a negative impact on recycling.	Manufacturing	a,b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Material	Extender oils	Phenanthrene	85-01-8			The substance is on the candidate list due to its vPvB properties and restricted according to Annex XVII entry 50a REACH. This might have a negative impact on recycling.	Manufacturing	a,b
Rubber components: e.g., tread, sidewall	Material	Extender oils	Pyrene	129-00-0			The substance is on the candidate list due to its PBT and vPvB properties and restricted according to Annex XVII entry 50a REACH. This might have a negative impact on recycling.	Manufacturing	a,b
Tyre tread - additives	Rubber compounds	Preservatives	Halogenated cyanoalkanes					Manufacturing	
Tyre tread - additives	Rubber compounds	Anti-oxidants	Amines, phenols					Manufacturing	
Tyre tread - additives	Rubber compounds	Desiccants	Calcium oxides	1305-78-8				Manufacturing	
Tyre tread - additives	Rubber compounds	Plasticisers	Aromatic and aliphatic esters					Manufacturing	
Tyre tread - additives	Rubber compounds	Processing aids	Mineral oils, peptisers					Manufacturing	

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Tyre tread	Rubber compounds	Filler	Silicon dioxide (silica)	7631-86-9 (amorphous)	10%-15%	15%	Silica is currently under evaluation for a possible classification (STOT RE 1 or STOT RE2). If RAC confirms silica's classification, recycled rubber (granulates/powders) is at risk to be classified STOT RE 1 or STOT RE2, depending on silica's classification and its concentration in rubber. If classified, most outlet markets for rubber will be at risk of being lost	Manufacturing	d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Tyre tread	Rubber compounds	Filler	Precipitated Silica	112926-00-8	10%-15%	15%	Silica is currently under evaluation for a possible classification (STOT RE 1 or STOT RE2). If RAC confirms silica's classification, recycled rubber (granulates/powders) is at risk to be classified STOT RE 1 or STOT RE2, depending on silica's classification and its concentration in rubber. If classified, most outlet markets for rubber will be at risk of being lost. Information on content is needed to allow optimisation of ELTs in sorting	Manufacturing	d
Tyre tread	Rubber compounds	Silane is coupled with silica (hydrophilic) to improve its bonding with rubber polymers (hydrophobic)	Bis[3-(triethoxysilyl)propyl] tetrasulfide (Si-69 or TESPT)	40372-72-3	0.75-1.5%			Manufacturing	

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Tyre tread, sidewall, inner liner	Rubber compounds	Filler, reinforcing agent, enhances strength, durability, heat dispersion, UV resistance, and traction	Carbon Black(C)	1333-86-4	20-25% w/w%	30-35%		Manufacturing	
Rubber components: e.g., tread, sidewall	Rubber compounds	Filler	Calcium carbonate (CaCO3)	471-34-1		30-35%		Manufacturing	
Rubber components: e.g., tread, sidewall	Rubber compounds	Accelerator - used to control the sulfur reaction	1,3-Diphenylguanidin (DPG)	102-06-7	1%			Manufacturing	b
Noise reduction foam layer	Noise reduction material	Polyurethane sponge	Triphenyl phosphate	115-86-6				Manufacturing	a
Tyre belts, bead reinforcement, and sidewalls	Aramid fibres	Reinforcement	Poly(p-phenylene terephthalamide (PPTA)	24938-64-5				Manufacturing	
Tyre belts, bead reinforcement, and sidewalls	Aramid fibres	Reinforcement	Poly(m-phenylene isophthalamide) (PMIA)	25035-79-8				Manufacturing	
TPMS	Tyre mounted sensor - battery		1,3-propanesultone	1120-71-4				Use*	a,b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
TPMS	Tyre mounted sensor - battery		1, 2-dimethoxyethane; ethylene glycol dimethyl ether (EGDME)	110-71-4	≥ 20.0% w/w and < 100% w/w			Use*	a,b
TPMS	TPMS module - battery		Decamethylcyclopentasiloxane	97 541-02-6				Use*	a
TPMS	TPMS module - electrolyte		1,3-propanesultone	1120-71-4	> 0.1% w/w and ≤ 100% w/w			Use*	a,b
TPMS	TPMS module - printed circuit boards		2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one	71868-10-5	> 0.1% w/w and ≤ 100% w/w			Use*	a,b
TPMS	TPMS module - coils		Potassium 1,1,2,2,3,3,4,4,4-nonafluorobutane-1-sulphonate	29420-49-3	> 0.1% w/w and ≤ 100% w/w			Use*	a
Rubber components	Styrene-butadiene rubber		Tris(4-nonylphenyl, branched and linear) phosphite (TNPP) with ≥ 0.1% w/w of 4-nonylphenol, branched and linear (4-NP)	26523-78-4	> 0.1% w/w and ≤ 100% w/w			Manufacturing	a

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Steel – rubber componnets	Steel-belts, bead rubber	Adhesion promoter to ensure the rubber sticks reliably to the brass-plated steel cords	Cobalt naphthenate	61789-51-3	0.2–0.6 parts per hundred rubber		Cobalt is a critical raw material	Manufacturing	a,b
Steel – rubber componnets	Steel-belts, bead rubber	Adhesion promoter to ensure the rubber sticks reliably to the brass-plated steel cords	Cobalt neodecanoate (cobalt neodecanate)	27253-31-2	0.2–0.6 parts per hundred rubber		Cobalt is a critical raw material	Manufacturing	a,b
Steel – rubber componnets	Steel-belts, bead rubber	Adhesion promoter to ensure the rubber sticks reliably to the brass-plated steel cords	Cobalt stearate	1002-88-6	0.2–0.6 parts per hundred rubber		Cobalt is a critical raw material	Manufacturing	a,b
Textile plys/carcass	Reinforcing textile	Reinforcing material	Rayon	61788-77-0				Manufacturing	a,b
Textile plys/carcass	Reinforcing textile	Reinforcing material	Polyester	113669-95-7	400 gr			Manufacturing	

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Textile plys/carcass	Reinforcing textile	Reinforcing material	Nylon	25038-54-4				Manufacturing	
Textile plys/carcass	Reinforcing textile	Reinforcing material	Polyethylene terephthalate	25038-59-9				Manufacturing	
Recycling outputs	1 kg Ground rubber (recycled content)	Recycled content rubber (Filler?) - origin form mechanical tyre recycling / tyre retreading (if ground rubber is collected from buffings from retreading)	Oxalic acid	144-62-7	0.0035 kg / kg ground rubber			EoL	
Recycling outputs	1 kg Ground rubber (reccyled content)	Recycled content rubber (Filler?) - origin form mechanical tyre recycling / tyre retreading (if ground rubber is collected from buffings from retreading)	Urea	57-13-6	0.0065 kg / kg ground rubber			EoL	
Pyrolysis outputs	Recovered carbon black	Recycled content CB - origin pyrolisis	Recovered carbon black	1333-86-4				EoL	
Pyrolysis outputs	Tyre pyroliysis oil		Tyre pyroliysis oil	61789-60-4				EoL	b
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	Benzene	71-43-2				Use	b

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	Toluène	108-88-3				Use	b
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	6PPD	793-24-8				Use	b
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	Aniline	62-53-3				Use	b
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	Retinole	68-26-8				Use	b
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	Retinol, acetate	127-47-9				Use	b
Tyre tread	Abrasion particles originating in trye treads	Abrasion particles originating in trye treads	Naphthalene	91-20-3				Use	b
Non-Intentionally added substances (NIAS)									

