Environmental Product Declaration

In accordance with ISO 14025 for:

The Self-Propelled Bulk Carriage

RZV d.o.o. – Railway Carriages Factory Čakovec Ltd.

Programme:	The International EPD® System www.environdec.com
Programme operator:	EPD® International AB
EPD® registration number:	S-P-00900
Publication date:	2016-06-27.
Valid until:	2019-06-27
Geographical scope:	*Global*

Company

Name and address:

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About the company:

Railway Carriages Factory Cakovec Ltd. is an organization managing the production, maintenance and repair of new types of freight carriages under the Saadkms-z series, which are used for the transport of goods. Furthermore, the company is specialized in the repair and maintenance of various freight carriages, and tank cars used for the transport of petroleum products, production of low-flow tram construction and electric multiple units (EMUs), and construction and reconstruction of carriages for the accommodation of workers and warehousing. The Factory was founded in 1945 and today it has three manufacturing facilities with a total floor space of 12,094 m2, including offices and storage areas.

Railway Carriages Factory Cakovec (RZV) is headquartered in Čakovec, Croatia. RZV is a medium-sized company with a production capacity of 100 units per year. It is possible to raise production capacity to 500 units/year through its production cluster.

Product

Product description:

Railway construction, maintenance and repair are resource-demanding activities because materials delivered to the construction site need to be unloaded at various points along the tracks. Currently, this is done with the help of diesel locomotives shunting/shuffling the bulk carriages along the tracks. Because of carriages' technical characteristics, a diesel locomotive works constantly, either in a stand-by mode or by actively shuffling the carriages. As a resource, the locomotive is taken up all day, even though its services may be needed for a couple of minutes every hour. The carriages are delivered to the spot of discharge one by one, requiring other equipment and human resources to be engaged significantly throughout the process.

With the Self-Propelled Bulk Carriage, RZV brings a new, innovative self-propelled bulk carriage to the market that does not need the locomotive for shuffling/moving during the process of cargo unloading. Also, it is able to discharge the needed amount of construction materials precisely where needed. It significantly increases resource efficiency (decreased use of equipment such as locomotives and construction equipment at the site, decreased energy use, and human resources for the shuffling and construction work). It also significantly reduces environmental impacts (reduced greenhouse gas, resource consumption, acidification, eutrophication, photochemical oxidant formation, waste relating to use and disposal of locomotives, etc.).

Using the Self-Propelled Bulk Carriage results in fewer resources being deployed for construction/ railway maintenance. One locomotive would be required for the work that now requires 3 locomotives.

The Self-Propelled Bulk Carriage is a resource efficient way of (re)construction of railways. The carriage saves energy, human resources and shortens the time of transportation and unloading. It is cost and time efficient, it enables point-to-point transportation, and there is no need for cost-intensive cargo manipulation machinery for freight handling or time-intensive coupling and reloading processes.

One of the innovative parts of this carriage is the development of a new construction opening and the unloading of cargo on 3 sides (i.e. a '3-side dump'). The carriage consists of 2 cargo crates with the possibility of side and frontal lifting. The unloading is controlled, enables full load ejection as well as dosing and partial unloading of cargo at points along routes. There is no need for manual unloading of cargo, use of other machinery for unloading or use of physical force when opening the doors and sides that is common in existing bulk carriages for railway construction.

Compared to existing carriages with inadequate pneumatic systems, the Self-Propelled Bulk Carriage has a larger cargo capacity, faster unloading using the 'tipping', i.e. tilting sideways, existence of the roof which enables transport of hygroscopic materials (grains, fertilizers, ore), ability to transport fine grit without spillage, and quieter operation (there are no huge air high-pressure tanks on the carriage any longer).

