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A VERIFIED ENVIRONMENTAL DECLARATION

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Bitumen with rubber dust from end-of-life tyres

Environmental Product Declaration

EN ISO 14025:2010
EN 15804:2012+A1:2013

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REPSOL

REPSOL LUBRICANTES Y ESPECIALIDADES, S.A.

The holder of this declaration is responsible for its contents and for preserving the supporting documentation that substantiates the data and statements included therein during the validity period.

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AENOR is a founding member of ECO Platform, the European Association of Verification Programmes for Environmental Product Declarations

European Standard EN 15804:2012+A1:2013 serves as the basis for the PCR
Independent verification of the Declaration and data, according to Standard EN ISO 14025:2010 ☐ Internal ☒ **External**
Verification body AENOR Confía

1. General Information

1.1. The organisation

The holder of this Environmental Product Declaration (EPD) is RLESA.

Repsol is a global company that seeks people's well-being and plays a proactive role in building a better future by developing smart energies. It is an integrated, highly diversified company that covers a wide range of businesses, from more classical ones such as exploration, refining, and fuel sale and distribution, to others such as LPG (a world leader) and new energies (wind power, etc.).

Repsol Lubricantes y Especialidades S.A. is a Repsol group company that develops, produces, and markets lubricants, specialised products, and asphalt bitumens and their derivatives.

1.2. Scope of the Declaration

This environmental product declaration describes the environmental information regarding the life-cycle of bitumens containing end-of-life tyre crumb rubber produced in 2018 by RLESA at its production plant in Puertollano (Ciudad Real, Spain).

The main purpose of these products is to act as a binding component that gives cohesion to asphalt bitumen mixes and is primarily responsible for their properties.

1.3. Life-cycle and compliance

This EPD has been developed and verified in accordance with Standards UNE-EN ISO 14025:2010 and UNE-EN 15804:2012+A1:2014.

This environmental declaration includes the following life-cycle stages: A1 to A3.

This EDP includes the life-cycle stages shown in table 1. This EDP is of the cradle-to-gate type.

This EPD may not be comparable with those developed in other Programs or according to different reference documents; in particular, it may not be comparable with EPDs not developed and verified in accordance with the Standard UNE-EN 15804.

Similarly, EPDs may not be comparable if the origin of the data is different (for example, databases), not all relevant information modules are included, or they are not based on the same scenarios.

Product stage	A1	Raw material supply	X
	A2	Transport to factory	X
	A3	Manufacturing	X
Const.	A4	Transport to site	MNE
	A5	Installation/construction	MNE
Use stage	B1	Use	MNE
	B2	Maintenance	MNE
	B3	Repair	MNE
	B4	Replacement	MNE
	B5	Refurbishment	MNE
	B6	Operational energy use	MNE
	B7	Operational water use	MNE
End-of-life	C1	Deconstruction/demolition	MNE
	C2	Transport	MNE
	C3	Waste processing	MNE
	C4	Disposal	MNE
	D	Potential for reuse, recovery and/or recycling	MNE

X = Module included in the LCA; NR = Module not relevant; MNE = Module not evaluated

Table 1. System boundaries. Information modules considered

2. The product

2.1 Identification of the product

As part of its continuing interest in innovation and its focus on improving the environment, Repsol has developed a proprietary technology to use rubber from end-of-life tyres that improves certain properties of conventional penetration bitumen, making them similar to polymer modified bitumens.

In addition to technical advantages, these bitumens (CPC 33500) provide significant environmental benefits as they help eliminate the disposal of end-of-life tyres in dumps.

It can be said that the bitumens manufactured using this technology stand midway between conventional bitumens and polymer modified bitumens.

To comply with the specifications described in OC 21/2007 on the use and specifications that binders and bituminous mixes including rubber from end-of-life tyres must meet, in addition to OC 21bis/2009 on improved bitumens and high-viscosity bitumens modified with waste (end-of-life) tyre rubber (WTR) and the criteria to be taken into account for their manufacture in situ and worksite storage, RLESA uses an industrial wet manufacturing process that makes it possible to ensure traceability during production, quality, and product digestion times.

The stability and homogeneity of the final product is achieved using a special process and preselected bitumens, resulting in the following range of products: Rubber Improved Bitumens, Rubber Modified Bitumens and High Viscosity Rubber Modified Bitumen.

End-of-life crumb rubber bitumens are mainly used to manufacture bituminous mixes in accordance with the instructions described in the PG-3 General Technical Specifications for Road and Bridge Works road regulations.