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Benzo[a]pyrene	50-32-8	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Benzo[e]pyrene	192-97-2	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Benzo[j]fluoranthene	205-82-3	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Benz[a]anthracene	56-55-3	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Chrysene	218-01-9	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Dibenzo[a,h]anthracene	53-70-3	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d

Component	Material	Function class	Intentionally added Substance	CAS number	Average concentration as provided by stakeholders	Maximum concentration as provided by stakeholders	Comments on substance	Life cycle process	Identified as SoC under art 2(27)
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Benzo[b]fluoranthene	205-99-2	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	Benzo[k]fluoranthene	207-08-9	Variable		Recycling quality disturbing; Limits the applications for recycled rubber in other applications	Manufacturing	a,b,d
Rubber components: e.g., tread, sidewall	Rubber compounds	Impurity	In general PAH	unkown	Variable		Recycled rubber cannot be used for the production of articles that may come into contact with the skin or the oral cavity of young people.	Manufacturing	d

*In the case of TPMS, use phase is referred to as life cycle phase as most TPMS are not part of the tyre but will be attached to it when it is assembled in the vehicle. As the tyre is post-manufacture at this stage it has been opted to refer to the use phase for such components.

5.2. Bill of chemicals

Building on the SoC inventory, this section assesses whether any identified substances could hinder the recycling process.

Utilising the SoC inventory, a further assessment was conducted to identify if any substances would be hindering recycling. With the limited stakeholder perspectives obtained on this aspect, literature research and expert judgement is used to assess what is present in the identified substances that could impact recycling, based on customer requirements, regulatory limitations for the product group, or impacts on the recycling process or resulting quality of the recycling output. The outcomes are presented in **Table 5-2** and analysed afterwards.

As in the tyre substance inventory is considered to be non-exhaustive, some substances may also be missing in the following list specified in **Table 5-2**.

Questions or stakeholders

1. Please specify additional substances of relevance to the bill of chemicals for tyres that are not yet specified.
2. Please check the substances listed in **Table 5-2** and contribute information to complete missing information or comment where information is incorrect or unprecise.

463 **Table 5-2: Bill of Chemicals for tyres**

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Sealing material - Unidentified	Self sealing tyres; Sealing material	Manufacturing				d			Shredder disruptive		
Polyurethane	Noise cancelation tyres; Noise reduction material	Manufacturing				d			Shredder disruptive		
Foam adhesive in noise reduction tyres - Unidentified	Noise cancelation tyres; Adhesive	Manufacturing				d			Shredder disruptive		
Chlorobutyl Rubber	Inner liner rubber; Maintaining the low gas permeability	Manufacturing				d			Can cause extensive damage via corrosion during the pyrolysis process and during the use of TPO as a feedstock for material re-use.	Affects the quality of TPO and its use as a feedstock for material re-use.	Stakeholders suggested to limit but said it cannot be avoided
Bromobutyl Rubber	Inner liner rubber; Maintaining the low gas permeability	Manufacturing				d			See chlorobutyl rubber	See chlorobutyl rubber	Stakeholders proposed to restrict as more problematic

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Short chain chlorinated paraffins (SCCP)	Rubber components: e.g., tread, sidewall; Plasticisers	Manufacturing	a		c	d		POPs Regulation: listed for elimination		Recycling quality disturbing	
Collective inorganic substances (magnesium, silicon, copper, calcium, lead, zinc, iron, and other heavy metals).	;Multiple = Constituents of many additives, and steel alloy	Manufacturing				d				Affects quality of recycled carbon black - ash content needs to be controlled and limited to allow for reuse in tyre manufacture without extra processing (extra resources and energy) assuming possible.	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Zinc	Rubber components: e.g., tread, sidewall; Multiple. In many types of additive…see next lines..., blowing agent, from brass - steel alloy.	Manufacturing				d				During pyrolysis, zinc partitions into oil and char, thereby impairing the use of pyrolysis tyre-derived recyclate; Zinc leaches out into the environment from recycled tyre products such as playground mats and artificial turf	
Cadmium oxide	Rubber components: e.g., tread, sidewall;	Manufacturing	a	b		d		SVHC Candidate list, ELVD		Affects quality of recycled carbon black	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Lead	Rubber components: e.g., tread, sidewall; Possibly as PbCO3 or PbO for cross-linking, and an attendant substance of zinc oxide.	Manufacturing	a	b		d		Lead and its compounds addressed under REACH, ELVD		Affects quality of recycled carbon black - ash content needs to be controlled and limited to allow for reuse in tyre manufacture without extra processing (extra resources and energy) assuming possible.	
Lead oxide (PbO)	Rubber components: e.g., tread, sidewall; Cross linking agent /impurity in ZnO	Manufacturing				d				See lead	
Lead carbonate (PbCO3)	Rubber components: e.g., tread, sidewall; Cross linking agent /impurity in ZnO	Manufacturing				d				See lead	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Magnesium	Rubber components: e.g., tread, sidewall; Vulcanisation accelerator and activator, cross-linking agent, filler	Manufacturing				d				See lead	
Calcium	Rubber components: e.g., tread, sidewall; Vulcanisation activator, filler	Manufacturing				d				See lead	
Silicon	Rubber components: e.g., tread, sidewall; Filler	Manufacturing				d				See lead	