A "self-propelled" carriage means complete autonomy of action and better distribution of the locomotive fleet, which ensures enhanced resource efficiency in terms of less working hours for a locomotive, less waste being produced, less fuel consumption and thus lower CO2 emissions. The carriage is an independent self-propelled unit with two cases having a complete integrated system of hydraulic manipulation of boxes and carriages. Handling is completely automatized with a simplified operating console that is adjusted to the user, and it needs only 1 person to operate it. The difference between this carriage and others is in the driving system, which is not installed on the existing driving carriage wheels. The self-propelled working mode is enabled by an 'extra' neutral wheel which goes down on tracks only in the moments when it needs to move down the rail (on switching gauges, industrial gauges, and rail tracks for (re)construction). This ensures greater safety because there are no lateral and axial forces on the existing rolling wheels; and additional certification of the wheeling system is not needed. Since the 'extra' wheel is not in use during transportation to the construction place and existing driving wheels are free from any further construction elements (gears, propeller shafts), there is less resistance, and therefore less locomotive power required. For the drive of the Self-Propelled Bulk Carriage uses a small mobile hydraulic generator, driven by an industrial diesel motor which satisfies EPA Tier 3/Stage IIIA emissions regulations.

CPC code

Product group: UN CPC 495, Rolling Stock

Technical specifications of the Self Propelled Bulk Carriage:

Type of bogie	**Y25 Lsd-1**
Compressed air brake	**Yes (KNORR) KE-GP-A-2x10“**
Slack adjuster	**DRV2A-450H**
Number of axles	**4**
Axel load	**22,5 t**
Tara weight	**37,34 t**
Max. weight of loaded wagon	**90,0 t**
Cargo weight	**52,66 t**
Max. speed of empty wagon	**100 km/h**
Max. speed of full loaded wagon	**100 km/h**
Loading volume	**50 m^3**
Loading area	**35 m^3**
Loading length	**11,2 m**
Loading width	**2,72 m**
Length between the pivot	**10700 mm**
Length over buffers	**15740 mm**
Width of tracks	**1435 mm**
Buffer height	**1060+5-10 mm**
Draw gear	**ST-9-2/160 – 1500 kN**
Screw coupler	**1350 kN**
Towing hook	**1500 kN**
Buffers	**50 kJ**

Figure 1 and Figure 2 show the Self Propelled Bulk Carriage in 3D model as well as in the real environment.

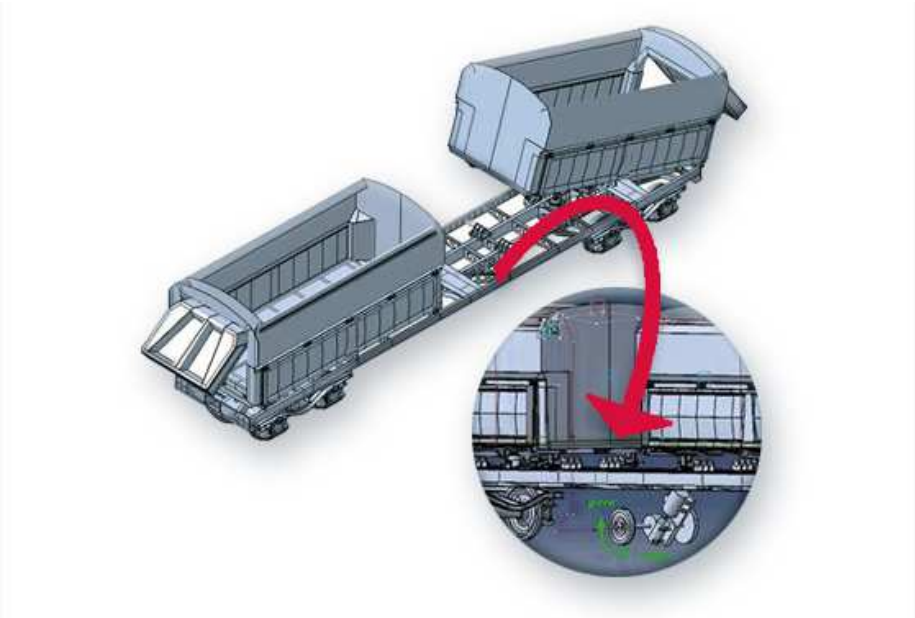

Figure 1, 3D Model of the SPBC

Figure 2, The Self Propelled Bulk Carriage

Functional unit

The function of the studied system is delivery of construction material on the site and discharge of the needed amount of the material precisely where it is going to be used.

