EPD
INTERNATIONAL EPD SYSTEM

ROAD MARKING SYSTEMS

PRODUCT GROUP CLASSIFICATION: UN CPC 53211, 53222, 54211

C-PCR-034 (TO PCR 2019:14)
VERSION: 1.0.0

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1 INTRODUCTION

1.1 GENERAL

This document constitutes complementary Product Category Rules (c-PCR) developed in the framework of the International EPD System: a programme for Environmental Product Declarations (EPD)[1] according to ISO 14025, ISO 14040, ISO 14044, and product-specific standards such as EN 15804, EN 15941 and ISO 21930 for construction products.[2] EPDs are voluntary documents for a company or organisation to present transparent, consistent and verifiable information about environmental performance of their product (goods or services).

The General Programme Instructions (GPI), publicly available on www.environdec.com, includes the rules for the overall administration and operation of the programme and the basic rules for developing EPDs registered in the programme. PCRs and c-PCRs complement the GPI and the normative standards by providing specific rules and guidelines for developing an EPD for one or more specific product categories (see Figure 1). A PCR/c-PCR should enable different practitioners using the PCR/c-PCR to generate consistent results when assessing products of the same product category.

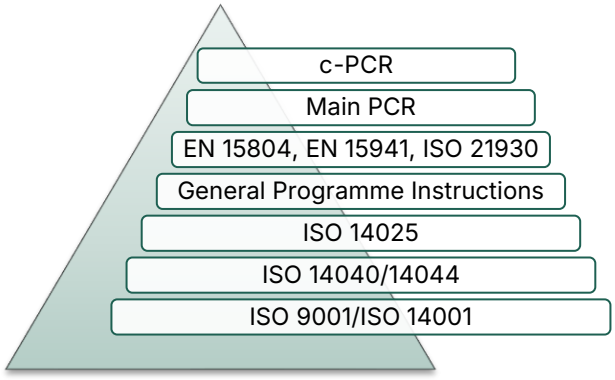

Figure 1. This c-PCR in relation to the hierarchy of standards and other documents.

The present c-PCR uses the following terminology:

- The term “shall” is used to indicate what is obligatory, i.e., a requirement.
- The term “should” is used to indicate a recommendation. Any deviation from a recommendation shall be justified in the EPD development process.
- The terms “may” or “can” are used to indicate an option that is permissible.

For definitions of further terms used in the document, see the GPI, the main PCR, and the normative standards.

A main PCR and its c-PCRs are valid for a pre-determined period of time to ensure that it is updated at regular intervals. The latest version of the PCR and its c-PCRs are available on www.environdec.com. Stakeholder feedback on PCRs and c-PCRs is very much encouraged. Any comments on this c-PCR may be sent directly to the PCR Moderator and/or the Secretariat during its development or during its period of validity.

Any references to this document shall include the PCR registration number, name and version.

The programme operator maintains the copyright of the PCR to ensure that it is possible to publish, update, and make it available to all organisations to develop and register EPDs. Stakeholders participating in PCR development should be acknowledged in the final document and on the website.

[1] Termed type III environmental declarations in ISO 14025.

[2] When standards are referred to in this document, the version listed in Section Error! Reference source not found. is i ntended unless otherwise stated.

1.2 ROLE OF THIS DOCUMENT

This c-PCR complements the main PCR of construction products in the International EPD System, PCR 2019:14 Construction products, available on www.environdec.com. The c-PCR cannot be used by itself but shall be used together with PCR 2019:14, and EN 15804 and EN 15941, for products within the scope of the PCR (see Section 2.2.1). It is required to use an applicable c-PCR after it has been published 90 days. It is optional to the use the c-PCR if it has been published for less than 90 days.

If more than one c-PCR is applicable, the EPD owner may choose to use any of them, but it is recommended to use the one that is more specific in scope in terms of product function. An alternative is to use, and verify the EPD towards, several applicable c-PCRs, as long as there are no conflicting requirements in the c-PCRs.

If requirements in the main PCR and the c-PCR are in conflict, the requirements in the c-PCR take precedence over those in the main PCR.

See Figure 2 for an illustration on how PCR 2019:14 and this c-PCR relate to each other and the EPDs that may be based on them.

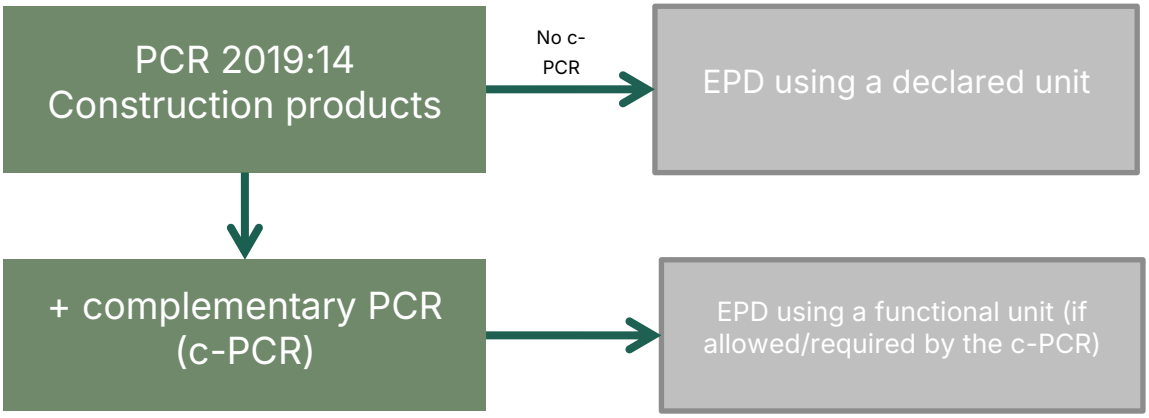

Figure 2. Overview of how PCR 2019:14 can be used directly, or together with a c-PCR, to develop an EPD. An EPD that uses a functional unit shall be based on a c-PCR. An EPD based on a declared unit can be developed without a c-PCR.

2 GENERAL INFORMATION

2.1 ADMINISTRATIVE INFORMATION

Name:	Road marking systems	
Registration number and version:	c-PCR-034, version 1.0.0	
Programme:	EPD INTERNATIONAL EPD SYSTEM	
Programme operator:	EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden. Website: www.environdec.com E-mail: support@environdec.com	
PCR Moderator:	Áron Mári, Geveko Markings ApS, moderator on behalf of SVMF (Skandinaviska Vägmarkeringsföreningen), amari@gevekomarkings.com	
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	Jon Kjær Jørgensen	Vejdirektoratet [Danish Road Directorate]
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	Toni Ogemark	Skandinaviska Vägmarkeringsföreningen [SVMF]
	Michaux Gauthier	SPW mobilité & infrastructures
	Louis Ducassou	Société d'Application Routière
	Selwyn Boerma	Kraton Chemicals BV
Publication date	2025-06-03 See Section 9 for a version history of the c-PCR.	
Valid until:	2029-06-03	

	The validity may change. See www.environdec.com for the latest version of the PCR and the latest information on its validity and transition periods between versions.
Development and updates.	The c-PCR has been developed following ISO 14027, including public consultation and review. The rules for the development and updating processes are described in Section 9 of the GPI. The c-PCR is valid for a pre-determined time period to ensure that it is updated at regular intervals. When the c-PCR is about to expire, the PCR Moderator shall initiate a discussion with the Secretariat on if and how to proceed with updating the c-PCR and renewing its validity. A c-PCR may be updated before it expires, based on changes in normative standards or provided significant and well-justified proposals for changes or amendments are presented. When there has been an update of the c-PCR, the new version should be used to develop EPDs. For small updates (change of third-digit version number), the previous version is normally immediately removed from the PCR library on www.environdec.com and there is no transition period. For medium updates (change of second-digit version number), the previous version of the c-PCR is valid in parallel during a transition period of at least 90 days, but not exceeding its previously set validity period. For large updates (change of first-digit version number), the previous version is valid in parallel during a transition period of at least 180 days, but not exceeding its previously set validity period. In case a c-PCR is developed by a CEN Product TC, the standard will replace this c-PCR, with a transition period of at least 90 days under which both are valid. Stakeholder feedback on PCRs is very much encouraged. Any comments on this PCR may be sent directly to the PCR Moderator and/or the Secretariat during its development or during its period of validity.
Standards documents and conformance:	▪ General Programme Instructions of the International EPD System, version 5.0.0, based on ISO 14025 and ISO 14040/14044.[3] ▪ EN 15804:2012+A2:2019/AC:2021 ▪ EN 15941:2024 ▪ ISO 21930:2017. This standard is used in selected sections, such as allocation, when it provides additional but not contradictory rules to EN 15804. EPDs may comply with this standard if additional requirements are met, see Section 1.5. ▪ ECO Platform standards, versions published 2024-12-20[4,5] If PCR 2019:14 refers to a later version of any of the above standards, the later version applies.

