EPD®

MLA Metrobus Brescia

Certified Environmental Product Declaration

Rev. 0 - Date: 2010-04-16

Approval date: 2010-04-29

Registration N. S-P-00208

UN CPC Code 495

AnsaldoBreda
A Finmeccanica Company

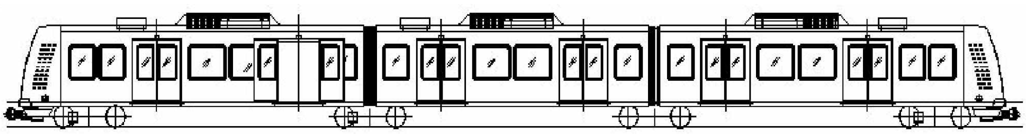
Index

The Company

AnsaldoBreda S.p.A. is a company specialized in the production of rail vehicles and is part of Finmeccanica Group.
AnsaldoBreda S.p.A. rises from the merger of Ansaldo Trasporti and Breda Costruzioni Ferroviarie in 2001. Both previous companies already were the most important heirs of historical Italian tradition in the field of electric transport, both being set up in the second half of the nineteenth century.
Today AnsaldoBreda S.p.A. is organized in four Plants in Italy: Napoli, Pistoia, Reggio Calabria and Palermo. Furthermore, it can rely on some operating plants abroad, achieving an overall number of about 2,400 employees. Site plants involved in MLA Metrobus Brescia production are Reggio Calabria, where body structure is built and painted, and Naples, where carbodies coming from Reggio Calabria are completed with boogies, interior windows and doors installation.

The Product

MLA Metrobus Brescia is a light automatic metro designed for passengers transport. It is designed for Urban transport. Train configuration is showed in the following figure.



MLA Metrobus Brescia consists of three carbodies with two articulations. The traction is supplied by six electric engines, coupled on three of the four boogies; the fourth truck is a trailer one.

Management system and safety train

The train, through configuration's selectors, can select 4 different modes of operation:

- AUTO: all transactions are handled automatically, and it's not required the presence of the driver. The security system is maintained by ATP
- ATO+ATP: the gait is automatic, but the command door closing is made by the driver
- ATP: the gait is manual, but ATP system security is active
- ATC-bypass: the gait is manual, without the control ATP Safety

The train is equipped with a system of safety and operability of the vehicle ATC which includes:

- ATO: manages the vehicle and the management of the station stops
- ATP: ensures the operating vehicle safely
- ATS: collects diagnostic information on the vehicle and directs the activities of solution failures

Environmental protection

The use of materials that can cause allergic reactions is absolutely excluded in the train.

Technical information

Dimensions	
• Length	39 m (to coupler)
• Width	2.65 m (external)
• Height from railway plane	3.25 m
Net weight	59.357 kg
Weight with different loads	
• L1	75.675 kg - All seats filled + 3 passengers per m^2
• L2	79.840 kg - All seats filled + 4 passengers per m^2
• L3	88.170 kg - All seats filled + 6 passengers per m^2
Maximum speed	80 Km/h
Maximum number of passengers	434 whereof:
• seat	72 + 2 wheelchairs (or pram for babies)
• standing	360
Power supply	Electric
Power voltage	780 V
Available power	105 kW x 6 = 630 kW

L2 is the configuration used for environmental impacts assessment.
Following table shows distribution of materials which the Metro is made of.

Product group	Materials (kg)							
	Metals	Polymers no elastomers	Elastomers	Glass	Fluids	MONM	Other	Total
1 - Carbody	12,745	316	181	-	6	-	13	13,261
2 - Interior. windows and doors	4,996	49	1,357	1,508	35	115	1,787	10,882
3 - Bogies and running gears	20,818	162	260	-	90	-	104	21,434
4 - Propulsion and electric equipment	9,349	989	45	40	65	5	528	11,021
5 - Comfort systems	2,499	121	28	-	54	-	57	2,759
Total	50,407	1,637	1,871	1,548	250	1,155	2,489	59,357
	84.9%	2.8%	3.2%	2.6%	0.4%	1.9%	4.2%	100.0%

MONM = Modified Organic Natural Materials (i.e. leather. wood. cardboard. etc.)