The PCR (UN CPC 495 Rolling Stock[1]) for rolling stock distinguishes passenger rolling stock and freight rolling stock. The Self Propelled Bulk Carriage fits in the category of freight rolling stock. Therefore a functional unit for this study is defined as: "*one ton of transported and discharged material per kilometre*".

Scope and system boundaries and key assumptions

The LCA calculations include all upstream, core and downstream processes as defined in the PCR for Rolling Stock. Within the system boundaries are processes related only to the production, operation and disposal of the rolling stock. Upstream and downstream infrastructure is excluded from the calculations. Flow chart showing rough system boundaries is given in the figure 4. All available elementary flows are included. The total mass of the materials not included in the LCA based on the general cut-off rule does not exceed 5% of the total mass of the rolling stock. Cut-off rules are based on the recommendation given in the EPD® PCR for rolling stock. Exclusion of any process within the system boundary is justified. The exclusion of processes falling under the cut-off criteria for each module is avoided as much as possible but in case it had to be excluded, those processes were always clearly documented in the underlying LCA.

Key assumptions are made in the core module concerning the use and maintenance intervals. Lifespan of the SPBC is estimated to be 35 years, with an average of 1250 working hours per year.

Primary data used are from the year 2014. Secondary data are based on the ELCD 3.2 database and correspond to the year of every particular dataset. The timeframe of ELCD 3.2 dataset is from 2010 to 2015.

[1] Product Category Rules (PCR) – UNCPC CODE: 495 PCR 2009:05, Version:2.11, International EPD® Consortium, IEC

To calculate the environmental impact OpenLCA software version 1.41 was used. The environmental impact of the SPBC throughout its life cycle is quantified through environmental impact categories based on the CML 2001 (baseline) method.

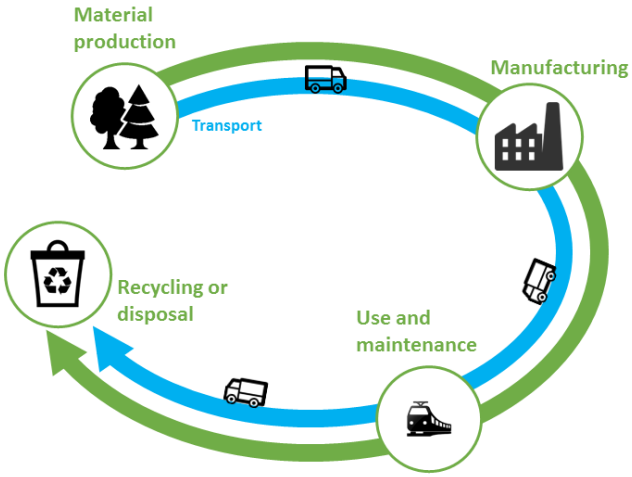

Figure 3, LCA stages covered by the scope of the EPD®

Lifecycle stages flow chart

Figure 4 shows product lifecycle stages and rough representation of the system boundaries.