[3] Some rules influencing EPD development are independent of the GPI version referred to in the PCR. For example, the latest rules on EPD verification procedures in the GPI shall be followed within 90 days of its publication. See Section 5.1 in the GPI for a description of the four categories of rules and when they shall be followed.

[4] The ECO Platform standards consist of several documents, see footnote 5, whereof the LCA Calculation Rules and Digital Data Requirements are specifically relevant for this PCR. All requirements in the ECO Platform Standards that are additional to EN 15804 and EN 15941, are repeated in this PCR. Therefore, EPD developers and verifiers do not need to check the LCA Calculation Rules, Digital Data Requirements, or other documents of the ECO Platform standards.

[5] The following versions of the ECO Platform standards were published 2024-12-20: General Remarks v1.2, LCA Calculation Rules v2.0, Tool Verification Guidelines v1.1, Digital Data Requirements v1.1, Requirements for publishing digital data in ECO Portal v1.0, Quality Management Guidelines v2.0, Audit Guidelines v1.1, Audit Requirements v2.0.

PCR language(s):	At the time of publication, this c-PCR was available in English. If the c-PCR is available in several languages, these are available on www.environdec.com. In case of translated versions, the English version takes precedence in case of any discrepancies.

2.2 SCOPE

2.2.1 PRODUCT CATEGORY DEFINITION AND DESCRIPTION

This document provides complementary product category rules (c-PCR) for the assessment of the environmental performance of road marking systems and the declaration of this performance by an EPD. The product category corresponds to UN CPC 53211 - Highways (except elevated highways), streets and roads, UN CPC 53222 – Tunnel and UN CPC 54211 - General construction services of highways (except elevated highways), streets and roads.

2.2.1.1 UN CPC classification hierarchy:

- Section: 5 - Constructions and construction services
  - Division: 53 - Constructions
    - Group: 532 - Civil engineering works
      - Class: 5321 - Highways (except elevated highways), streets, roads, railways and airfield runways
        - SubClass: 53211 - Highways (except elevated highways), streets and roads
- Section: 5 - Constructions and construction services
  - Division: 53 - Constructions
    - Group: 532 - Civil engineering works
      - Class: 5322 - Bridges, elevated highways and tunnels
        - SubClass: 53222 - Tunnel
- Section: 5 - Constructions and construction services
  - Division: 54 - Construction services
    - Group: 542 - General construction services of civil engineering works
      - Class: 5421 - General construction services of highways (except elevated highways), streets, roads, railways and airfield runways
        - Subclass: 54211 - General construction services of highways (except elevated highways), streets and roads

For additional information, please visit https://unstats.un.org/unsd/classifications/Econ/Detail/EN/1074/54211.

2.2.1.2 Road marking materials:

Road marking materials are used to enforce traffic rules and guide drivers, pedestrians, cyclists, and other road users to their destinations in a safe and timely manner. Road marking materials are a crucial element in urban environments, guiding vehicle traffic and creating dedicated spaces for micromobility like bikes and scooters. These markings also play a vital role in Advanced Driver-Assistance Systems (ADAS) by providing visual cues for automated vehicle functions.

Road marking materials are typically systems, composed of a pigmented material and a surface component consisting of reflective objects (glass beads) to provide nighttime visibility and/or anti skid aggregates or and/or anti-skid properties of the road marking surface.

Road marking materials are a mixture of binders, pigments, fillers (incl. premix beads and antis-skid aggregates) and various additives (including polymers). Based on their composition and usage, these materials can be categorised as:

- Hot-applied thermoplastics;
- Preformed thermoplastics;
- Waterborne paints;
- Solvent-borne paints;
- Reactive, plural component systems;
- Preformed cold plastics, and
- Tapes.

The definition of each of these materials is described in the EN1871 and EN1790 standards. For preformed materials please follow the the definition described in EN18124.

Raised pavement markers, while providing similar function as road marking systems, are excluded from this c-PCR due to their specific technical properties.

In conclusion, [1] road marking materials are a speciality, heavy-duty industrial maintenance coating, [2] two-layer system always comprised of the road marking material and the drop-on glass beads and/or anti-skid materials, [3] only the combination of the two layers creates a functional road marking system, [4] the same materials used as drop-on material can be premixed with the road marking material.

2.2.1.3 Definition of premix and drop-on glass beads and other aggregates:

An essential part of road marking systems are premix and drop-on glass beads as well as antiskid aggregates. The glass beads (premix and drop-on) provide retroreflection, the aggregates skid resistance and all of them provide protection for road marking systems. Premix glass beads may additionally used as filler material to modify the rheology of the road marking material. According to the EN 1423 and EN 1424 standards, the definition of these products is the following:

- Glass beads - transparent spherical glass particles, used to provide night visibility for the road marking materials by retroreflecting the incident headlight beams of a vehicle towards the driver. Crystalline particles with refractive indices >1.9 are not necessarily glassy but in road marking materials play the same role, so they must be considered equally. In order to enhance friction, drop-on material typically is a mixture of glass beads and anti-skid aggregates.
- Antiskid aggregates - hard grains of natural or artificial origin, used to provide anti-skid qualities for road marking materials. They can be grouped into transparent anti-skid aggregates and non-transparent anti-skid aggregates.

2.2.2 TYPE OF EPD AND INFORMATION MODULES INCLUDED

See PCR 2019:14.

Following the requirements in Section 'Type of EPD and information modules included' of PCR 2019:14, an EPD based on this c-PCR may be in terms of system boundaries:

Type a.) Cradle to gate with modules C1-C4 and module D (A1-A3 + C + D);

Type b.) Cradle to gate with options, modules C1–C4, module D and with optional modules (A1–A3 + C + D and additional modules). The additional modules may be one or more selected from A4–A5 and/or B1–B7;

Type c.) Cradle to grave and module D (A + B + C + D);

Type e.) Cradle to gate with options (A1-A3 and additional modules). The additional modules may be A4 and/or A5.

EPDs of type e in the list above shall only be used if the following conditions are valid:

- the product or material is physically integrated with other products during installation so they cannot be physically separated from them at end of life,
- the product or material is no longer identifiable at end of life as a result of a physical or chemical transformation process,
- the product or material does not contain biogenic carbon, and
- the EPD is not intended to be used for business-to-consumer communication.

Section 4.3 provides more rules on the system boundaries.

2.2.3 GEOGRAPHICAL SCOPE

This c-PCR may be used globally.

2.2.4 EPD VALIDITY

See PCR 2019:14.

3 PCR REVIEW AND BACKGROUND INFORMATION

This c-PCR was developed in accordance with the PCR development process described in the GPI of the International EPD® System, including open consultation and review.

3.1 OPEN CONSULTATION

3.1.1 VERSION 1.0.0

This c-PCR was available for open consultation from 2024-11-05 until 2025-01-05 , during which any stakeholder was able to provide comments by contacting the PCR Moderator and/or the Secretariat.

Stakeholders were invited via e-mail or other means to take part in the open consultation and were encouraged to forward the invitation to other relevant stakeholders. The following stakeholders provided comments during the open consultation and agreed to be listed as contributors in the c-PCR and on www.environdec.com.

- Gernot Sauter - 3M Deutschland GmbH

3.2 PCR REVIEW

3.2.1 VERSION 1.0.0

PCR review panel:	The Technical Committee of the International EPD System. A full list of members is available on www.environdec.com. The review panel may be contacted via support@environdec.com. Members of the Technical Committee were requested to state any potential conflict of interest with the PCR Committee, and if there were conflicts of interest they were excused from the review.
Chair of the PCR review:	Rui Wang
Review dates:	2025-03-07 until 2025-04-18

3.3 EXISTING PCRS FOR THE PRODUCT CATEGORY

As part of the development of this c-PCR, existing PCRs and c-PCRs and other internationally standardised methods that could potentially act as c-PCRs for the product category in scope, were considered to avoid unnecessary overlaps in scope and to ensure harmonisation with established methods of relevance for the product category. The existence of such documents was checked among the following EPD programmes and international standardisation bodies:

- International EPD System. www.environdec.com.

No overlap found with other c-PCRs in the EPD programmes and international standardization bodies.

3.4 REASONING FOR DEVELOPMENT OF C-PCR

This c-PCR was developed to provide rules and guidance additional to those in PCR 2019:14 and EN 15804, for developing EPDs for the product category. The c-PCR thereby enables different practitioners to generate consistent results when assessing the environmental impact of products of the same product category, and thereby it supports comparability of products within a product category.