Mineral oil: Various subgroups characterised by various percentages of paraffinic, naphthenic and aromatic carbon atoms. Aromatic oils predominate in tyres.	Rubber components: e.g., tread, sidewall; Plasticiser	Manufacturing				d	Contains polycyclic aromatic hydrocarbons which are known to be present in, and leach out of, recycled tyre material such as playground mats and artificial turf;	Contains polycyclic aromatic hydrocarbons which are restricted under REACH		Recycling quality disturbing; When tyres are subjected to end-of-life pyrolysis, the hydrocarbons in mineral oil, along with hydrocarbons in the elastomer itself, form more heavy and toxic PAHs. The toxicity of these substances and the high content of PAHs in pyrolysis oil (of tyres) makes the oil unfit for use without extensive upgrading The PAHs also transfer into recycled carbon black which is one reason why recycled carbon black	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
										from pyrolysis of tyres cannot be used.	
Sulphur / sulfur	Rubber components: e.g., tread, sidewall; Cross-linking agent	Manufacturing				d			Results in SOx emissions when tyres are burned in cement kilns and where tyres form a component of solid recovered fuel in incineration.	When tyres are pyrolysed, the high sulphur content of the oil and the char makes these products unfit for use, necessitating further energy- and resource-intensive purification stages.	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Chlorine	Rubber components: e.g., tread, sidewall; Cross-linking agent, chlorinated paraffin plasticiser, anti-degradant.	Manufacturing				d			Waste treatement process disturbing; Transfers into products such as pyrolysis oils and pyrolysis process wastewater. Also results in the formation of chlorinated dioxins, furans and other POPs, along with the formation of corrosive, water-soluble compound HCl during all thermal treatment.		
Benzo[a]pyrene (BaP) Polycyclic-aromatic hydrocarbons (PAH)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Benzo[e]pyrene (BeP) Polycyclic-aromatic hydrocarbons (PAH)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	
Benzo[a]anthracene (BaA) Polycyclic-aromatic hydrocarbons (PAH)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	
Chrysen (CHR)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	
Benzo[b]fluoranthene (BbFA) Polycyclic-aromatic hydrocarbons (PAH)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	
Benzo[j]fluoranthene (BjFA)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing		b		d	See mineral oil	See mineral oil		See mineral oil	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Benzo[k]fluoranthene (BkFA) Polycyclic-aromatic hydrocarbons (PAH)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	
Dibenzo[a,h]anthracene (DBAhA) Polycyclic-aromatic hydrocarbons (PAH)	Rubber components: e.g., tread, sidewall; Extender oils	Manufacturing	a	b		d	See mineral oil	See mineral oil		See mineral oil	
N-1,3-dimethylbutyl-N'-phenyl-p-phenylenediamine (6PPD)	Rubber components; Antioxidant, Antiozonant;	Manufacturing		b		d		Additional studies are being conducted on the exposure routes and risks related to these substances and the substance is being assessed for a possible restriction.		Should the amount of 6-PPD and it 's conversion product 6-PPDQ be too high, there may be concerns of the environmental impact of products produced with recycled rubber	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Silicon dioxide (silica)	Tyre tread; Filler	Manufacturing				d	Customer-driven limitations along the supply chain	Silica is currently under evaluation for a possible classification (STOT RE 1 or STOT RE2) which could require specifying its content in the future		Information on content needed to allow batch optimisation during tyre sorting as must by limited in pyrolysis.	
Precipitated Silica	Tyre tread; Filler	Manufacturing				d	See silicon dioxide	See silicon dioxide		See silicon dioxide	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
1,3-Diphenylguanidin (DPG)	Accelerator used to control the sulfur reaction; Rubber components	Manufacturing				d?		DPG is a rubber additive transformation product (RATP) of 6PPD and it has been detected in maternal and umbilical cord blood		Further investigation is needed to understand if this substance disrupts waste management of tyres or of the concern is due to ongoing investigations of 6DPP transformation products.	
Benzo[a]pyrene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 50		Limits the applications for recycled rubber in other applications	
Benzo[e]pyrene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 51		Limits the applications for recycled rubber in other applications	

Substance	Component and function	Origin	SoC Art 2(27)a	SoC Art 2(27)b	SoC Art 2(27)c	SoC Art 2(27)d	Customer driven limitations	Regulatory limitations/ thresholds	Process disturbing	Quality disturbing	Exemptions according to stakeholders
Benzo[j]fluoranthene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 52			
Benz[a]anthracene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 53			
Chrysene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 54			
Dibenzo[a,h]anthracene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 55			
Benzo[b]fluoranthene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 56			
Benzo[k]fluoranthene	Rubber components: e.g., tread, sidewall; Impurity	Manufacturing	a	b		d		REACH restricted as a PAH. Entry 57			

464

5.2.1. Assessment based on Bill of chemicals from a recycling perspective

The overall majority of the identified substances can be classified as Art. 2(27)a SVHCs, Art. 2(27)b substances covered by the CLP hazard classification and substances that may disrupt waste management which are covered by Art 2(27)d. An additional large share of substances identified are considered to fall under Art 2(27)d without being in other categories of Article 27(2). Only one POP regulated substance was identified.

The problems associated with **sticky gel materials used in self-sealing tyres** to gauge punctures have been reported by various stakeholders and are also discussed in the Task 4 report (Baron et al., 2025). A stakeholder provided additional detail, explaining that adhesive sealant materials generate strong friction on shredder blades and clog discharge hoppers, causing operational disruptions and requiring frequent maintenance. Resulting friction and recirculation of rubber in the shredder can increase process temperatures and thus also the risk of fires. Where water is used to mitigate overheating, the shredded rubber is contaminated with sealant and can agglomerate, making it difficult to handle and dose in downstream processes (i.e., cement kiln co-processing and mechanical recycling (granulation)). Agglomerated rubber granules further result in a loss of marketability and value. Waste operators view such sealants as a major operational and quality constraint for tyre recycling processes. They propose that tyres containing such materials are banned, arguing that a labelling or information requirement though supporting sorting, would still require screening 100% of ELTs to identify a small fraction of tyres containing sealants (currently a few percent of the market), generating disproportionate operational costs for recyclers. The constituents of sticky gel sealant materials are however at this stage unknown. A ban could thus not be associated with a specific substance or group of substances and would need to target self-sealing tyres in general.

Questions for stakeholders

1. Are you aware of substances that are constituents of sticky gel materials used in self-sealing tyres? Please provide substance name and CAS number and any additional information you consider relevant.

Foams and noise absorbing materials are included in “noise reduction tyres” within the tyre and have been reported by retreaders and waste operators as problematic for both mechanical and chemical recycling as explained in the Task 4 report (Baron et al., 2025). From the literature it can be understood that such tyres use **polyurethane** (PU) foams for noise adsorption as well as **adhesives** to fix such foams in place. In addition to the disruption for the waste management, a stakeholder explained that the use of such foams also hinder repair, as the foam needs to be removed to facilitate the repair. Another stakeholder explained that during shredding, the foam is typically extracted together with the textile fraction, increasing the share of ELT material that cannot be recycled and reducing the overall recycling rate. Residual PU fragments may also contaminate rubber granulates and powders, negatively affecting the quality and market value of recycled materials. ELTs containing such foams are thus diverted to energy recovery instead of material recycling. A devulcaniser further explained that such tyres represent both a technical and economic challenge for devulcanisation as the difficulty of separating PU from rubber increases the cost of producing clean, devulcanisation-ready feedstock. A stakeholder

emphasises the conflict with ESPR objectives as materials that reduce recycling yield and contaminate secondary products directly undermine circularity and the effective reuse of ELTs. Nonetheless, manufacturers have emphasised that with the increase in number of electric vehicles, the relevance of noise reduction is expected to increase. This could potentially increase the market of such tyres in the future and exacerbate the problem.

Questions for stakeholders

1. Can noise reduction tyres be designed to enable easy removal of the PU foams?
2. Please confirm that the adhesives used in noise reduction tyres, though prohibitive to PU foam removal, do not negatively impact the quality of recycling outputs.
3. New developments in wheel rim design are looking into the use of perforations, grooves and other forms to reduce the noise created by vibrations of the wheel. Could such solutions provide an equivalent alternative to noise reduction tyres?

Halobutyl can include both **chlorobutyl rubber and bromobutyl rubber** and is used in tyre liners to ensure low gas permeability which is relevant to maintain air pressure in the tyre. Both have been explained to cause damage during the pyrolysis process via corrosion as well as during the use of tyre pyrolysis oils (TPO) as a feedstock for material re-use. Bromobutyl is said to be the more problematic of the two and some stakeholders suggest its restriction to prevent the negative impact on recycling equipment and the quality of recycling outputs. Though chlorobutyl is also problematic, it is understood that there is currently no substitute for this substance. Inclusion of information on the content of both substances in the DPP to allow sorting out of tyres with high levels was also proposed.

Questions for stakeholders

1. Would waste operators need the content of chlorobutyl rubber and/or bromobutyl rubber to be specified in information provision (e.g., concentration rounded at unit level) or would the specification of a range suffice (e.g., chlorobutyl rich or poor or >5% or >5%.