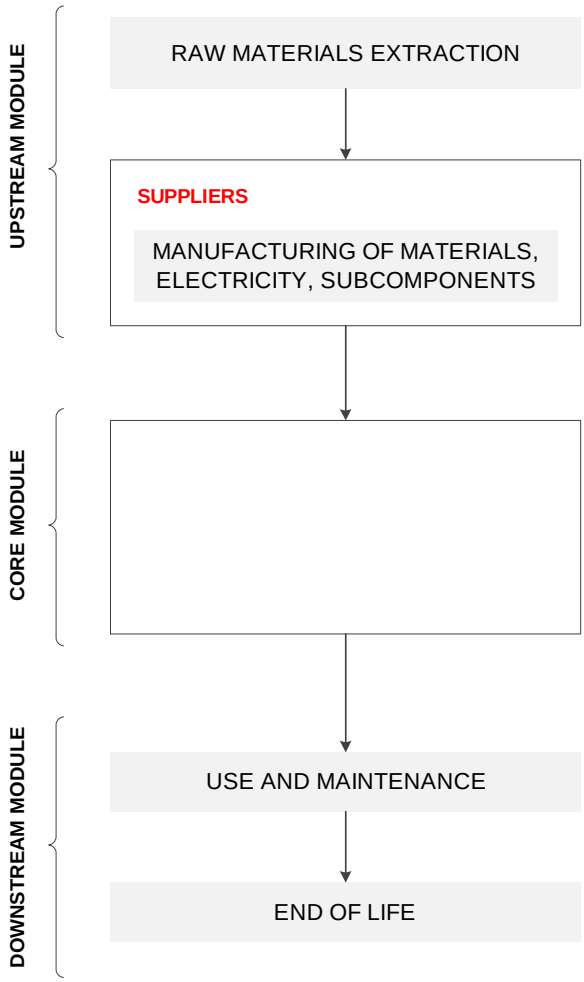

Figure 4, Product lifecycle stages

Content declaration

The Self Propelled Bulk Carriage is mainly built out of Metals (97,73%). Therefore manufacturing of metals, their transport and use will have the most significant impact in the upstream and core module, as well as in the End of life phase of the Downstream module.

Table 1, Materials used in SPBC

Materials used	Car body	Bogies and running gears	Propulsion and electric equipment	Total
Metals	61,18%	27,34%	9,20%	**97,73%**
Polymers	0,00%	0,01%	0,61%	**0,62%**
Fluids	0,00%	0,00%	0,78%	**0,78%**
Elastomers	0,00%	0,001%	0,004%	**0,01%**
Other	0,00%	0,29%	0,58%	**0,87%**
Total weight	**61,18%**	**27,65%**	**11,17%**	**100,00%**

*Glass and Electric equipment material were not take in consideration since their total quantity is insignificant

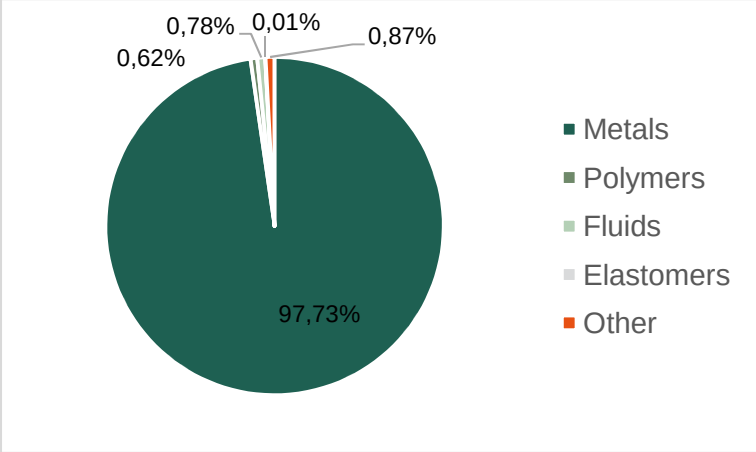

Figure 5, Graphical representation of the material used in the SPBC

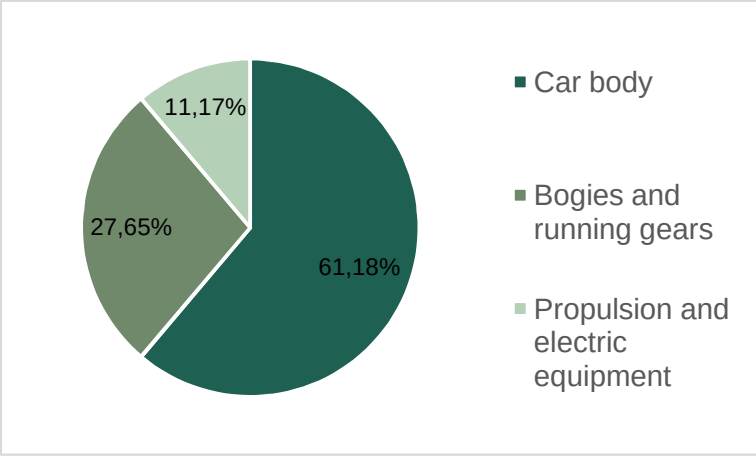

Figure 6, Graphical representation of the material used in the SPBC product groups