3.5 UNDERLYING STUDIES USED FOR C-PCR DEVELOPMENT

The methodological choices made during the development of this c-PCR (declared/functional unit, system boundary, allocation methods, impact categories, data quality rules, etc.) were primarily based on the following underlying studies:

- Deutsche Studiengesellschaft für Straßenmarkierungen e. V., "Environmental Impacts from Road Markings in Germany" 2024, Environmental Impacts from Road Markings in Germany (dsgs.de)
- Burghardt TE, Pashkevich A (2020) Materials selection for structured horizontal road markings: financial and environmental case studies, European Transport Research Review, 12, 11 doi: 10.1186/s12544-020-0397-x
- Cruz M, Klein A, Steiner V (2016) Sustainability assessment of road marking systems, *Transportation Research Procedia*, 14, 869-875. doi: 10.1016/j.trpro.2016.05.035
- Burghardt TE, Babić D, Pashkevich A (2022) Sustainability of thin layer road markings based on their service life. Transportation Research Part D: Transport and Environment, 109, 103339; doi: 10.1016/j.trd.2022.103339.
- Burghardt TE, Pashkevich A (2021) Green Public Procurement criteria for road marking materials from insiders' perspective. Journal of Cleaner Production, 298, 126521; doi: 10.1016/j.jclepro.2021.126521.
- Burghardt TE, Pashkevich A, Żakowska L (2016) Influence of volatile organic compounds emissions from road marking paints on ground-level ozone formation. case study of Kraków, Poland. Transportation Research Procedia, 14, 714–723; doi: 10.1016/j.trpro.2016.05.338.

4 LCA METHOD

This section provides rules for the LCA method used to develop an EPD for the product category as defined in Section 2.2.1.

4.1 MODELLING APPROACH

See PCR 2019:14.

4.2 DECLARED/FUNCTIONAL UNIT

EPDs based on this c-PCR may use a declared or functional unit. The declared or functional unit for road marking systems can be defined in the following ways:

- The declared unit is the specific unit for which the environmental impact of a product is assessed throughout its life cycle. Essentially it provides a base for comparison between different products within the same category.
    - The declared units for road marking systems are the following:
        - Mass: kg
        - Area: m^2
    - In every case conversion unit shall be provided in the technical details section in the EPD, to facilitate comparison between EPDs using different declared units. [e.g. Product Consumption: 0.428 kg/m^2, 4.56 kg/m^2]
- The functional unit refers to a quantified description of a product system's performance. It serves as a reference unit within an LCA study and provides a basis for comparing different products that fulfill the same function.
    - The functional unit shall be used if the road marking system's durability, performance and other services are also included in the environmental assessment.
    - The functional unit shall account for all variables that defines the durability of the road marking system during use phase, i.e.: [1] geographic region of the use phase, [2] the location of the road marking system in the traffic (if and which type of special area is applied on [i.e: curves, recessed road marking system, etc.]), [3] the width of the traffic lane, [4] number/type of heavy vehicles, [5] winter maintenance requirements, and [6] the presence and absence of studded tyres.
    - Example of functional units:
        - *"Guiding traffic and providing retroreflection on 1 m^2 of road surface with thermoplastic road marking system in Germany in a high traffic area with 150 mcd/m2/lx (R3), 130 mcd/m2/lx (Q3) with 50 (S2) SRT over 8 years of functional life time."*

Due to the wide variation of the influencing factors, even the same road marking system may require different functional units across regions – making direct comparison between the road marking systems difficult. Functional unit provide an accurate representation of the product performance under specific conditions. However, as these conditions – such as climate, traffic load, or road type – may vary significantly, the comparability between EPDs may be affected. To support informed decision-making, relevant product characteristics and certification details shall be included in the EPDs. The use of declared unit and the inclusion of certification and product performance details should enable EPD users to model scenarios that reflect local conditions.

4.2.1 REFERENCE SERVICE LIFE (RSL)

See PCR 2019:14.

The definition of the reference service life (RSL) of road marking systems is not straightforward. The performance of the road marking system is directly connected to their durability. The durability not only depends on the type of road marking material but also highly depends on environmental conditions, traffic load and type, surface texture, and proficiency of the application. The type of road marking system is defined by the formulation and the chemical properties of the products. Some road marking systems are inherently more durable than others. Environmental conditions such as climate (warm – cold), temperature fluctuations (high – low), precipitation (rain, snow, other), and UV radiation can hamper the performance and thus the durability of the road marking. Indirect effects of environmental conditions in cold climates, such as the negative effect of winter road maintenance and the use of studded tyres, which significantly reduce the reference service life of the road marking

systems must be considered. Depending on where the road marking systems are applied on the road surface, they can be exposed to various traffic loads. Generally, the areas with high traffic load areas are those where a significant transversal traffic (for example centre lines, stop lines, "zebra" crossings, internal edge lines at curves). The composition of the traffic load can further erode the durability of the road marking systems, with more heavy vehicles resulting in shorter reference service life. Furthermore, tyres of turning vehicles express torque that aggravates the damage to road markings disproportionally to the actual traffic load. The quality and conditions of application can also largely influence the durability of the products. Usually, better conditions during application and excellent workmanship result in higher durability.

The EPD shall declare the reference service life of the road marking system. If possible, the product life span can be declared, but it shall not exceed 15 years (or observation period) (see 4.2.2). These helps establish the maintenance period for the use phase of the road marking system and provides a consistent evaluation period when evaluating multiple EPDs.

4.2.1.1 Reference Service Life (Functional Service Life)

Reference service life refers to the period during which road markings effectively fulfil their intended purpose of guiding and informing road users and meeting the specified performance requirements. Homologation of road marking systems assures performance throughout the reference service life period. This encompasses several factors:

- Visibility: Road markings must be clearly visible both day and night and under various weather conditions. Retroreflectivity, measured as coefficient of retroreflected luminance [RL] is the ability of the road markings to reflect light from vehicle headlights back to the driver during night time, it is achieved due to the glass beads. Daytime visibility, measured as luminance coefficient under diffuse illumination [Qd] is used to assess the visibility of the road marking systems during daytime (alternatively, luminance factor β can be used).
- Color: The markings must retain their color on the road surface. For instance, white and yellow markings should remain distinct and not fade to the extent that they are hard to distinguish.
- Skid Resistance: Especially for areas like pedestrian crossings, the markings must maintain a certain level of skid resistance to ensure safety.
- Durability Against Wear: The markings must withstand traffic wear, such as abrasion from tires and mechanical wear from snow plows.
- Compliance with Standards: The markings should continue to meet regulatory standards set by relevant authorities.

The reference service life of the road marking system shall be selected based on the tables described in section 4.2.1.5. If the region of the road marking system in not described below, the relevant region shall be selected based on the climatic condition of the application region. If the climatic conditions does not match the reference service life shall be estimated based on the local conditions, and the details provided on the road marking system's durability.

The reference service life should be used to estimate the maintenance factor of the road marking system. For more information see section 4.2.2.

4.2.1.2 Product Lifespan (Physical Service Life)

The product lifespan refers to the total period during which the road marking system exists in place — from application until complete material degradation, regardless of whether it still meets functional performance requirements.

Key factors influencing physical service life include:

- Material durability: Resistance to UV radiation, thermal cycling, and moisture.
- Traffic loads: Volume and type (e.g., heavy turning vehicles).
- Environmental conditions: Climate, road surface characteristics, and winter maintenance practices.

It is important to note:

- The product lifespan is not necessarily equal to the RSL.
- A product may remain physically present after the end of its RSL but no longer provide the required visibility, safety, or compliance.
- In practice, road markings are often renewed upon reaching the end of their RSL, leading to a layering or stacking of marking systems over time.

In summary, while the RSL defines the performance-based timeframe for the EPD's functional unit, the product lifespan describes the physical persistence of the material. Proper design and maintenance can help optimize both.

4.2.1.3 Road marking systems' testing, durability and the markets' common practice defining the reference service life

The chapter aims to provide further understanding of the RSL and product life span of road marking systems. It details the certifications and testing of the road marking systems. Certifications can give credible guidance on the durability of a road marking system. It is not mandatory to follow them to create an EPD, as not all road marking systems are certified. The influencing factors of the road marking systems' durability are also described. Eventually, the common road marking practices are described, providing clear indication of the RSL in different regions.

A road marking system's certification gives indication about its quality and durability. Currently there are no globally accepted certifications; there are several well-established and respected systems in place. The standards EN 13197+A1:2014 and EN 1824:2020 describe the wear simulator or turntable testing and the field testing used for road marking certification. Both standards indicate the road marking system's quality and durability based on roll-over class. Due to the above-mentioned factors (see 4.2.1), translation of the rollover classes into an actual timeframe is difficult and not reliable.