Zinc oxide is used as a filler and an activator of rubber compounds. The reaction between sulphur and the rubber chains is facilitated by the presence of an activator system consisting of zinc oxide (ZnO) and stearic acid. The use of ZnO in rubber products is associated with environmental impacts, as this compound is released into the lithosphere through degradation of the rubber, after the end of a product's life. Zinc is toxic to aquatic organisms and is thus of regulatory interest and has led to efforts towards the reduction of its content through surface modifications or addition of other activators. Additionally, zinc oxide often has trace elements of lead and cadmium resulting from the smelting process, though this depends on the sourcing of the ores from which the ZnO is produced – see next paragraph. (Kołodziejczak-Radzimska & Jesionowski, 2014) Throughout the lifecycle, such metals are released into the environment through tyre wear or when granulated rubber is used in landscaping and sports fields.

When considering the Art 2(27) substances the stakeholders indicated that various **lead compounds** (CAS: 7439-92-1) and **cadmium oxide** (CAS: 1306-19-0) can be present in tyre rubber unintentionally, often being incorporated through impurities of zinc oxide. Lead is included in a larger group of inorganic substances, the cumulative content of which can affect the quality of recycled carbon black when such tyres undergo pyrolysis. The presence of both

lead and cadmium in tyres is already regulated through the ELV Directive that applies to tyres incorporated in a vehicle when it is placed on the market but is assumed to affect all tyres manufactured. As no valid exemptions are listed in Annex II of the ELV Directive at present, it is assumed that lead content is below the ELVD threshold of 0.1% and cadmium content below 0.01%. It is assumed that introducing an information requirement below these levels shall not be straightforward as this substances are added non-intentionally. Nonetheless, it can be understood that lead impurities in zinc oxide are a result of the mines from which the zinc ores are sourced. Should it be necessary to control the amounts of lead in tyres sent to pyrolysis, it could be considered to introduce requirements on the sourcing of zinc oxide as a means of limiting the amount of lead entering the material flow (e.g., requiring the introduction of binding thresholds from ZnO suppliers).

Questions for stakeholders

1. Are there practical thresholds that could be introduced for lead and for cadmium as information requirements to facilitate tyre sorting and batching of tyres sent to pyrolysis?
2. Considering the possible growth in pyrolysis treatment capacities in the EU, shall it become necessary in coming years to introduce measures for limiting the presence of lead, cadmium oxide and other organic substances in tyre rubber?

Task 4 notes that the pyrolysis of tyres using high amounts of **silica** (more common in the C1, C2 tyre classes) produces a low-quality recovered carbon black that is too high in ash content and cannot be used again in the production of new tyres without further processing (Baron et al., 2025). Silica is used as an alternative to carbon black. Though alternatives to silica are in development like silica derived from rice husk ash or biowaste, these do not solve the problem of silica content and thus substitution in the short-term seems unlikely. The provision of information on the share of silica in the tyre (exact share or range oriented, i.e., silica-free, silica poor, silica rich) and its localisation in the tyre component would allow better sorting and batching of tyres to ensure suitable "recipes" for pyrolysis.

Additional substances that are understood to affect pyrolysis process output quality include sulphur and chlorine. Though these also affect waste management emissions in some cases, it is unclear if they could be substituted.

Questions for stakeholders

1. Would specification of the general range of silica content support waste operators in the sorting and batching of tyres to be sent to pyrolysis (e.g., silica or poor or >5% or >5% silica content. Please propose suitable silica content categories for this purpose for use in information requirements.
2. Could information requirements for sulphur and chlorine be addressed in a similar way and if so, which range categories should be applied?

Poly Aromatic Hydrocarbons (PAH) are compounds that have been found to be carcinogenic and that are categorised as a SVHC under REACH. In the far past these substances were present in extender oils used in large amounts in the production of tyre rubber. They were found to be harmful to the aquatic environment and as they are contained in tyre abrasion particles, a risk to the environment was identified. A restriction was introduced into REACH Annex XVII, valid

from 1 January 2010, and limiting the contents of PAHs in extender oils used to produce tyres or parts of tyres if they contain

- more than 1 mg/kg (0,0001 % by weight) Benzo[a]pyrene (BaP, CAS: 50-32-8), or,
- more than 10 mg/kg (0,001 % by weight) of the sum of all listed PAHs.

Nonetheless, as explained in the Task 4 report (Baron et al., 2025) carbon black is also an important source of PAH in tyres, but is not affected by the REACH restriction. Though PAH levels in tyres have decreased significantly, they are still relevant as an impurity, affecting the mechanical recyclability of tyres as the PAHs remain present in resulting secondary substances. As explained in the Task 4 report REACH Annex XVII "Entry 50(1) sets limits for the concentration of 8 PAHs in oils used in tyre manufacturing at a threshold of 0.001 % by weight, while entry 50(5) and 50(9) set limits for the PAH content in rubber articles (0.0001 % by weight) and rubber infill/mulch (0.002 % by weight). While entry 50(1) refers to the PAH content in oil, the other restrictions refer to the total content of PAH, regardless of the material/component used in their manufacturing. This allows tyre manufacturers to use carbon blacks that contain PAHs at a level of up to 0.1%. As a result, ELT recycled rubber can fail at complying with the limits set by Restrictions 50(5) and 50(9), and therefore cannot be used in several applications. Harmonised legislation would be preferable, as it would prevent the use of PAH-contaminated raw materials in the first place, thus allowing recycled rubber to be used in a wider range of markets". In this case, though the original reason for restricting the content of PAHs is related to chemical safety, its content in carbon black affects the quality of secondary raw materials that are outputs of ELT management, affecting the ESPR Article 5(1)(m) aspect recyclability. It should be considered if to initiate an amendment of REACH entry 50 to address this problem or if a restriction could be introduced as a performance requirement under ESPR due to the relevance of recyclability.

As explained in the Task 4 report, rubber additives and their transformation products (RATPs) have become emerging pollutants of concern due to a recent discovery that **N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine quinone (6PPD-Q)**, which is a transformation product of **N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD**), is associated with the acute mortality of adult Oncorhynchus kisutch during substantial rainfall events. 6PPD is used in tyres due to its antioxidant and antiozonant effects which slow the aging process of rubber. The restriction of 6PPD is being considered under REACH. Though exchange with a material producer suggests that substitutes are market ready such as cyclohexyl-cyclohexyl-p-phenylenediamine (CCPD) it seems, the latter is understood not to be a drop-in substitute, requiring further efforts in compound development. Exchanges with tyre manufacturers also suggest that the substitution of 6PPD is not expected in the short term based on the experience with other substances that has taken up to 15 years in some instances.

Diphenyl guanidine (DPG) is a secondary accelerator widely used in tyre rubber, during the vulcanisation process it can form nitrosamines including in some case nitrosodiphenylamine (NDPhA) which is a carcinogenic nitrosamine. Though this derivative is not stable, it can trigger REACH Annex XVII Entry 28–30 limits due to worker exposure concerns. While DPG is not on the SVHC candidate list as of yet, some stakeholders are concerned that this could change in the future. It is not completely clear if this substance disrupts the waste management of tyres.

A few stakeholders referred to tyres reinforced with **aramid fibres** that cannot be recycled as the aramid fibres cannot be cut by the shredder blades, however further information was not provided in the last consultation efforts.