Energy

To calculate he environmental impact of the Electricity use in the manufacturing of the SPBC a Electricity mix for the EU-27 has been used. Figure shows the EU-27 Electricity mix (2007) which is based on the Europe's energy position markets and supply: "Market observatory for energy report 2009" published by European Commission in 2010.

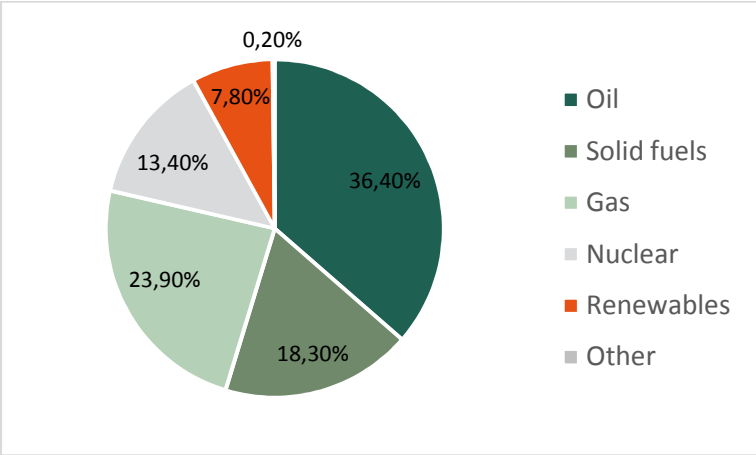

Figure 7, Electricity mix – EU-27 (2007), Source: Market observatory for energy report 2009

Noise

Noise level data are not available at the time of the EPD® publication.

Environmental performance

Renewable and non-renewable resource consumption, waste generation and values for environmental impact categories provide a detailed insight into the life cycle impact of the SPBC. Results are reported using functional unit 1 ton for 1 km. In total lifecycle 16.688.280,00 tkm is estimated. Results are based on one SPBC in service for 35 years which gives 476.808,00 tkm per year.

To run the SPBC a diesel motor is used. The data* concerning the diesel motor are given below.

Number of cylinders: 4
Cooling: Liquid
Power: 41,5 kW
Engine volume: 3200 cm^3
Fuel consumption (80% load): 230 gr/kWh; 8,0 l/h
NO_x: 5,8 gr/kWh
PT: 0,291 gr/kWh
rpm: 1500 g/1'

*The data were obtained from the official technical documentation provided by the manufacturer.

Use of resources

Non-renewable resources

		Unit	Upstream	Core	Downstream		Total
					Use and Maintenance	End of Life	
Material	Inert rock	kg / tkm	8,94E-04	1,16E-03	5,80E-03	2,04E-05	7,88E-03
	Iron	kg / tkm	6,21E-04	3,04E-07	5,55E-05	6,23E-08	6,77E-04
	Bauxite	kg / tkm	9,05E-05	3,03E-05	2,93E-04	1,89E-05	4,33E-04
	Calcium carbonate	kg / tkm	1,67E-04	4,82E-05	1,65E-04	1,10E-06	3,82E-04
	Other	kg / tkm	4,49E-05	4,21E-05	2,07E-04	1,69E-06	2,96E-04
	TOTAL	**kg / tkm**	**1,82E-03**	**1,28E-03**	**6,53E-03**	**4,21E-05**	**9,66E-03**
Energy	Crude oil	MJ / tkm	6,29E-03	9,83E-04	8,46E-01	1,77E-04	8,53E-01
	Natural gas	MJ / tkm	6,85E-03	5,09E-03	6,21E-02	1,29E-04	7,42E-02
	Hard coal	MJ / tkm	1,54E-02	1,23E-03	7,52E-03	9,90E-06	2,41E-02
	Uranium	MJ / tkm	1,20E-03	2,36E-03	1,20E-02	1,27E-04	1,57E-02
	Brown coal	MJ / tkm	2,71E-04	7,16E-04	2,89E-03	9,14E-06	3,89E-03
	TOTAL	**MJ / tkm**	**3,00E-02**	**1,04E-02**	**9,30E-01**	**4,52E-04**	**9,71E-01**