For more information on road marking systems' testing please see EN 13197+A1:2014 and EN 1824:2020.

4.2.1.4 Evaluating the durability of road marking systems

There is no single method to accurately define the reference service life and the product lifespan of the road marking systems because they depend on many variables. The durability of road markings in practice needs to be assessed based on empirical observation across the regional or national road network. All necessary information that might be helpful for properly evaluating the EPD and include it in sustainable road infrastructure planning shall be included in the EPD, Section 4.2.2 gives detailed information on the requirement.

Furthermore, it is advised that a model based on empirical data is developed for each type of road marking system under particular regional conditions. The purpose of the model shall be to define an annual wear factor that later can be used to define a scheduled maintenance for the road marking systems. The scheduled maintenance would allow the definition of how many times the road marking systems must be reapplied over the analysed time period, or maintenance factor. The maintenance factor could give the correct estimate on the amount of material used during the reference service life, or the analysed time period.

4.2.1.5 Examples of common practice in the road marking industry for estimating the reference service life of road marking systems

Working together with the local representative of the road marking industry, apart from the already mentioned, a more hands-on approach has been added to estimate the reference service life of the road marking systems. The regional details provide sufficient information to define the RSL of the analysed road marking system. The RSL shall be selected based on the road marking system's intended market. (e.g., The EPD describes a solvent borne road marking system that is intended to be applied in France, than Table 4 shall be used to find the relevant RSL).

More information on how to adapt the information below to an EPD is added in section 4.2.2.

4.2.1.5.1 France

In France, the regulatory framework includes the Highway Code, the Vienna Convention, and the Interministerial Instruction on Road Signs and Signals (IISR), particularly Part 7, which mandates certification for white and yellow road markings. Since 1992, the certification process has been managed by ASCQUER, following standards NF-EN 1824 and NF-EN 1436. Certified road marking systems, comprising marking products and glass beads or aggregates, are granted the NF 058 Road Equipment mark.

To be used on French roads, products shall have a technical sheet and an annual Right of Use from ASCQUER. Certification classes vary: for example, Type I [6]markings for permanent white require P1 Q2 R3 S1, while Type II[7] amarkings for temporary

[6] Type I road markings "do not necessarily have special properties intended to enhance the retroreflection in wet or rainy conditions." (CEN, EN 1436:2018, Clause 3.7)

[7] Type II road markings have "special properties intended to enhance the retroreflection in wet or rainy conditions."(CEN, EN 1436:2018, Clause 3.8)

yellow require P1 Q1 R4 RW2 RR2 S1. Certified products include various paints, hot coatings, cold plastics, and prefabricated tapes, with durability ranging from 1 to 10 years depending on the product type. Table 1, Table 2 and Table 3 concludes the minimum requirements for the different road marking systems tenders in France.

Table 1: Minimum requirements for Type I road markings in France (from P1 to P6 and T1 to T2)

Road marking system	Colour	Minium requirement
Permanent	White	P1 R3 Q2 S1 and P1 Q3 S1
Permanent	Yellow	P1 R3 Q1 S1 and P1 Q1 S1
Temporary	Yellow	T1 R4 Q1 S1

Table 2: Minimum requirements for Type II road marking systems in France (from P1 to P6 and T1 to T2)

Road marking system	Colour	Minium requirement
Permanent	White	P1 R3 Q3 RW2 RR2 S1
Permanent	Yellow	P1 R3 Q1 RW2 RR2 S1
Temporary	Yellow	T1 R4 Q1 RW2 RR2 S1

Table 3: Minimum requirement for DAS[8] road marking systems in France (from P1 to P6)

Road marking system	Colout	Minium requirement
DAS	White	P1 Q2 R3
DAS	Black	P1

The IDRRIM (The Institute for Roads, Streets and Infrastructures for Mobility) 2019 (Table 4) guide provides average durability estimates for these products and recommendations for their compatibility. Additionally, an optional NF 331 Environment certification, issued by AFNOR, ensures lower environmental impact and includes criteria such as reduced hazardous substances, minimal VOC content, and controlled production waste.

Table 4: Guideline to estimate the durability of different road marking systems in France.

Types of road marking system	Estimated functional service lifetime
Solvent-based paints	1 year
Water-based paints	2 years
Reactive paints	2 years
Thermo extruded	4 years
Thermo ribbon	5 years
Thermo spray	3 years
Cold plastics	6 years
Thermo prefa tapes	5 years
Glued prefa tapes	9 years
No product specifications by class of roads	

[8] Dispositifs d'Alerte Sonore: It is a sound system on the marking lane that alert drivers when driving on them. These systems include rib lines that can be white in the line or black it is on the side on the line.

4.2.1.5.2 Germany

In Germany, road markings are regulated under the Straßenverkehrsordnung (StVO), requiring certification from the Bundesanstalt für Straßenwesen (BASt - Federal Highway Research Institute) before use on public roads. Certification is based on testing according to standards such as DIN EN 1423, DIN EN 1436, and others, as detailed in the TP M 2024 document. Road marking manufacturers must ensure compliance with the TL M 23 technical delivery conditions, with certificates issued for both permanent white and temporary yellow markings. These certificates specify essential parameters like material composition, thickness, and retro-reflectivity.

The ZTV M 13 standard outlines performance requirements, including the coefficient of retroreflected luminance (R_L) and luminance coefficient under diffuse illumination (Qd). Applicators must submit a BASt test certificate when tendering and adhere to specifications during application, providing a warranty under VOB regulations. Durability is measured by the period during which retro-reflectivity remains above the required thresholds, with renewal recommended if values fall below 80% of the minimum standards.

Environmental impact assessments of these systems consider their functional durability, with data provided by the Deutsche Studiengesellschaft für Straßenmarkierungen e.V. (DSGS). This data, outlined in the 2024 DSGS study, forms the basis for calculating environmental impacts and should be referenced in future evaluations. Please refer to Table 5.

Table 5: Typical application scenarios as recommended by German guidelines ZTV M 13 for various road marking system technologies and functional durability@80% of the corresponding technology based on empirical data from roads in Germany.*

Wear of the marking	Type	System	Functional durability@80% of minimum retro-reflectivity in use-phase required by ZTV M 13 [years]
Very High	Type II	Tape	10
		Thermoplastic Agglomerates	8
		Thermoplastic Flat	8
		Preformed Thermoplastic	8
		Cold Plastic Agglomerates**	9
		Cold Plastic Flat	8
Medium to High	Type II	Thermoplastic Agglomerates	9
		Thermoplastic Flat	9
		Preformed Thermoplastic	9
		Cold Plastic Agglomerates**	10
		Cold Plastic Flat	9
		Cold Spray Plastic	5
		Thermoplastic Spray	5
		Water-based Paint	2
		Solvent-based Paint	2
Low	Type I	Thermoplastic Flat	15
		Preformed Thermoplastic	15
		Cold Plastic Flat	15
		Cold Spray Plastic	8
		Water-borne Paint***	4
		Solvent-borne Paint***	4

** In case of novel or experimental road marking system technologies 3rd party verified data from practical qualification on the road according to ZTV M 13 (Praxisbewährung) shall be used to temporarily assign a functional durability@80% at the respective wear scenario given at that road until more practical experience is available.*

***:Used Cold Plastic Agglomerates may be refreshed with cold spray plastic Type I to restore Type II characteristics of the marking. Functional durability@80% of the refreshed cold plastic agglomerates Type II is 4 years.*

****:High solid 1 component and 2 component water-borne/solvent-borne paints.*

4.2.1.5.3 Sweden

Swedish road markings are governed by the Traffic Regulation (SFS 1998:1276), the Swedish Transport Agency's Regulations (TSFS 2010:171), and the Road Sign Regulation (SFS 2007:90). The Swedish Transport Administration (Trafikverket) mandates that road marking systems on state roads must be certified by NordicCert, following standards such as EN 1824, EN 1423, EN 1424, and EN 1436. Certification includes specific requirements for material thickness, ranging from 0.6 mm for waterborne paint to 4 mm for thermoplastic extrusion, with performance assessed in road trials. Maintenance is guided by AMA Anläggning and specific contract documents, where the choice of marking materials varies based on road classification and traffic volume. In performance contracts, any material can be used if functional parameters are maintained throughout the contract period.