Following table shows distribution of materials which MLA Metrobus Brescia is made of, referred to the functional unit.

Product group	Materials (g)							
	Metals	Polymers no elastomers	Elastomers	Glass	Fluids	MONM	Other	Total
1 - Carbody	1.380	0.034	0.020		0.001		0.001	1.436
2 - Interior windows and doors	0.541	0.005	0.147	0.130	0.004	0.124	0.193	1.144
3 - Bogies and running gears	2.254	0.018	0.028		0.010		0.011	2.321
4 - Propulsion and electric equipment	1.012	0.107	0.005	0.040	0.007	0.001	0.057	1.229
5 - Comfort systems	0.271	0.013	0.003		0.006		0.006	0.299
Total	5.458	0.177	0.203	0.170	0.028	0.125	0.268	6.429
	85.1%	2.8%	3.2%	2.6%	0.4%	1.9%	3.9%	100.0%

MONM = Modified Organic Natural Materials (i.e. leather. wood. cardboard. etc.)

Following regulated hazardous material are present on the Metro.

Hazardous materials	kg	Where
Cadmium	21.4	Battery
Lubricants/oil/grease	113.6	Coupler, brakes, electric engines, HVAC
Gas refrigerants	42.2	HVAC
Nickel	154.1	Electric equipment

There are no SVHC (Substances of Very High Concern) on the Metro.

Environmental Performance Declaration

Methodology

The environmental performance of the considered product has been quantified by Life Cycle Assessment (LCA) approach in accordance with ISO 14040 and ISO 14044. Data used for the study refers to year 2008. Specific and generic data fulfil General Program Instruction criteria for EPD as well as PCR for preparing EPD for rail vehicle. Contribution given by generic data is less than 10% of the total. The use phase has been modelled using simulating computation that takes into account following issues:

- Maximum speed
- Average speed (commercial)
- Average slope of the run
- Maximum acceleration on horizontal rectilinear railway steep
- Jerk in traction
- Maximum deceleration on horizontal rectilinear railway steep
- Deceleration normally used for station stop
- Jerk in deceleration
- Normal load
- Length of the route
- Number of station along the run and distance between one station and the next one
- Average number of runs per day and year

The model adopted is coherent with "*Specification and verification of energy consumption for railway rolling stock - Railenergy WP 2.2: Input to future UIC/UNIFE Technical Recommendation*".

In calculation, the mission of the Metro for Brescia municipality has been used as specific route.

Following assumption has been taken.

• Route length (round trip)	26.2 km
• Life span of the Metro	30 years
• Maximum number of Metros in exercise on the route	16
• Number of Metros in maintenance	2
• Number of passengers	314 (L2)
• Load factor	0.275 (L2)

- Different runs frequency for weekdays and holydays
- Different runs frequency for weekdays during scholastic and non-scholastic periods

Italian electricity energy mix for the use phase has been assumed.

Boustead Model database has been used for all processes and basic materials production with the exception of waste treatment processes and electronic parts production which Ecoinvent database has been used for.

Functional Unit

According to relating PCR, the functional unit is the transport of **1 passenger for 100 km.**