Lithium batteries used in TPMS have also been raised as a problematic component that is sometimes left in the tyre and damages shredders. Nonetheless, from exchange with stakeholders, it is understood that tyres are rarely designed with sensors that include batteries. Rather the batteries said to be included in TPMS systems that are attached to the tyre valve, on a strap on rim or in a container (glued on the innerliner of the tyre) and to be removeable before the tyre is sent to shredding.

6. Considerations on information and performance requirements

6.1. Information requirements

Article 7 of the ESPR mandates that any product containing a Substance of Concern must be accompanied by standardised information covering: the exact name or numerical identifier of each substance; its precise location within the product; the concentration (or concentration range/maximum value) at the product, component, or spare-part level; clear instructions for safe use; and guidance on environmentally sound end-of-life treatment. Drawing on stakeholder consultations, literature, and draft JRC guidance, this section explores the specific concentration thresholds, exemptions, and implementation timeline to be applied to information requirements for tyres.

Multiple stakeholders suggest introducing information requirements only for substances that are actually in the final product. This is explained in particular due to the large volumes of imported tyres for which verification of use of other substances is expected to be difficult, potentially creating an unfair playing field. Some stakeholders go a step further and propose to only obligate the reporting on such substances when they are also acknowledged to be an Article 2(27)(d) substance. The latter approach is understood not to be in line with ESPR which sets out an obligatory monitoring for all substances identified in relation to Article 2(27)(a-d) unless this can be justified, e.g. for reasons such as practicality, proprietary information etc.

From exchange with stakeholders, it could be understood that though it is possible to provide data on the contents of various substances, specifying data on exact location and concentration or amounts is not always as straightforward. This is related to the variations in the composition of a specific tyre model which is in part related to the nature of tyre compositions as well as to the sourcing of raw materials. Though manufacturers will have a specific recipe for each tyre model, the composition in practice is not just a result of the combination of various materials in each tyre component. The nature of manufacture in this case is that the materials of which a specific tyre part consists of are mixed, in the production process and undergo various reactions. Some of these reactions may continue also beyond the manufacture of the tyre (affected also by environmental conditions) changing the composition of the tyre also during the use phase. The use of a substance as part of a raw material is thus not a guarantee that it shall be contained in the final product in the locations and quantities in which it has been initially included. Concentrations may vary over time and in some cases, substances transform into other substances, making an exhaustive identification of contained substances an impossible task.

To demonstrate the latter, an example of the curing process was given at which stage mineral sulphur almost disappears through the reaction with the elastomer and included chemical accelerators in parallel to the vulcanisation process and the appearance of the sulfurised elastomers. Similarly, silane is coupled with silica to improve its bonding with rubber polymers and will irreversibly integrate into the silica or react with it. Such chemical reactions are not sufficiently quantified in the literature and thus the final substances and concentrations contained in the final product are not predictable. After the curing process, rubber compounds continue to evolve due to material aging and conditions of use, affecting the concentrations of included substances and in some cases also their localisation (e.g., antioxidants migrate to the surface, protecting the tyre throughout its lifetime, sulphur bonds evolve due to thermal conditions). Tyre wear will also cause the tyre weight to change as the outer tread is subject to abrasion, further affecting the composition of the tyre at EoL. Furthermore, for substances with degradation products like 6PPD, predicting the degradation products, their concentration and localisation in the tyre is not possible as the process is dependent on environmental conditions (sun, water, ozone, temperature, etc.), meaning that composition shall vary between product to product of a given model.

Finally, deriving the substance composition of a tyre through measurement after it is manufactured is not a simple task, as neither methods to predict the evolution of substances nor analytical techniques are sufficiently available, not to mention that measuring each and every substance and its localisation is not pragmatic for a product like a tyre that can include hundreds of substances and cannot be disassembled for the purpose of analytics like an electronic devices. To clarify the administrative burden that is associated with the monitoring of substances, one stakeholder explained that once a substance is determined to be used in a tyre model, providing information would require listing all raw materials as well as the concentration of the substance when the latter is above the specified threshold. This would be followed by listing all rubber compounds in which these raw materials are used as well as the concentration of the material. Subsequently and based on the concentrations, the expected concentration would need to be calculated for each instance of use and for each relevant tyre model the maximum amount of substance that could be present per tyre would be derived. To ensure precision, for each given model, this would then be followed by analytical work on a unit of that model to allow adjusting the substances and concentrations before data is provided to stakeholders (e.g., through a DPP).

Assuming that a substance is used in rubber clarifies how complex this exercise is. As various elastomers are produced for use in different rubber compounds, a substance with an information requirement could potentially be used in a few tens of different elastomers. In turn, these elastomers, together with other chemicals, would be used in over 1000 different rubber compounds which could then be used in a large number of tyre models of a single manufacturer. In each of these cases, the manufacturer would need to follow the “trail of use”, singling out the concentrations and deriving the expected amounts contained in the final product. If this is then coupled with analytical work, aside from the time needed to derive and document all instances of use for a single substance, additional costs for analytical testing would then also be needed.

Some manufacturers thus propose at this stage to limit information requirements to a declaration requirement applying to all SVHC present in the tyre at a concentration above 0.1% weight/weight which is aligned with the obligations in Article 33 of the REACH Regulation.

AGIR, the national association Act for the Environment, recently analysed the chemical composition of car tyres from 6 major brands represented in the European market to learn of the potential pollutants that reach the environment through abrasion related microplastic emissions. Their analysis identified 785 substances contained in tyres which pose serious risks to health and the environment when emitted to the environment, of these:(AGIR, 2026)

- 237 are said to have a long-term harmful effect on ecosystems;
- 85 are potentially fatal if ingested and entering the respiratory tract;
- 112 are carcinogenic, mutagenic, or reprotoxic (CMR) substances; and
- There are dozens of substances considered fatal if ingested, inhaled, or absorbed through skin contact.

AGIR thus calls for more transparency in relation to the substance contents of tyres. Initially, in 2024, Agir published a first study on tyre abrasiveness, showing that tested tyres lost between 65 and 151 milligrams of rubber per kilometer traveled, in the form of micro- and nanoparticles. In France alone they estimated that this represents more than 50,000 tonnes of rubber particles and additives released into the environment each year. (AGIR, 2026)

A few substance and substance groups were highlighted in a summary of the AGIR report. Nonetheless the list is understood to be inexhaustive and it is also clarified that while some substances in these groups pose a high toxicity others do not: (AGIR, 2026)

- Polycyclic aromatic hydrocarbons (PAHs) are substances with a particularly stable cyclic structure that are often highly toxic to human health. Many of these substances are classified as carcinogenic, mutagenic, and/or reprotoxic (CMR), in addition to posing other serious risks to human health and the environment. PAHs represent 40% to 60% of the organic compounds identified in tyres.
- Alkanes, alkenes, alkynes, and their cyclic forms (AAA-C) pose the main risks of mucous membrane irritation and organ damage, in addition to environmental risks, and represent 33% to 50% of the organic compounds in tyres.
- Acids and alcohols are primarily responsible for environmental damage and represent 10% or less of the identified molecules.
- Benzene is a compound found in tyres, which, through abrasion, generates toxic ultrafine particles containing, in addition to benzene, a mixture of substances that are dangerous to the body.
- 6PPD is an organic compound added to tyres to prevent their degradation by ozone and extend their lifespan. But once released into the environment by tyre microparticles, it transforms into 6PPD-quinone (6PPDQ), a molecule now identified as highly toxic to aquatic life, with long-term effects (H400, H410). Since 2020, scientific studies have shown that this substance causes mass die-offs of salmon exposed to urban runoff and highways in the United States. All the tyres tested in the AGIR study contained 1,4-benzenediamine, N-(1,3-dimethylbutyl)-N'-phenyl, more commonly known as 6PPD, demonstrating its widespread presence. This substance is already the subject of a restriction assessment under the REACH Regulation.