Road marking classes (1-5) are determined by traffic volume, with higher classes receiving more frequent maintenance (Table 6). Thermoplastic extrusion is preferred for high-traffic roads, while waterborne paint is used for lower-traffic areas and maintenance. Solvent-based paints are prohibited, and cold plastics are rarely requested. The functional lifetime of road markings varies, with thermoplastic extrusion lasting up to 9 years on low-traffic roads.

Table 6: Functional service life of the corresponding technology based on experience from roads in Sweden for the different road marking classes.

Road marking Class	System	Thickness (mm)	Functional lifetime (years)
Class 1	Thermoplastic Extrusion	4	5
	Thermoplastic Extrusion	3	4
	Thermoplastic Extrusion*	2	2
	Thermoplastic Spray*	1.5	2
	Water-based paint*	0.6	1
Class 2	Thermoplastic Extrusion	4	6
	Thermoplastic Extrusion	3	5
	Thermoplastic Extrusion*	2	4
	Thermoplastic spray*	1.5	2
	Water-based paint*	0.6	1
Class 3	Thermoplastic Extrusion	4	7
	Thermoplastic Extrusion	3	6
	Thermoplastic Extrusion*	2	4
	Thermoplastic spray*	1.5	3
	Water-based paint*	0.6	2
Class 4	Thermoplastic Extrusion**	4	8
	Thermoplastic Extrusion**	3	7
	Thermoplastic Extrusion*	2	5
	Thermoplastic spray*	1.5	4
	Water-based paint*	0.6	2
Class 5	Thermoplastic Extrusion**	4	9
	Thermoplastic Extrusion**	3	8
	Thermoplastic Extrusion*	2	6
	Thermoplastic Spray*	1.5	5
	Water-based Paint*	0.6	4

**Only used for maintenance where the material is applied on top of the old road marking*
***Normally not used*

4.2.1.5.4 Austria

In Austria, road authorities are responsible for awarding contracts for road markings, with the selection of marking systems governed by the provisions of RVS 05.03.12. Tender documentation typically includes specific phrases derived from the standardized service catalogue LB-VI (RVS 01.03.12, Design and Structure of the Service Description for Traffic and Infrastructure). Among other specifications, traffic classes are outlined in the tender documents, and applicators must submit the BMK approval for the road marking system along with their bid. Upon contract award, applicators are required to apply the marking system precisely as specified in the approved documentation.

Applicators must provide a warranty in accordance with Austrian regulations ONR 22440-1 and ONR 22440-2. The functional life or durability of the road markings is defined by the period during which retroreflection remains above the specified threshold under traffic load. According to Austrian regulations, renewal of permanent white markings is mandatory when the remaining road marking surface falls below 85% or when critical performance values for retroreflection (R2), luminance (Q2), and skid resistance (S1) are not met.

The selection of road marking systems is based on multiple factors, including traffic load, lane width, type of marking, its position within the lane or in curves with specific radii, and environmental influences such as increased wear from grit spreading, snow chains, snow plowing, or maintenance vehicles. Additional considerations may include unusual or excessive wear.

From these factors, four traffic wear groups are calculated: low, low-medium, medium-high, and high (Verwendungsgruppe VG 1, 2, 3, 4). Road marking systems are then categorized into classes based on their projected lifespan within these wear groups (Markierstoffklasse MSK A, B, C, D), where MSK A represents the lowest performance, and MSK D represents the highest performance, as determined through test field application.

Adherence to these standards ensures that only appropriate materials, capable of withstanding the expected traffic wear, are used in road marking projects. This regulatory framework minimizes the risk of applying materials that would fail to meet the durability and safety expectations over time.

Table 7: Requirements according to traffic wear group (Markierungsstoffklasse)

Marking material Class (MSK)	Usage Group	Functional duration	End of warranty period
A	1	12	15th of May the following year
B	1	24	15th of May the second year
	2	12	15th of May the following year
C	2	24	15th of May the second year
	3	12	15th of May the followng year
D	2	48[b]	15th of May the fourth year
	3	36[b]	15th of May the third year
	4	24	15th of May the second year
[a]Not exceeding the functional duration. [b]Except for night visibility from the 24th month.			

Table 8: Typical application scenarios as recommended by Austrian guidelines RVS 05.03.12 for various road marking system technologies and functional durability of the corresponding technology based on empirical data from roads in Austria adapted to a 3 class without specific road conditions.

Wear of the marking	MSK	System	Minimum functional durability	Maximum functional durability
Very high VG4	D	Tape	4	10
		Preformed Thermoplastic	4	6
		Cold PLastic Agglomerates	4	6
		Cold Plastic Flat	4	6
Medium to High VG3	C	Preformed Thermoplastic	4	10
		Cold PLastic Agglomerates**	4	8
		Cold Plastic Flat	4	8
		Cold Spray Plastic	2	4
Low VG1, 2	A, B	Water-borne Paint	2	4
		Solvent-borne Paint	2	4
* according to regulations warranty for minimum requirements according to ONR 22440 ** according to common use and estimated latest maintenance				

4.2.1.5.5 Other regions

The estimates above might be used in other regions, with cautions related to climatic conditions. Future revisions of the c-PCR may include new estimates for other regions. Local standards and requirements can divert from the previously introduced EN standards. If necessary, consulting with local industry experts can help to define the reference service life and product life span of the road marking systems. Additionally local authorities may help interpret the most commonly used standards and certification within the region.

See PCR 2019:14 and Section 4.2.1.3.

4.2.2 TECHNICAL SPECIFICATION

Road marking systems are typically a composite product, with two main components:

- Road marking material
- Drop-on blends[9]

Standardized formulations of road marking materials and drop-on materials (such as glass beads) are manufactured for different national markets. The application technologies are typically adapted to the material rather than local specifics. System composition and traffic class are defined by national certifications. Countries have their own standards based on local traffic wear and climate conditions. As a result, many different certifications exist across markets.

Including the parameters defined by the certification (traffic wear, climate conditions, national certifications) in an EPD's use phase makes the outcome highly specific. Performing third-party verification of each country-specific road marking system EPD would be impractical due to the financial burden and additional workload it would impose on producers. Instead, producers can publish separate verified EPDs for their materials and drop-on components (such as glass beads and anti-skid aggregates), which is a more manageable approach. The application/use phase scenarios may be standardized to meet national requirements.

Whether the use phase is included in the EPD or not, it shall follow and document the principles below to develop a scenario for the use phase of the road marking system. This ensures that the road marking system can be properly evaluated over its lifetime, and supports the EPD user in building a representative use-phase scenario if needed.

The information shall include the followings:

- Road marking system composition: The amount of road marking material and the amount of drop-on material used to create the road marking system shall be specified, based on the road marking system's certification (*Error! R eference source not found.*). If a road marking material has multiple certification with different drop-on materials, all must be listed an the one used to create the scenario in the use phase shall be highlighted. The table shall include all the road marking materials that is expected to be used during the maintenance of the road marking system.

Table 9: Example of road marking system composition table that shall be included in the EPD

Certification body	Certification Number	Road marking material	Dosage/Consumption of road marking material	Drop - on metrial name	Drop-on amount [g/m^2]
NordicCert	*ABCD01-02 NO*	*Thermoplastic Agglomerate*	*3 – 5 kg/m^2*	*Glass beads 850-180*	*400 g/m^2*

- Observation period shall be 15 years, accounting for the expected performance under real-world traffic and environmental conditions.

- Maintenance factor: (dimensionless) indicates how many times the material is applied over the full observation period, and is used to scale the material quantities accordingly in the LCA. These values ensure consistent comparison across materials with different service lives within the same observation period.
  Certain road marking materials might fail to meet the given observation period, due to the traffic and environmental conditions they are exposed to. In such case additional road marking material may be used to maintain the road marking system's performance (The material may differ from the original product, in this case this shall be declared). The maintenance factor shall be based on the road marking material estimated reference service life (see under 4.2.1.5) and the observation period. The calculation of the maintenance factor shall be described transparently. E.g., if the road marking material is designed to be used in different regions/climatic conditions or certified with multiple certification bodies, all calculated maintenance frequency shall be listed in a table (Error! Reference source not f ound.).

[9] *Drop-on blends: mixture of drop on beads and anti-skid material. Manufacturer of drop on blends delivers the calculated emissions (e.g. eCO₂/m²) depending on the mixture/percentage of used drop on beads and anti-skid material, together with the required EPDs (for drop on beads and for anti-skid material).*

$$Maintenance\ factor = \frac{Observation\ period\ [years]}{Reference\ Service\ Life\ (RSL)[years]}$$

Table 10: Example on the inclusion of maintenance frequency

Road marking System	Intended regions	Traffic Load	RSL	Observation period	Maintenance factor
Cold plastic Agglomerates	Germany	Very high	9 years	15 years	1.875
	Austria	Very high	6 years	15 years	2.5

4.3 SYSTEM BOUNDARY

See PCR 2019:14.