System boundaries

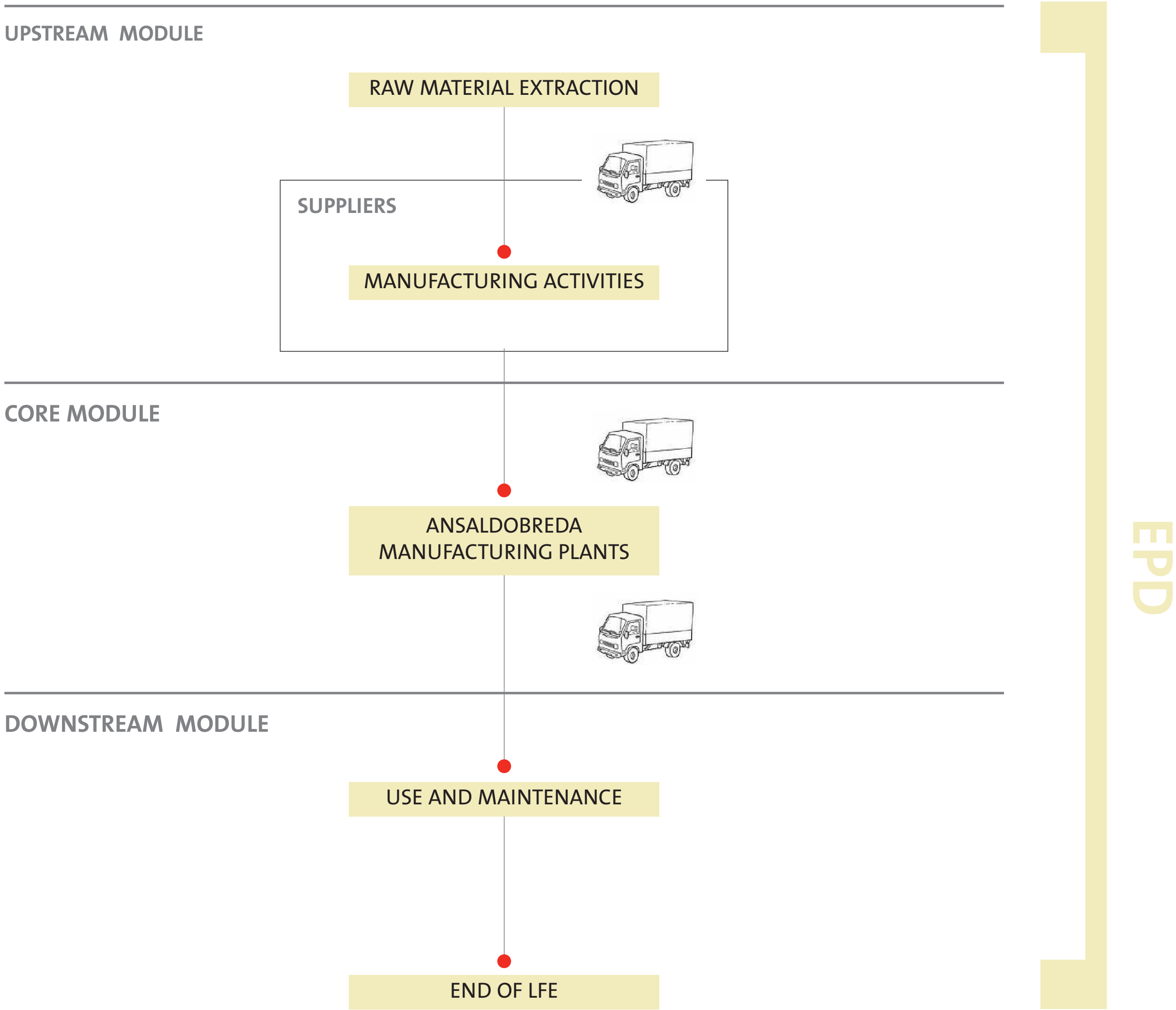


Figure 1 – System boundaries. All main module from the extraction of natural resources to the end of life are included

The considered System is split into three phases according to the following hypothesis.

Upstream Module

- Extraction and production of raw and basic materials
- Electricity, heat, steam and fuel production
- Production of auxiliary materials for rail vehicle assembly/manufacturing
- Production of maintenance materials and spare parts
- Transportation of products from supplier's manufacturing facilities to rail vehicle AnsaldoBreda plants
- Generation and treatment of waste for included upstream processes

Core Module

- Electricity, heat, steam, fuel and auxiliary material used for rail vehicle assembly/manufacturing
- Transportation of the rail vehicle to the customer
- Generation and treatment of waste for included core processes
- Transport of rail vehicle from AnsaldoBreda Naples site to Brescia via truck

Downstream Module

- Electricity consumption for rail vehicle operation
- Consumption of maintenance materials and spare parts
- Waste from maintenance materials and spare parts
- Direct disposal of materials
- Incineration of materials with no energy recovery

Exclusions

Following operations of downstream module have not been taken into account because their contribution to each impact category is less than 1% of the total environmental impact:

- Rail vehicle dismantling
- Building, maintenance, dismantling and disposal of rail vehicle disassembly and waste treatment facilities
- Transport of spare parts from supplier plants to maintenance site