2.2. Product features

Those described in OC 21/2007 and 21bis/2009 for products manufactured at the RLESA facility.

2.3. Product composition

The following table shows the main components of the product.

Substance	Content	Units
Bitumen	90-95	%
WTR Powder	5-15	%

Table 2. Main product components

None of the raw materials used to produce this product are on the Candidate List of Substances of Very High Concern (SVHC) for Authorisation or subject to any other regulation.

3. LCA Information

3.1. Life cycle assessment

The LCA report was drawn up by ReMa- INGENIERÍA, S.L., using data provided by REPSOL on the production processes of end-of-life crumb rubber bitumens at the plant in Puertollano (Ciudad Real, Spain). Subsequently, the data were entered into the LCAmanager tool developed by SIMPPLE to obtain the various impact values from the Ecoinvent database v3.6 and CML method characterisation factors (September 2016 revision). All this information was included in the "LCA report on conventional bitumen, polymer modified bitumen, bitumens with end-of-life tyre crumb rubber and bituminous emulsions – REPSOL. v5. 26 June 2020".

The LCA study followed the recommendations and met the requirements of international standards ISO 14040:2006 and ISO 14044:2006, in addition to the standards corresponding to the basic product category rules for construction products, UNE EN 15804, and type III of the environmental labelling standard UNE EN ISO 14025.

3.2. Functional/declared unit

The declared unit was defined as: **"1 tonne of end-of-life crumb rubber bitumen"**.

3.3. Reference service life (RSL)

Not applicable.

3.4. Allocation and cut-off criteria

Bitumen is a co-product of the oil refining process. To evaluate the environmental impact of bitumen, a method must be determined for allocating the impacts of the production chain to bitumen and other co-products: liquefied petroleum gas, gasoline, kerosene, diesel, heavy fuel oil, etc. The refinery receives crude oil from various sources and, after several distillation stages, refinery flows are obtained that will be used to produce bituminous materials, among other products. When assigning the energy consumption associated with the production of refinery flows, the methodology described in the document "The EUROBITUME Life-cycle inventory for bitumen. Version 3.0. December 2019" was followed.

As indicated in that study, the distillation process is governed by thermodynamic principles that determine the change of state (from liquid to gas), and most of the energy needed by the distillation process is used to provide the enthalpy of vaporization to change the distillate fractions from the liquid phase to gas (enthalpy of vaporisation).

This energy is recovered as the enthalpy of condensation when the distillates condense further up the distillation column and are collected using heat exchangers.

Bitumen is a residual flow and its state does not change during the distillation process. The approach taken in this study was to consider only the heat required to raise the temperature of the bitumen molecules contained in the crude oil, using the specific heat capacity of bitumen to determine the amount of energy required to raise the temperature of the crude oil bitumen fraction to 175°C. A conservative estimate of 90% efficiency was used for the heat exchanger and the energy consumption was adjusted as a result.

The following procedure was followed to assign the loads for the use of recycled materials and the recycling of waste: the recycling of waste from one process that is reused in a different productive process is assigned to the cycle of the second product.

More than 95% of all energy and material inputs and outputs to and from the system were included in this cradle-to-gate LCA study.

3.5. Representativeness, quality and selection of data

To conduct the study of the upstream stages (crude oil extraction and transport) data were used from the document "THE EUROBITUME LIFE-CYCLE INVENTORY FOR BITUMEN VERSION 3.0. December 2019" and the reports of the International Association of Oil & Gas Producers(IOGP) for the period 2013-2017.

To inventory the environmental loads associated with recycling crumb rubber, bibliographic data were used.

To conduct the study on the process of producing bitumen with crumb rubber from end-of-life tyres, data for 2018 relating to REPSOL refineries (Puertollano and Cartagena, Spain) and from the RLESA production plant that manufactures this product in Puertollano (Ciudad Real, Spain) were used.

The precision and accuracy of the data entered into the databases used (Ecoinvent v3.6) were evaluated by the authors and the degree of uncertainty obtained was acceptable for the purposes of this report. In addition, the data collected or calculated by the authors of this study are considered to have a low level of uncertainty, since they refer to manufacturing information that was supplied and explained in detail by the company's managers.

To evaluate the quality of the primary data on the production of the declared product, semi-quantitative data quality assessment criteria were followed (data quality rating or DQR), as proposed by the European Union in its Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF) Guide.

The following table shows the data quality rating (DQR) used to identify the quality level.