Renewable resources

		Unit	Upstream	Core	Downstream		Total
					Use and Maintenance	End of Life	
Material	Water	kg / tkm	1,54E-02	1,44E-02	5,01E-02	1,01E-02	8,99E-02
	Air	kg / tkm	1,55E-03	1,48E-02	3,76E-02	3,51E-04	5,43E-02
	Other	kg / tkm	4,46E-06	4,83E-06	2,53E-05	2,06E-06	3,66E-05
	TOTAL	**kg / tkm**	**1,69E-02**	**2,92E-02**	**8,77E-02**	**1,04E-02**	**1,44E-01**
Energy	Hydro power	MJ / tkm	8,64E-04	5,16E-04	4,21E-03	1,66E-04	5,76E-03
	Solar power	MJ / tkm	2,58E-05	4,64E-05	2,39E-04	1,96E-05	2,92E-04
	Wind power	MJ / tkm	1,42E-05	5,89E-05	2,45E-04	7,24E-08	3,19E-04
	Other	MJ / tkm	6,16E-06	1,94E-05	9,09E-05	4,83E-06	1,12E-04
	TOTAL	**MJ / tkm**	**9,10E-04**	**6,41E-04**	**4,79E-03**	**1,90E-04**	**6,48E-03**

Water use

Resource	Unit	Upstream	Core	Downstream		Total
				Use and Maintenance	End of Life	
Water	kg	256736,00	240.144,00	835.777,00	168076,00	1.500.733,00

Potential environmental impact

Environmental impact category	Unit	Upstream	Core	Downstream		Total
				Use and Maintenance	End of Life	
Acidification Potential	kg (SO_2 – eq.) / tkm	8,285E-06	3,065E-06	5,264E-04	1,096E-07	5,378E-04
Global Warning Potential	kg (CO_2 – eq.) / tkm	2,810E-03	7,614E-04	7,021E-02	7,133E-05	7,386E-02
Eutrophication Potential	kg (PO_4 – eq.) / tkm	7,947E-07	3,866E-07	1,198E-04	1,086E-08	1,210E-04
Ozone Depletion Potential	kg (CFC-11 – eq.) / tkm	2,760E-11	6,753E-11	1,262E-08	3,632E-12	1,272E-08
Photochemical Ozone Creation Potential	kg (C_2H_4 – eq.) / tkm	1,215E-06	1,688E-07	1,429E-05	6,903E-09	1,568E-05

Waste production

Resource type	Unit	Upstream	Core	Downstream		Total
				Use and Maintenance	End of Life	
Non Hazardous	kg / tkm	3,75E-02	4,42E-03	5,39E-03	2,72E-02	4,87E-04
Hazardous	kg / tkm	1,03E-04	3,04E-06	8,46E-06	9,18E-05	7,24E-08
TOTAL	**kg / tkm**	**3,76E-02**	**4,42E-03**	**5,39E-03**	**2,73E-02**	**4,87E-04**

Other environmental indicators

The Self-Propelled Bulk Carriage is 97,73% built out of metals, which gives it significant potential for recyclability and recoverability. Therefore, the Recyclability Rate of the SPBC is 97,1%, and Recovery rate is 98% which was calculated using ”UNIFE - Recyclability and Recoverability Calculation Method Railway Rolling Stock”.