To conclude, whereas it is clear that tyres contain multiple SoC about which stakeholders and in particular waste management operators should be informed, the level of granularity necessary is observed differently by the various stakeholders. While the ESPR mandates the provision of information about all substances falling under Article 27(2)(a-d) definitions, the consultants can

follow that detailed information including not just the identification of the substance but also its localisation and concentration could create a significant administrative burden.

For the most part the consultants agree that at the first stage, manufacturers should be obliged to provide information on the contents of substances above a certain threshold in a specific tyre model. While various stakeholders suggest limiting this to REACH SVHC candidate substances, in the consultant's opinion POPs Regulation substances should also be included in the list of substances with information requirements due to their relevance to waste management. This is all the more so warranted considering that at present it seems that only a single POPs substance group is relevant to the tyres product group, though probably no longer in use in manufacture of new tyres. In addition, for SoC that fall into the Article 27(2)(d) category, specific information requirements are to be considered and shall be discussed in section 6.2.4 in more detail.

Once the information is available and waste management operators collect experience as to how it is used and the added value of having more specific data on concentrations and localisations for certain substances, the level of granulation could be extended in a second stage (i.e., once ESPR legislation for tyres is reviewed) for substances where this is expected to have a positive impact on waste management.

6.2. Threshold for information requirements

The tracking thresholds proposed in this section are based on draft JRC guidance and trigger the information requirement obligation. If a SoC falls into multiple categories (for example, Article 2(27)(a) and 2(27)(b)), the most conservative (i.e. lowest) threshold should be applied. All included thresholds for tracking in this section apply to the IAS in the final product (including components and spare parts.

To avoid disproportionate data generation, many stakeholders suggest aligning the cut-off value for reporting on SoCs of the types addressed under Article 2(27)(a)-2(27)(c) with other policy, namely with reporting thresholds used for safety data sheets and those prescribed in the REACH Regulation.

6.2.1. Art. 2(27)(a) substances

The largest share of SoCs identified in the consultation and literature for this product group fall under Annex XIV candidate list SVHCs. For these substances, the 0.1% w/w threshold and REACH Art. 33(1) disclosure requirements should guide threshold-setting. Though ESPR would warrant the provision of concentration and localisation for each substance when contained in a certain tyre model, this could substantially increase the administrative burden for stakeholders. As explained above, at this stage it is thus suggested to only require provision of information if each of these substances is present above the 0.1% threshold or not, unless stricter requirements are specified for one of the other SoC categories addressed in the next sections.

6.2.2. Art. 2(27)(b) substances

For SoCs falling under Article 2(27)(b) in products classified as articles, a generic concentration threshold equal to the cut-off values in Table 1.5.1 of Section 1.5.3 ("General guidance for compiling safety data sheets") of the Globally Harmonised System (GHS) has been contemplated. These cut-offs define the minimum concentration at which a hazardous constituent must be disclosed in any GHS-compliant Safety Data Sheet worldwide. Where a relevant hazard class or category is absent from Table 1.5.1 but appears in Annex I of the CLP Regulation with a generic concentration limit (GCL) for mixtures, the lowest GCL that would classify the mixture into the most severe category of that hazard class could be used as a conservative proxy. Additionally, for the following hazard classes (introduced in 2022) the GCLs from the Delegated regulation (EU) 2023/707 could be used:

- (iv) endocrine disruption for human health categories 1 and 2 (Table 3.11.2)
- (v) endocrine disruption for the environment categories 1 and 2 (Table 4.2.2)
- (vi) persistent, mobile and toxic or very persistent, very mobile properties (PMT or vPvM, Art. 4 (4)(3))
- (vii) persistent, bioaccumulative and toxic or very persistent, very bioaccumulative properties (PBT or vPvB, Art. 4 (3)(3))

Though ESPR would warrant information requirements for such substances, the consultants fear that this could significantly increase the burden of compliance without resulting in an immediate benefit. Provision of such data would ease identification by waste management operators of such substances in tyres once there is a decision to take regulatory action against the use of a substance in the future. Nonetheless, the consultants are concerned that provision of such data would create a significant administrative burden without delivering benefits in most cases. An alternative would be to require manufacturers to provide data on such substances retroactively in the case of identification as an SVHC on the candidate list or other regulatory action that would prohibit or limit use in the future. As manufacturers are expected to internally document the use of these substances through the documentation of tyre recipes, retroactive provision within a short timeframe is assumed to be feasible.

Stakeholder questions

1. Would it be practical for information on SoCs covered by Article 27(2)(b) to be provided retroactively within 6 months of a substance being subjected to EU regulatory action that would limit the substances' usability in tyres?
2. In the latter case, would the indication of use above the threshold of 0.1% w/w be sufficient as a general obligation?

6.2.3. Art. 2(27)(c) substances

For persistent organic pollutants (POPs) covered by Article 2(27)(c), a 0.1 % w/w threshold is proposed based on the guidance, treating them as SVHCs on the REACH Candidate List, unless the POPS Regulation specifies a stricter threshold. This harmonised threshold streamlines compliance, ensures consistent notification criteria across both SVHCs and restricted POPs.

Currently, only SCCPs have been identified by stakeholders as substances used in tyre manufacture. Nonetheless, it is assumed that due to the listing of this substance group in the

807 POPs Regulation (and in the Stockholm Convention) that it is no longer used in the manufacture
808 of tyres intentionally and not contained in tyres at levels above the 0.15% threshold specified in
809 the POPs Regulation annex I. Substitution is assumed to have taken place. Though in theory
810 there may still be tyres in the EU stock placed on the market before 2012, their amount is
811 expected to be negligible considering the average lifetimes of tyres.

812 Information requirements should address substances in the POPs Regulation as a precaution at
813 a threshold of 0.1% unless the Regulation specifies stricter thresholds.

814 6.2.4. Art. 2(27)(d) substances

815 A generic threshold of 0.1 % w/w is likewise proposed for SoC that fall under Article 2(27)(d),
816 namely those substances whose presence can negatively affect reuse and recycling, unless
817 otherwise specified in **Table 6-1** below. Without any information requirement, future data
818 collection on these SoCs would remain severely constrained. Adopting the 0.1 % w/w threshold
819 used for SVHCs and POPs provides a clear, uniform obligation, which covers the complete bill of
820 materials, including all components.