Overall data quality rating (DQR)	Overall data quality level
≤ 1.6	Excellent quality
1.6 to 2.0	Very good quality
2.0 to 3.0	Good quality
3.0 to 4.0	Reasonable quality
> 4.0	Poor quality

Overall data quality rating based on the data quality score obtained

The overall quality of the data was calculated by adding together the quality score obtained on each of the quality criteria and dividing it by the total number of criteria. The score for each of the criteria varies from 1 to 5, with 1 being the highest quality and 5 the worst.

The results obtained for each of the criteria are as follows:

- Technological representativeness (TeR): Very good, score 1.
- Geographical representativeness (GR): Very good, score 1.
- Time-related representativeness (TiR): Very good, score 1.
- Completeness (C): Very good, score 1.5.
- Precision/uncertainty (P): very low, score 1.5.
- Methodological appropriateness and consistency (M): Reasonable, score 3.

According to these results, the data quality rating (DQR) obtained is equal to 1.5, which indicates that the quality of the data used is excellent.

3.6. Other rules for calculation and hypotheses

This EPD describes the average behaviour of a set of products. The results presented in this document are representative of the product "end-of-life crumb rubber bitumen". These average results were calculated as the average of the results for bitumens manufactured in 2018 at the Puertollano plant (Ciudad Real, Spain).

To check the representativeness of the average results, the coefficient of variation was calculated by dividing the standard deviation by the arithmetic mean of the impact category results for products containing a lesser and greater percentage of bitumen, obtaining values below 6%. There are no universal criteria for stating that a coefficient is "low" or "high", although in practice values of less than 30 or 40% tend to be considered low, between these figures and approximately 80% are considered moderate, and the dispersion is considered to be quite high when they exceed 120 or 140%. Therefore, in light of these results, it can be stated that the dispersion is generally low; therefore the representativeness is high. The results for each of the products and the coefficient of variation can be found in section 5 of this declaration.

4. System boundaries, scenarios and additional technical information

The scope of this study was defined as cradle to gate, covering only the manufacturing module (extraction and preparation of raw materials, production of bitumen with end-of-life crumb rubber and transport between these stages).

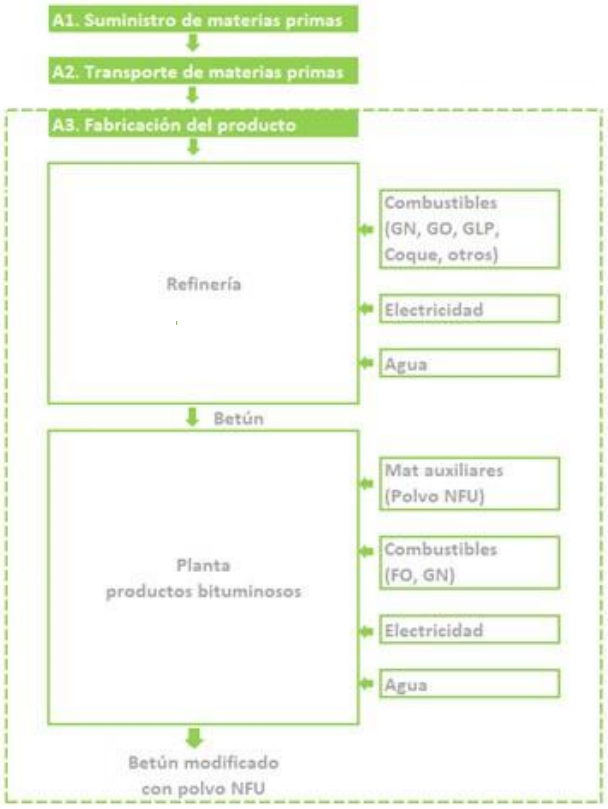

Figure 1. Stages studied

4.1. Processes prior to manufacture (upstream) and product manufacture (A1-A3)

A1 Production of raw materials

The crude oil extraction data used in this study are based on data from the International Association of Oil & Gas Producers (IOGP), provided in the document "The EUROBITUME Life-cycle inventory for bitumen. Version 3.0. December 2019" and supplemented by Ecoinvent datasets for secondary processes.

The crude oil extraction data are an average of the data for the years 2013–2017, extracted from the IOGP Environmental Performance Indicators reports.

The IOGP data include the following operations, among others:

- Drilling (exploration, evaluation and production Drilling
- Extraction and separation of crude oil and gas (primary production).
- Primary crude oil processing (separation of water, stabilisation);
- Transport of crude oil by pipeline to storage facilities;
- Loading of crude oil tankers at sea from primary production;
- Onshore crude oil storage connected to primary production facilities by pipeline;
- Transport of gas to the processing plant (offshore/onshore);
- High sea support and reserve vessels;
- Mining activities related to hydrocarbon extraction.