Nowadays, railroad mainteanace process uses 3 locomotives to manipulate bulk carriage on the site, and most of the time those locomotives are working in standby mode. To fullfil the need of the lover environmental impact, the Self Propelled Bulk Carriage is developed which can substitute aforementioned locomotives. Downstream activities, mainly, Use and maintanence, have a significant enironmental impact. This is due to the use of diesel fuel to operate the Self Propelled Bulk Carriage. On the other hand, use of the Self Propelled Bulk Carriage which consumes in average 8 litres of fuel per working hour in comparison with 3 locomotives consuming in average 300 litres of diesel fuel per locomotive and hour is already significant decrease in environmental impact of the rail road maintenance activities. One locomotive is still needed to haul a bulk carriage to a worksite, then uncouple it and return to base. The environmental impact of this locomotive was not in scope of the underlaying LCA study. But it can be concluded that there is positive environmental impact already presented in the fact that now only one locomotive is needed to haul this wagon to the construction site instead of 3 locomotives needed full time earlier for the same process. This locomotive which brings the Self Propelled Bulk Carriage to the site will then uncouple it and return to base because self-propelled wagon is able to move around the site and also travel to nearby worksites using its own power.

Additional information

RZV Ltd is committed to quality and environmental sustainability of its products and process as well as to control and improve its health and safety performance through occupational health and safety management systems (OHSMS). This committment is demonstrated with 3 internationaly recognized standards: EN ISO 9001:2008; EN ISO 14001:2004 and BS OHSAS:18001:2007.

Environmental policy of the RZV Ltd is defined in accordance with the EN ISO 14001:2004:

- By defining important environmental aspects we recognize our goals that we want to realize through our environmental management system (EMS) and develop plans and programs to realize those goals,
- Throughout the activities of all our processes, all our employees take care of the environmental aspects and their impact on the environment. For this purpose we are regularly identifying and evaluating the significance of our environmental aspects, and taking all the necessary actions to put this effects within the acceptable limits,
- Plans and programs of continuous improvement and prevention of pollution as well as the activities of their implementation are obligations of management and every employee,
- In all our processes in the environmental management system, we have included the obligation to meet all the legal requirements as well as compliance with other regulations,
- Education and training of our employees in the terms of environmental protection is a continuous task, and the Management provides all the necessary preconditions for its realization,
- Suppliers are selected based on the criteria that ensure high-quality materials and products and which take care about the environmental protection and the impact of their products and materials to the environment,
- For all the non-compliance with the environment is responsible its performer, also all employees have to work responsibly to execute their job well the first and each subsequent time

Environmental awareness and respect for the fundamental principles of environmental protection are also part of RZV's environmental policy.

Programme-related information and verification

Programme:	The International EPD® System EPD® International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com
EPD® registration number:	S-P-00900
Published:	2016-06-27
Valid until:	2019-06-27
Product Category Rules:	PCR 2009:05 Rolling Stock. Version 2.11
Product group classification:	UN CPC 495
Reference year for data:	2014
Geographical scope:	Europe and Global

Product category rules (PCR): *ROLLING STOCK, 2009:05, VERSION 2.11 / DATE 2014-10-29*
PCR review was conducted by: *The Technical Committee of the International EPD® System.* *Full list of TC members available on http://www.environdec.com/TC*
Independent verification of the declaration and data, according to ISO 14025:2006: ☐ EPD® Process Certification (internal) ☒ EPD® Verification (external)
Third party verifier*:* *Marcel Gómez Ferrer.* *www.marcelgomez.com.* *Email: info@marcelgomez.com.* Accredited by: *"Approved by the International EPD® System"*

The validity of the EPD® is set at three years.

Mandatory statements

- This EPD® covers the full life cycle of the Self-Propelled Bulk Carriage
- This EPD® is developed according to the PCR for the Product Group: UN CPC 495 – Rolling Stock, 2009:05 – Version 2.11; and ISO 14025:2006
- This EPD® refers to the International System EPD® developed by the International EPD® Consortium (IEC) and is available on the website www.environdec.com
- EPD®s within the same product category but from different programmes may not be comparable

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Programme operator:	EPD® International AB info@environdec.com

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