821 **Table 6-1: Specific information requirements for Article 27(2)(d) SoC.**

Substance	CAS	Proposed threshold	Additional information requirements or comments
Sealing material - sticky gel materials used in self-sealing tyres	Unidentified	0.1% w/w	Specific substances should be specified, if possible, for this category
Polyurethane	9009-54-5	0.1% w/w	Localisation and instructions for easy removal should be specified
Chlorobutyl rubber	68081-82-3	0.1% w/w	In addition, chlorobutyl rich (≥3%) and chlorobutyl poor (<3%) should be specified
Bromobutyl rubber	68441-14-5	0.1% w/w	In addition, bromobutyl rich (≥3%) and bromobutyl poor (<3%) should be specified if use of this substance is not restricted
Zinc oxide	1314-13-2	0.1% w/w	It should be considered to require the introduction of binding maximum content thresholds for Pb and Cd from ZnO suppliers
Cadmium oxide	1306-19-0	0.1% w/w	
Lead and lead compounds	7439-92-1 68411-78-9 598-63-0	0.1% w/w	
Silica	7440-21-3 7631-86-9 (amorphous) 112926-00-8	0.1% w/w	In addition, silica rich (≥5%) and silica poor (<5%) should be specified
Poly Aromatic Hydrocarbons (PAH)	50-32-8 192-97-2 56-55-3 218-01-9 205-99-2 205-82-3 207-08-9 53-70-3	0.1% w/w	

Substance	CAS	Proposed threshold	Additional information requirements or comments
N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD)	793-24-8	0.1% w/w	
Diphenyl guanidine (DPG)	102-06-7	0.1% w/w	
Poly(p-phenylene terephthalamide (PPTA) Poly(m-phenylene isophthalamide) (PMIA)	24938-64-5 25035-79-8	0.1% w/w	
Lithium battery related substances: 1,3-propanesultone 1, 2-dimethoxyethane; ethylene glycol dimethyl ether (EGDME) Decamethylcyclopentasiloxane 1,3-propanesultone 2-methyl-1-(4-methylthiophenyl)-2-morpholinopropan-1-one Potassium 1,1,2,2,3,3,4,4,4-nonafluorobutane-1-sulphonate	1120-71-4 110-71-4 97 541-02-6 1120-71-4 71868-10-5 29420-49-3	0.1% w/w	Localisation and instructions for easy removal of the battery should be specified

6.2.5. Information requirement exemptions and timelines

Stakeholders expressed concerns over the administrative burden of collecting information for all Article 27(2)(a-d) substances and demonstrated the complexity of the data collection exercise. They suggested to limit information requirements to SoC that are present in the final product and covered by the SoC definitions of Article 2(27)(a, c and d). Some additional information requirements have further been suggested for 2(27)(d) SoCs.

Regarding the SoC that must still be tracked under the information requirement, several approaches are possible, each with its own level of ambition and associated administrative burden. For example, from highest to lowest burden:

- Highly ambitious scenario: All SoC listed in Art. 2(27)(a–d) present in the product would fall under the information requirement with the proposed thresholds (see previous chapters), with no exemptions.
- Moderate ambition scenario: All Art. 2(27)(a,c and d) SoC would be tracked, requiring retroactive information on substances that are only in the scope of 2(27)(b) within 6 months for any of these substances once it is subject to regulatory action that would restrict its use in tyres.
- Limited ambition scenario: All SoC listed in Art. (a,c and d) present in the product would fall under the information requirement with a threshold of 0.1% w/w and no further information requirements.

Given the complexity of tyres (each containing numerous material components composed of multiple constituents) a five-year implementation period after adoption of the delegated act would be warranted for each of the scenarios. This timeline would allow for:

- Year 1: Preliminary identification of substances present, including ones that have not been identified in this study.
- Years 2–3: Collection of necessary information and initiation of contractual negotiations.
- Years 4–5: Receipt of supplier data, management of any supplier non-compliance, organisation of information in accordance with Art. 7(a) of the ESPR and sharing via a Digital Product Passport and/or existing information channels (for instance technical product information).

That said, before choosing an exemption approach for the information requirements under Art. 7 of the ESPR, the impacts of each scenario and the proposed timeline must be assessed further in the impact assessment.

6.3. Performance requirements

As is also addressed under ESPR, multiple stakeholders request that the regulation of substances when purely motivated by chemical safety, should be addressed through the REACH Regulation and not under ESPR. The latter is suggested only to address cases where the sustainability aspects addressed in Article 5 are affected by the use of the substance in tyres.

Though the SoC methodology requires looking into the end-of-life phase in the form of substances contained in recycling outputs, this is not straightforward for tyres. Though current recycling practices result in various outputs, currently only small amounts of these are used as recycled content in the manufacture of new tyres. Furthermore, this aspect is understood by the consultant to be addressed through reference to substances present in tyres that have been identified to hinder recyclability and/or to hinder the quality of outputs of recycling processes. Though such substances were considered to some degree in the SoC inventory, they are not addressed in relation to the EoL phase beyond that compilation.

Several substances have been identified as falling under the category defined in Article 27(2)(d), sometimes also being in other SoC categories. For these substances, ESPR enables considering additional performance requirements in certain cases, potentially restricting the use of such substances where substitutes exist and can be applied. Within this group, two sub-groups can be identified:

- Those substances for which the main reasoning for restrictions is on grounds of chemical safety, in particular where regulatory action is already under consideration under REACH:
  - Poly Aromatic Hydrocarbons (PAH): the REACH annex XVII restriction should be revised to also apply to carbon black;
  - N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD): a REACH restriction is under consideration and should not be pursued under ESPR;
  - Diphenyl guanidine (DPG): expectations exist that regulatory action shall be considered under REACH. The main reason is chemical safety and it is not yet clear if waste management is disrupted or not.
- Those for which the main reasoning for restrictions is to facilitate tyre recycling and the quality of recycling output materials:

- Sticky gel sealing materials used in self-sealing tyres create damage to shredding equipment and also have a negative effect on recycling output materials. Though a prohibition of use is under consideration, this could only be associated to SoC if the substances could be identified. Alternatively, a ban on self-sealing tyres should be considered. This is recommended due to the understanding that run-flat tyres provide the same safety function without creating the operational and safety issues associated with self-sealing sealants, demonstrating that viable alternatives exist.
- Chlorobutyl rubber and bromobutyl rubber are both used in inner liners of tyres and associated with corrosion damage during the pyrolysis process as well as affecting the quality of TPO as a feedstock for material re-use. Bromobutyl has been referred to as more problematic than chlorobutyl and has been suggested to be restricted for use by some stakeholders. It was also suggested to limit the use of chlorobutyl as far as possible. As both substances have been stated to be used in amounts between 3-5%, it is suggested to set a maximum content for chlorobutyl at 3%, while prohibiting the use of bromobutyl.
- To minimise the content of cadmium and lead compounds in tyres, it is proposed to introduce a binding maximum content threshold for Pb and Cd from ZnO suppliers.

As explained by one stakeholder, various recycling methods vary in their tolerance to the presence of different substances. In this respect, where a substance is not used in all tyres and has only been identified as disruptive to some recycling practices, at this stage it is rather suggested to introduce information requirements to the substance to allow considering its presence in the sorting and preparation of tyre batches for different recycling routes. In addition, multiple stakeholders refer to the constant development of recycling technologies and emphasise the need to review the lists of substances for which information and/or performance requirements exist from time to time. Such a review would be expected and is also recommended to take place periodically each time the ESPR Regulation is reviewed.

7. Conclusions

This report aims to identify and assess SoC in tyres under the ESPR. A stakeholder consultation (June–September 2025) confirmed that most intentionally added chemicals in these appliances are already SVHCs under REACH and exceed the 0.1% w/w threshold, triggering existing disclosure requirements. Only one POP group of substances was found as well as a number of substances that disrupt waste management and substances of relevance to the CLP Regulation.