EPDs that are developed based on this c-PCR shall cover product stage (A1-A3), end-of-life stage (C1-C4) as well as benefits and loads beyond the system boundary (D). Construction stage (A4-A5) and use stage (B1-B7) are optional. The scope allowed by this c-PCR and requirements for excluding information modules shall be aligned with PCR 2019:14 and EN 15804.

In case of conflicts between PCR for subsystems of the infrastructure (infrastructure components, e.g asphalt pavement) and this c-PCR, system boundaries specified in this c-PCR shall be used.

The following subsections describe the covered information modules, respective processes, and other rules on the setting of system boundary. For detailed information on each module, see EN 15804 (Section 6.3.5). Here only specific descriptions related to this c-PCR are provided.

4.3.1 PRODUCT STAGE: MODULES A1-A3

See PCR 2019:14 and Section 6.3.5.2 of EN 15804.

Guiding examples of processes to include in A1 – A3:

- Extraction and production of raw materials used in road marking materials' formulation [A1] (See Table 11),
- Extraction and production of raw materialsof product used during application that provide further functionality for the products [A1] (See Table 12)
- Transportation of raw materials to the production facility [A2]
- Manufacturing of road marking materials [A3]
- The tables below should be used as a guiding example, its content is not limited to the listed technologies and raw materials.

Table 11: Examples on product types and their chemical compositions (Non-comprehensive list)

Type	Raw material Groups	Raw Materials
▪ Waterborne paints	▪ Filler ▪ Binder ▪ Pigment ▪ Additive ▪ Solvent	▪ Calcium carbonate, talc, nepheline syenite… ▪ Acrylates, other polymers… ▪ Titanium dioxide and other inorganic pigments, organic pigments… ▪ Platicizers, defoamers, coalescent, dispersants, other chemicals… ▪ Water, organic co-solvents (like ethanol)…
▪ Solventborne paints	▪ Filler ▪ Binder ▪ Pigment ▪ Additive ▪ Solvent	▪ Calcium carbonate, talc, nepheline syenite, other … ▪ Acrylates, styrenic, other polymers… ▪ Titanium dioxide and other inorganic pigments, organic pigments… ▪ Platicizers, defoamers, dispersants, other chemicals… ▪ Organic solvents (ester, ketone, or hydrocarbon solvents)…

▪ Reactive, plural component systems	▪ Filler ▪ Binder ▪ Pigment ▪ Additive	▪ Calcium carbonate, sand, glass beads… ▪ Methyl methacrylate (MMA), other acrylates, epoxy… ▪ Titanium dioxide and other inorganic pigments, organic pigments… ▪ Platicizers, initiators, stabilisers, accelerators, retarders, other chemicals…
▪ Thermoplastics	▪ Premix Glass beads ▪ Filler ▪ Binder ▪ Pigment ▪ Additive	▪ Glass beads ▪ Calcium carbonate, sand, other inorganic fillers… ▪ Rosin esters, C5 hydrocarbon resin, C9 hydrocarbon resin, and their mixtures… ▪ Titanium dioxide and other inorganic pigments, organic pigments… ▪ Plasticizers, EVA, SIS, SBS and other polymers, other chemicals…
▪ Tape	▪ Adhesive ▪ Elastic rubber layer ▪ Polyurethane topcoat ▪ Surface materials ▪ Pigments ▪ Fillers ▪ Additives	▪ Organic chemicals ▪ Rubber ▪ Polyurethane ▪ Calcium carbonate, sand, ground ceramic particles (embedded ceramic elements, ceramic or non-ceramic anti-skid aggregates), and/or glass beads ▪ Titanium dioxide and other inorganic pigments, organic pigments… Plasticizers, other chemicals…
▪ Preformed materials (other than preformed tapes)	▪ Raw materials groups are the same depending on the type of the material. The production process is different.	

Table 12: Examples on additional products used during application and their chemical compositions (Non-comprehensive list)

Function provided	Product Groups	Raw Materials
▪ Retroreflection	▪ Glass beads ▪ Ceramic elements	▪ Sand, lime, dolomite, soda… ▪ Recycled materials (cullet)
▪ Friction	▪ Glass granulates ▪ Other friction materials	▪ Sand, lime, dolomite, soda … ▪ Corundum, crystobalite, crystalline silica, ceramic aggregates, crushed glass…
▪ Adhesion	▪ Primers ▪ Glues	▪ Resins, rosin esters, organic chemicals (plasticisers, solvents..), pigments… ▪ Resins, organic chemicals…
▪ Rheology and viscosity Modifiers	▪ Thinners	▪ Organic solvents (ester, ketone, or hydrocarbon solvents)), ▪ Additives…
▪ Initiators	▪ Liquid and solid peroxides ▪ Others	▪ Organic oxidisers (like dibenzoyl peroxide), addditives for stabilisation (like dibutyl phthalate)… ▪ Fillers (calcium carbonate, sand…), additives
▪ Retarders	▪ Composition differs in road markings types	▪ Glycols, waxes and plasticizers, organic acids…
▪ Accelerators	▪ Composition differs in road markings types	▪ Organic peroxides, ammonium chloride, amine accelerators (DMPT)…

4.3.2 CONSTRUCTION PROCESS STAGE: MODULES A4-A5

See PCR 2019:14 and Section 6.3.5.3 of EN 15804.

4.3.2.1 Transportation to the application site [A4]: (Processes not listed may be included).

The following processes shall be included in the transport scenario:

- Transportation distance of the road marking system from the manufacturing site to the application site.
  - The distance may be an estimation or the actual travel distance of the road marking system depending whether this information is known, or the EPD is project specific.
- Transportation method
  - If the transportation method is known it shall be included in the transportation scenario, if it is unknown, estimation based on the geographical scope (the road marking system's intended market) of the study may be made.
- IMPORTANT:
  - Additional transport distance and method for the maintenance shall be allocated in the use phase [Maintenance (B2)]
  - Example scenario:

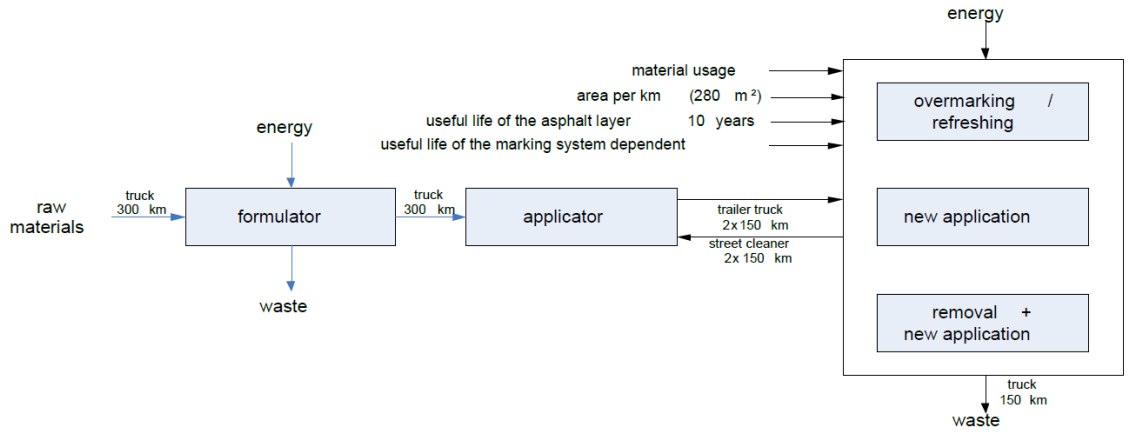

Figure 3: Transport routes of precoursors and marking systems from cradle to grave (Klein and Cruz, 2016)

4.3.2.2 Application [A5]:

The application method is a highly variable factor in terms of road marking systems. The design and intended application method for the road marking system shall be carefully considered and presented.