A2 Transport

The crude oils used in European bitumen production are mainly transported to refineries by ship. The exception is crude oil from the former Soviet Union, which is partly transported by pipeline. This study presumes that the crude oil from this region is transported from the Samara region to the Baltic Sea by the Baltic Pipeline System (BPS) and then from the Baltic Sea to the ARA region by ship.

For transport by oil pipeline and ship, oil pipeline company data were used from the document "The EUROBITUME Life-cycle inventory for bitumen. Version 3.0. December 2019" was followed.

A3 Product manufacturing

REFINERY

The crude oils received by the refinery are heated and enter the atmospheric distillation column.

The residue from atmospheric distillation is subject to a second distillation in a vacuum column to produce paving-grade bitumen. The refinery produces a wide range of petroleum derivative products, with bitumen being a minor product compared to others.

END-OF-LIFE CRUMB RUBBER BITUMEN PLANT

The tyres have previously been treated using a grinding process and, after removing other components such as metals and fibres, a powder or crumb is obtained containing granules measuring between 5-8mm.

The powder contains rubber and other components, and when added to bitumen it gives it certain rheological properties that conventional penetration bitumens do not have.

The manufacturing process takes place at special plants that have a bitumen storage tank, and the end-of-life crumb rubber is added to this tank.

The entire process takes place at the temperature defined using a formula that has been previously validated in the laboratory and the proportions of each of the components depend on the type of product to be manufactured. The mix is made using a powerful shearing process, which produces a product that is stable when stored at suitable temperatures to allow homogenisation.

In addition to the shearing process, there is another recirculation stage so that the final product reaches the highest degree of homogenisation.

The various products manufactured are stored in tanks with temperature and agitation systems and are distributed by tankers to bituminous mix manufacturing plants.

Prior to marketing, the penetration and softening point of the products are tested to ensure that they meet the specifications described in the regulations applicable to these products, as established in OC 21/2007 and OC 21bis/2009.

In addition to the initial checks made at the manufacturing plant, there is a scheduled and documented quality control system to ensure that all product characteristics meet the corresponding standards.

4.2. Transport and construction process *(A4-A5)*

Modules A4-A5 not evaluated.

4.3. Use linked to the building's structure

Modules B1-B5 not evaluated.

4.4. Use linked to the building's operation

Modules B6-B7 not evaluated.

4.5. End-of-life

Modules C1-C4 not evaluated.

4.6. Benefits and loads beyond the building system boundaries

Module D not evaluated.

5. Declaration of environmental parameters derived from the LCA and LCI

The estimated impact results are relative and do not indicate the final value for the impact categories, nor do they refer to threshold values, safety margins or risks.

	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP	1,85E+02	3,25E+01	3,64E+01	2,54E+02	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
ODP	1,20E-05	6,83E-06	3,25E-06	2,20E-05														
AP	7,91E-01	7,26E-01	8,89E-02	1,61E+00														
EP	9,90E-02	1,14E-01	8,33E-03	2,22E-01														
POCP	3,47E-02	1,59E-02	4,65E-03	5,53E-02														
ADPE	5,83E-05	2,57E-05	8,91E-06	9,29E-05														
ADFP	4,35E+04	3,63E+02	1,60E+02	4,40E+04														

GWP [kg CO_2 eq]	Global warming potential
ODP [kg CFC-11 eq]	Ozone depletion potential
AP [kg SO_2 eq]	Acidification potential of soil and water
EP [kg $(PO_4)^{3-}$ eq]	Eutrophication potential
POCP [kg ethylene eq]	Photochemical ozone creation potential
ADPE [kg Sb eq]	Abiotic depletion potential for non-fossil resources (ADP-elements)
ADPF [MJ]	Abiotic depletion potential for fossil resources (ADP-fossil fuels)

Table 2. Parameters describing the environmental impacts defined in Standard UNE-EN 15804

Coefficient of variation

Bitumens with tyre crumb rubber are only produced at the Puertollano plant. To calculate the dispersion of the results, the products with the greatest and least impact were studied, i.e., those with the greatest and lowest percentage of bitumen, 95% and 90% respectively. The following table shows the results corresponding to the environmental impacts of the different bitumens and the coefficient of variation of the results:

Impact category	Average WTR bitumen	Least WTR bitumen	Greatest WTR bitumen	Coefficient of variation (%)
GWP	2.54E+02	2.34E+02	2.55E+02	4.13
ODP	2.20E-05	2.04E-05	2.22E-05	4.09
AP	1.61E+00	1.48E+00	1.62E+00	4.35
EP	2.22E-01	2.05E-01	2.23E-01	4.05
POCP	5.53E-02	5.11E-02	5.56E-02	4.07
ADPE	9.29E-05	8.58E-05	9.34E-05	4.09
ADPF	4.40E+04	4.06E+04	4.43E+04	4.20

Variability/Dispersion. WRT crumb rubber modified bitume

	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	2,02E+01	7,52E+00	3,56E+00	3,13E+01	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
PERM	0,00E+00	0,00E+00	0,00E+00	0,00E+00														
PERT	2,02E+01	7,52E+00	3,56E+00	3,13E+01														
PENRE	4,73E+04	3,95E+02	1,66E+02	4,78E+04														
PENRM	4,12E-01	0,00E+00	0,00E+00	4,12E-01														
PENRT	4,73E+04	3,95E+02	1,66E+02	4,78E+04														
SM	0,00E+00	0,00E+00	0,00E+00	0,00E+00														
RSF	0,00E+00	0,00E+00	0,00E+00	0,00E+00														
NRSF	0,00E+00	0,00E+00	0,00E+00	0,00E+00														
FW	2,07E-01	2,49E-02	2,27E-01	4,59E-01														

PERE *[MJ]* Renewable primary energy use excluding renewable primary energy resources used as feedstock
PERM *[MJ]* Use of renewable primary energy used as feedstock
PERT *[MJ]* Total renewable primary energy use
PENRE *[MJ]* Non-renewable primary energy use, excluding non-renewable primary energy resources used as feedstock
PERNRM *[MJ]* Use of non-renewable primary energy used as feedstock
PERNRT *[MJ]* Total non-renewable primary energy use
SM *[MJ]* Use of secondary materials
RSF *[MJ]* Use of renewable secondary fuels
NRSF *[MJ]* Use of non-renewable secondary fuels
FW *[m³]* Net use of tap water resources

Table 3. Parameters describing resource use

	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	1,06E-03	5,37E-04	4,48E-03	6,08E-03	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE	MNE
NHWD	1,03E+00	4,03E-01	4,18E-01	1,85E+00														
RWD	1,37E-03	4,35E-03	1,21E-03	6,93E-03														
CRU	0,00E+00	0,00E+00	0,00E+00	0,00E+00														
MFR	0,00E+00	0,00E+00	5,20E+00	5,20E+00														
MER	0,00E+00	0,00E+00	0,00E+00	0,00E+00														
EE	0,00E+00	0,00E+00	1,66E+01	1,66E+01														
EET	0,00E+00	0,00E+00	0,00E+00	0,00E+00														

HWD	*[kg]*	Hazardous waste disposed of
NHWD	*[kg]*	Non-hazardous waste disposed of
RWD	*[kg]*	Radioactive waste disposed of
CRU	*[kg]*	Components for re-use
MFR	*[kg]*	Materials for recycling
MER	*[kg]*	Materials for energy recovery
EE	*[kg]*	Exported energy
EET	*[kg]*	Exported energy (thermal)

Table 4. Parameters describing output flows and waste categories

6. Additional environmental information

Recycling of bituminous materials

According to the Austroads "Asphalt Recycling Guide", in general, 100% of the materials recovered from damaged road surfaces can be reused, either for the site where they were generated, for another road surface (the more usual practice), or on other construction sites.

Asphalt road surfaces can be reused in two ways: at plants manufacturing new hot mixes, a process which involves removing the bituminous layers from old roads using grinding or demolition in order to transport the material to a manufacturing centre, where it is stored, characterised and possibly processed until it meets certain size, humidity, etc., conditions. Subsequently, after treatment, this material is incorporated into the new mix in different percentages depending on the capacity of the plant. Alternatively, it is mixed while hot with virgin aggregates, new bitumen and/or rejuvenating agents to obtain a composite bituminous mix that is laid and compacted on-site as if it were a conventional mix, providing the same performance.

One way to use the material from roads is to apply it while cold using a bituminous emulsion as a binding agent. This technique also has the advantage of making it possible to reuse 100% of the recycled material extracted directly from the road surface without the need to transport it to a plant or heat the material before applying it again, which helps eliminate the use of both virgin materials and fuels.

Recycling materials during the road construction and repair process is the best option to reduce the consumption of new materials and, at the same time, the exploitation of quarries. Recycling bituminous layers and taking advantage of the binding agent that they contain reduces bitumen consumption. In addition, the volumes of waste disposed of – which would otherwise require a physical space for storage and lead to waste management costs – are also reduced.

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