The ESPR requires manufacturers of tyres to adhere to information requirements for all SoCs present in their products, resulting in tracking obligations concerning their identity, location, concentration, safe-use instructions, and end-of-life treatment. To meet these obligations while avoiding a significant administrative burden, the following requirements are proposed for the various substance groups (see specific details in above chapters):

- A 0.1 % w/w threshold for SVHCs (Art. 2(27)(a)), POPs (Art. 2(27)(c)) and Art. 2(27)(d) SoCs in line with REACH Art. 33(1) threshold is proposed;
- For some Art. 2(27)(d) SoCs, additional information requirements have been proposed
- UN Globally Harmonised System (GHS) generic concentration limits (or, where absent, the lowest CLP GCLs) for hazard-classed substances under Art. 2(27)(b), supplemented by the latest endocrine-disruptor and PMT/PBT criteria should be documented by manufacturers however information on content should only be required retroactively should regulatory action be decided upon for one of these substance; and
- For a few SoCs affecting circularity (Art. 2(27)(d)), performance requirements have been proposed.

Because full-life-cycle IAS and NIAS data collection is time- and resource-intensive, the scope is limited to product-specific IAS present in the final product, also with the understanding that this should ensure a level playing field as verification of other substances for imported tyres is not ensured. Three implementation scenarios are proposed:

- Ambitious: generic information requirements covering all SoCs without exemptions, including more specific information requirements for several 27(2)(d) substances and performance requirements for a few Article 27(2)(d) substances;
- Intermediate: exemptions from information requirements for Article 27(2)(b) substances, generic information requirements for other SoCs and some specific information requirements for Article 27(2)(d) and performance requirements for a few Article 27(2)(d) substances;
- Limited: tracking only Art. 2(27)(a, c and d) substances with a generic threshold of 0.1% w/w for all SoCs affected.

A five-year roll-out is recommended across all scenarios to allow for supplier engagement, data gathering, and Digital Product Passport integration. An assessment of feasibility and administrative burden should be undertaken as part of the impact assessment.

8. References

AGIR. (2026, März). *TIRE COMPOSITION OF 6 MAJOR BRANDS: A TOXIC COCKTAIL FOR HEALTH AND THE ENVIRONMENT* [Press Release]. https://partage.agirpourlenvironnement.org/s/la-composition-des-pneus-un-cocktail-toxique/?utm_source=brevo&utm_campaign=CP%20-%20Rapport%20pneus%20v2&utm_medium=email

Baron, Y., Hinchliffe, D., Adjei, F., Gascon, L., Hay, D., Kosińska-Terrade, I., Mayer, F., Haita-Falah, C., & Van den Boogart, L. (2025). *Preparatory Study and Impact Assessment support study on tyres Draft report Tasks 1-4 of the Preparatory study Version 1.0—Draft*. VITO, Oeko-Institut Consult GmbH, Trinomics, Ecomatters. https://ecodesign-tyres.eu/sites/ecodesigntyres/files/downloads/espr_sr8_report_task1-4_2025_v1_clean.pdf

Bharadwaj, P. (2024, Dezember 18). Get To Know Your Car Better: A Detailed Guide To Automotive Terms—Car Tyres. *Automotive Terms , Dubi Guides*. https://www.dubicars.com/news/car-tyres-automotive-terms-guide-types-components-more-details.html

Continental. (o. J.). *Tire components*. Abgerufen 15. April 2026, von https://www.continental-tires.com/tire-knowledge/tire-components/

Continental. (n.d). *Recycled PET bottles in tyres*. https://www.continental-tyres.co.uk/about-us/stories/recycled-pet-bottles-in-tyres/

Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles - Commission Statements [Consolidated version] (2000). http://data.europa.eu/eli/dir/2000/53/oj

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance) [Consolidated text] (2008). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20240218

Giechaskiel, B., Grigoratos, T., Mathissen, M., Quick, J., Tromp, P., Gustafsson, M., Franco, V., & Dilara, P. (o. J.). *Contribution of Road Vehicle Tyre Wear to Microplastics and Ambient Air Pollution* (Sustainability 2024 16, S. 522). https://doi.org/10.3390/su16020522

IDIS. (2026, April 10). The International Dismantling Information System (IDIS) Website. https://data.idis2.com/online/

Kadhem, A. A., Enad, M. H., & Yasir, A. S. (2017). *STUDY THE EFFECT OF STEEL WIRES PRE-TENSION ON THEBENDING AND ADHESION PROPERTIES OF BEAD PLY IN RUBBERTIRES*. https://www.researchgate.net/publication/322267602_Study_the_effect_of_steel_wire_pre-tension_on_the_bending_and_adhesion_properties_of_bead_ply_in_rubber_tires

Kołodziejczak-Radzimska, A., & Jesionowski, T. (2014). *Zinc Oxide—From Synthesis to Application: A Review*. Material. https://doi.org/10.3390/ma7042833

988 Nideröst, K. J., & Walters, M. H. (2000). *Comprehensive composite materials—Polymer Matrix*
989 *Composites*.

990 Oponeo.pl S.A. (2019, April 10). *How much does a tyre weigh?*
991 https://www.oponeo.ie/blog/how-much-does-a-tyre-weigh

992 Pérez-Camacho, M. N., Cappucci, G. M., Faraca, G., Bracalente, G., Bennett, M. J., & García John,
993 E. (2025). *Method for the identification and tracking of substances of concern in products*
994 *and for the preparation of restriction measures on the use of substances in products:*
995 *ESPR Methodology Task B5*. Joint Research Centre (JRC).
996 https://vitoresearch.sharepoint.com/sites/22057-fwc-ecodesign-2023-
997 /Shared%20Documents/General/3_Methodologies/3.3_ESPR%20methodology_JRC/JR
998 C%20Methodology%20-
999 %20FINAL/B5_Substances_of_concern.pdf?CT=1775568185037&OR=ItemsView&wdO
1000 rigin=TEAMSFILE.FILEBROWSER.DOCUMENTLIBRARY

1001 Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December
1002 2008 on Classification, Labelling and Packaging of Substances and Mixtures, Amending
1003 and Repealing Directives 67/548/EEC and 1999/45/EC, and Amending Regulation (EC)
1004 No 1907/2006 (2008). https://eur-lex.europa.eu/eli/reg/2008/1272/oj/eng

1005 Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December
1006 2006 Concerning the Registration, Evaluation, Authorisation and Restriction of
1007 Chemicals (REACH), Establishing a European Chemicals Agency, Amending Directive
1008 1999/45/EC and Repealing Council Regulation (EEC) No 793/93 and Commission
1009 Regulation (EC) No 1488/94 as Well as Council Directive 76/769/EEC and Commission
1010 Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (2006). https://eur-
1011 lex.europa.eu/eli/reg/2006/1907/oj/eng

1012 Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on
1013 persistent organic pollutants (recast) (2019). https://eur-lex.europa.eu/legal-
1014 content/EN/TXT/?uri=CELEX:02019R1021-20260101

1015 PWC (2022), FWC ECHA/2018/452 SC02 First ex-post Evaluation of SCIP

1016 United Nations (2023), Globally Harmonised System on Classification and Labelling of Chemicals
1017 (GHS)

<Catalogue number>

Publications Office
of the European Union