- The application phase shall include all related inputs and outputs needed for the application of the road marking system.
- Transportation during application: The application of the road marking system can be executed manually on site (i.e.: rolling two-component paint to a parking lot) or by specialized machinery. These vechicles can travel long distances during application due to the nature of the application site (i.e. 50 km right side lane application with extrusion application).
- Example:
  - Extrusion of a thermoplastic road marking system:
  - Input:
    - Road marking system components:
      - Thermoplastic extrusion road marking material
      - Drop-on material [Glass beads, agglomerate or both]
    - Energy used for melting the materials in the boilers, energy used for heating
    - Type of the energy used for melting the materials in the boilers, energy used for heating
    - Number of vehicles used in the application unit

- Fuel consumption of these vehicles
- Distance travelled, if relevant

- Output:
  - Losses of materials from the road marking system and transport to the waste treatment facility and end-of-life scenario
  - Packaging materials and its estimated losses (if applicable) and transport to the waste treatment facility and end-of-life scenario
  - Type and amount of materials used for cleaning the application equipment

Figure 6 illustrates the most common application methods used by the contractors in Norway:

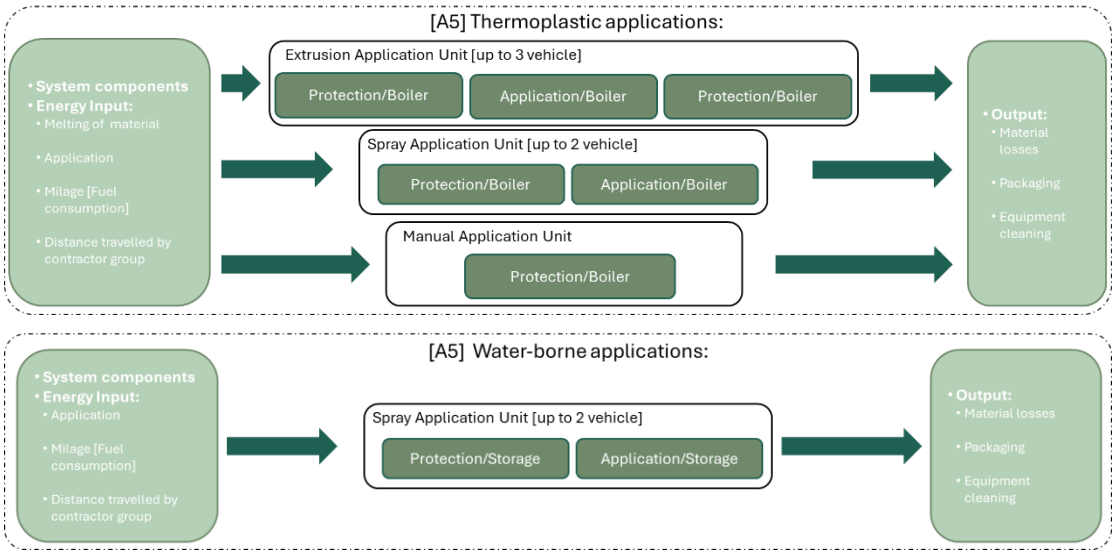

Figure 4: Example application scenarios in Norway

Table 13 compiles various application method for the different type of road marking systems. The application methods can be different in each region. It is suggested to consult with local authorities or contracting companies to find the right application method for the analysed road marking system in the EPD.

Table 13: Examples on application methods (Non-comprehensive list)

Application	Description	Material Type

▪ Manual	▪ Roller, brush, screed-box
	▪ Cleaning of the equipment (materials used in the process)
	▪ Additional output flows to air, soil or water (solvents, VOCs, etc.)
	▪ Tape:
	  ▪ Automatic tape applicator, manual tape applicator, stamping process – manual tamping or driving on tape with heavy vechicle
	▪ Preformed materials:
	  ▪ The application depens on the type of the preformed material. (Thermoplastic – blowtorch, PU materials – manual gluing, ect.)
	  ▪ The selected application method, and the used inputs shall be defined.
	▪ Consider other inputs and outputs
		▪ Primer
		▪ Tape
		▪ Waterborne paints
		▪ Solvent-borne paints
		▪ Reactive, plural component systems [cold plastics, two component systems, etc.]
		▪ Thermoplastics
		▪ Preformed materials

▪ Spray	▪ Various types of spray machinery. Collaboration with the local contractors is suggested to sufficiently estimate the input flows of the application process (fuel consumption during application, material loss…) ▪ Cleaning of the equipment (materials used in the process) ▪ Other output flows, such as fumes and pollutants has to be described if there are available data…	▪ Primer ▪ Water borne paints ▪ Solvent-borne paints ▪ Reactive, plural component systems [cold plastics, two component systems, etc.] ▪ Thermoplastics
▪ Extrusion	▪ Various types of extrusion machinery. Collaboration with the local contractors is suggested to sufficiently estimate the input flows of the application process (fuel consumption during application, material loss…) ▪ Cleaning of the equipment (materials used in the process)… ▪ Other output flows, such as fumes and pollutants has to be described if there are available data… ▪ Thermoplastics: ○ The heating of the thermoplastic material must be to be included in the application process (heat capacity of the material, type of energy used for heating…)	▪ Reactive, plural component systems [cold plastics, two component systems, etc.] ▪ Thermoplastics

4.3.3 USE STAGE: MODULES B1-B7

See PCR 2019:14 and Section 6.3.5.4 of EN 15804.

The following processes should be included in B1 – B7, if applicable:

- B1 – Use: This stage should include all the expected emissions[10] to the environment that is anticipated during the use of the road marking system.
- B2 – Maintenance: If scheduled maintenance activities, such are renewal, are expected during the road marking system's lifetime, the associated materials and energy flows shall be included in this module. (The right application method has to be selected based on the application methods described in Table 13)
- B3 – Repair: If scheduled repair activities, such as cleaning or mild abrasion to restore retroreflectivity, are expected during the road marking system's lifetime, the associated materials and energy flows shall be included in this module.
- B4 – Replacement: If schedule replacement activities, suh are replacement after winter maintenance, are expected during the road marking system's lifetime, the associated materials and energy flows shall be included in this module.
- B5 – Refurbishment: Not applicable.
- B6 – Operational Energy Use: All road marking systems are providing their function passively, thus this life cycle stage is not applicable.
- B7 – Operational Water Use: All road marking systems are providing their function passively, thus this life cycle stage is not applicable.

4.3.4 END-OF-LIFE (EOL) STAGE: MODULES C1-C4

See PCR 2019:14 and Section 6.3.5.5 of EN 15804.

The choice of the road infrastructure's end-of-life scenario shall be described in the EPD. The EPD developer should consider national standards and policies while creating the scenario.

- Typical end-of-life scenarios for road marking systems:
    - Worst case scenario, in which the road marking system is worn off completely at the end of the physical service life period.
    - Removal of the asphalt surface with cold planning/cold milling and landfilling of the materials
    - Removal of the asphalt surface, remelting it to a new asphalt surface together with the road marking system
    - Removal of road marking system with water jet/dry ice/cold planning etc.,
        - Removed material disposal or recycling or down-cycling in form of filler material for new road construction
- Define the fate of residual and lost material during the application and the use phase – i.e. dust pollution

4.3.5 BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY: MODULE D

See PCR 2019:14 and Section 6.4.3.3 of EN 15804.

The choice of scenario for benefits and loads beyond the system boundary shall be described in the EPD. The EPD developer should consider national standards and policies while creating the scenario.

4.4 CUT-OFF RULES

See PCR 2019:14 and EN 15804.

[10] These emissions could be expected substances (i.e. high boiling film forming agents in paints or plasticizers that contribute to VOCs, POCP or other toxicity emissions). Furthermore, particles from wear of the road marking system (i.e. microplastic particles), whose during small maintenance work such as washing and winter maintenance.

4.5 PROCESS FLOW DIAGRAM

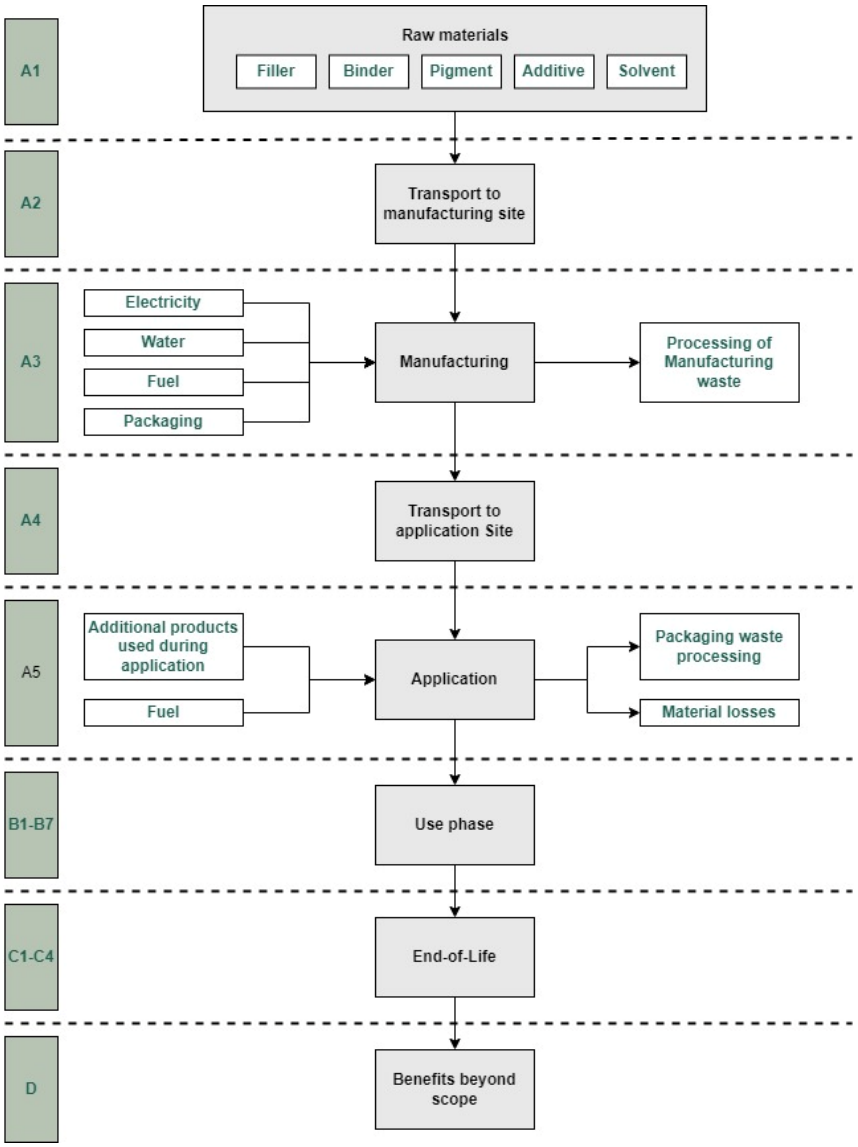

Figure 5. Process flow diagram illustrating the processes that shall be included in the product system, divided into the life-cycle stages. The illustration of processes to include may not be exhaustive.

4.6 ALLOCATION RULES

See PCR 2019:14 and EN 15804.

4.7 DATA CATEGORIES AND DATA QUALITY RULES

See PCR 2019:14 and EN 15804.

4.8 OTHER LCA RULES

See PCR 2019:14.

4.9 SPECIFIC RULES PER LIFE-CYCLE STAGE AND MODULE D

See PCR 2019:14.

4.10 ENVIRONMENTAL PERFORMANCE INDICATORS

See PCR 2019:14 and EN 15804.

4.11 SPECIFIC RULES PER EPD TYPE

See PCR 2019:14.

5 CONTENT OF THE LCA REPORT

See PCR 2019:14.

5.1 LAYOUT OF THE PRESENTATION

See PCR 2019:14.

5.2 DESCRIPTION OF THE LCA MODELLING

See PCR 2019:14.

6 CONTENT AND FORMAT OF EPD

See PCR 2019:14.

6.1 EPD LANGUAGES

See PCR 2019:14.

6.2 UNITS AND QUANTITIES

See PCR 2019:14.

6.3 USE OF IMAGES IN EPD

See PCR 2019:14.

6.4 SECTIONS OF THE EPD

See PCR 2019:14.

6.4.1 COVER PAGE

See PCR 2019:14.

6.4.2 GENERAL INFORMATION

See PCR 2019:14.

6.4.3 INFORMATION ABOUT EPD OWNER

See PCR 2019:14.

Mandatory information:

- The owner of the EPD shall be the producer of the road marking material/system, glass beads and other aggregates or applicator/contractor. An environmental management system may be cited
- Short description of the organisation, including all relevant information on products- or management system-related certifications (e.g. Ecolabels [Type I], ISO 9001 and 14001 certificates, etc.) and other sustainability work that the organization wants to communicate (e.g. social responsibility, supply-chain management, etc.)
- Name and contact information of the organisation carrying out the underlying LCA study.

Recommended information:

- In case other partners are involved in the EPD development process, their role and contribution may be described.

6.4.4 PRODUCT INFORMATION

See PCR 2019:14.

Mandatory information to declare:

- The name, location of manufacturing and the product design shall be described. A descriptive image of the product must me included.
- Description of the intended usage.
- Relevance to any websites for more information or explanatory materials.
- Declared/Functional Unit

- All assumptions made while defining the RSL and product life span.
- The following information shall be shared:
  - Description of road marking system (See 4.2.2)
  - Estimated dosage [kg/m^2]
  - Recommended thickness (note whether it is dry or wet) [mm]
  - Drop-on amount [kg/m^2]
  - Additional products used for application (primer, initiator, actual quantity, etc.)
  - Observation period (See 4.2.2)
  - Maintenance factor (See 4.2.2)
- Process flow diagram/system diagram, divided into the life cycle stages and information modules defined according to the EN 15804 standard. See Table 3 in PCR 2019:14, v.1.3.4 for an example.
- Description of geographical scope.
- Declaration of the year(s) representative for the inventory used for the A and B modules.
- Reference to the main database(s) for generic data and LCA software used, if relevant.
- The EPD shall declare the energy source behind electricity used in the manufacturing process in A3 and its climate impact as kg CO2 eq./kWh (using the GWP-GHG indicator)
- Data and information from the technical datasheet of the product.

6.4.5 CONTENT DECLARATION

See PCR 2019:14.

6.4.6 LCA INFORMATION

See PCR 2019:14.

6.4.7 ENVIRONMENTAL PERFORMANCE

See PCR 2019:14.

6.4.8 ADDITIONAL ENVIRONMENTAL INFORMATION

See PCR 2019:14.

In addition, available additional information not derived from the LCA study may be included in the EPD. This information can be the following:

- Recommended handling of packaging waste during application
- Biodegradability of the product
- Use of locally sourced materials
- Efforts to reduce packaging impact
- Transport optimization and logostic efficiency
- Social and ethical sourcing

6.4.9 THADDITIONAL SOCIAL AND ECONOMIC INFORMATION

See PCR 2019:14.

6.4.10 INFORMATION RELATED TO SECTOR EPDS

See PCR 2019:14.

6.4.11 VERSION HISTORY

See PCR 2019:14.

6.4.12 ABBREVIATIONS

See PCR 2019:14.

6.4.13 REFERENCES

See PCR 2019:14.

7 LIST OF ABBREVIATIONS

In addition to abbreviations listed in PCR 2019:14, Section 7:

ADAS	Advanced Driver-Assistance Systems.
AMA	Allmänna Material- och Arbetsbeskrivningar (Swedish General Material and Work Descriptions).
CEN	European Committee for Standardization (an organisation that develops EN standards).
DIN	The German Institute for Standardization
DMPT	Dimethylaminopropyl methacrylamide (chemical used in some road marking materials).
EN	European Norm
EVA	Ethylene Vinyl Acetate (a copolymer).
ISO	International Organization for Standardization
MEK	Methyl ethyl ketone (solvent, VOC).
MMA	Methyl Methacrylate (resin / binder used in some road markings).
NF	Norme Française (French Standard).
POPC	Polyolefin Plastic Composite (material used in some road marking or related products).
PU	Polyurethane (polymer used in some road marking systems).
SBS	Styrene-Butadiene-Styrene (an elastomer used in thermoplastic road markings).
SIS Polymer	Styrene Isoprene Styrene polymer
SVHC	Substance of Very High Concern (REACH classification).
SVMF	Svenska Väg- och Markbeläggningsfabrikanternas Förening (Swedish Association of Road and Pavement Manufacturers).
TSFS	Swedish Transport Agency Regulations and General Advice (Transportstyrelsen Föreskrifter och Allmänna Råd)
VOB	Vergabe- und Vertragsordnung für Bauleistungen (German Construction Contract Regulations).
VOC	Volatile Organic Compound (evaporating chemicals).
VTI	Väg- och Trafikinstitutet (Swedish National Road and Transport Research Institute).
ZTV M	Zusätzliche Technische Vertragsbedingungen für Markierungen (German Additional Technical Contract Conditions for Markings).
IDRRIM	The Institute for Roads, Streets and Infrastructures for Mobility

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CEN (2014) EN 13197+A1:2014 Road marking materials. Wear simulator Turntable.

CEN (2011) EN 1824:2020 Road marking materials. Road trials.

CEN (2012) EN 1423:2012 Road marking materials. Drop on materials - Glass beads, antiskid aggregates and mixtures of the two.

CEN (2013) EN 1790:2013 Road marking materials. Preformed road markings.

CEN (2014) EN 13197+A1:2014 Road marking materials. Wear simulator Turntable.

CEN (2024) EN EN 18124:2024 Road marking materials - Temporary road markings

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9 VERSION HISTORY OF C-PCR

VERSION 1.0.0, 2025-06-03

Original version of the c-PCR.