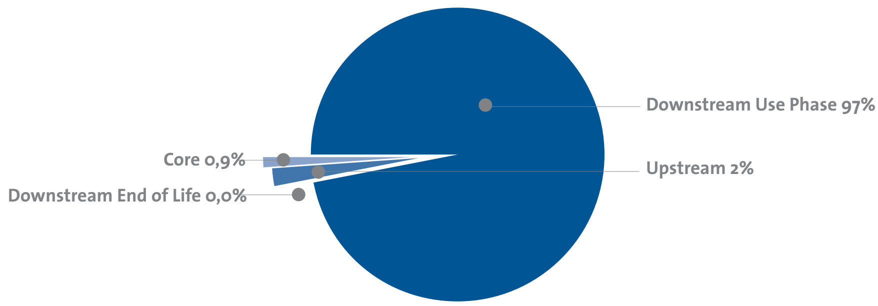
Environmental Results

Resources consumption

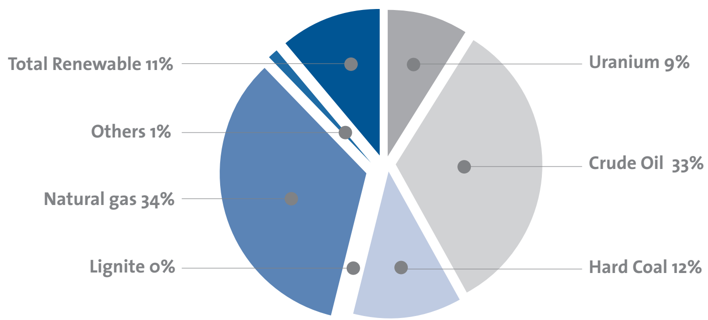
Non renewable resources data for transport of 1 passenger for 100 km	Life Cycle Modules				Total life cycle
	Upstream	Core	Downstream		
			Use phase	End of life	
Materials (g)					
Bauxite	6.6810	0.0001	2.6911	-	9.3722
Fe	3.0805	0.0222	4.6950	-	7.7977
Limestone ($CaCO_3$)	1.0248	0.0082	1.3228	-	2.3558
Sand	0.5380	0.0001	0.3594	-	0.8975
Cu	0.4998	-	0.4081	-	0.9079
Others	1.3515	0.0318	0.9865	-	2.3698
Total	*13.1756*	*0.0624*	*10.4629*		*23.7009*
Energy (MJ)					
Uranium	0.0271562	0.0170376	2.5262122	-	2.5704060
Crude oil	0.1656124	0.1185749	9.4750867	0.0000288	9.7593028
Hard Coal	0.0841229	0.0231149	3.4809595	0.0000003	3.5881976
Lignite	0.0017263	0.0000001	0.0012298	0.0000002	0.0029564
Natural gas	0.1852695	0.0947481	9.4521102	0.0000021	9.7321299
Others	0.0022635	0.0009379	0.1441906	-	0.1473920
Total	*0.4661508*	*0.2544135*	*25.0797890*	*0.0000314*	*25.8003847*

Renewable resources data for transport of 1 passenger for 100 km	Life Cycle Modules				Total life cycle
	Upstream	Core	Downstream		
			Use phase	End of life	
Materials (g)					
Natural rubber	0.04	-	14.82	-	14.86
Biomass (including water)	0.02	0.1	0.15	-	0.27
Other	0.06	-	0.01	-	0.07
Total	*0.12*	*0.1*	*14.98*	-	*15.20*
Energy (MJ)					
Hydropower	0.1189825	0.017866	2.76417	0.0000003	2.9010188
Biomass	0.0001766	0.000864	0.13150	-	0.1325406
Wind power	0.0000565	0.000101	0.01521	-	0.0153675
Solar energy	0.0000004	0.000161	0.02446	-	0.0246214
Geothermic	0.0000001	0.000002	0.00029	-	0.0002921
Others	0.0032930	0.000019	0.00142	-	0.0047320
Total	*0.1225091*	*0.019013*	*2.93705*	*0.0000003*	*3.0785724*

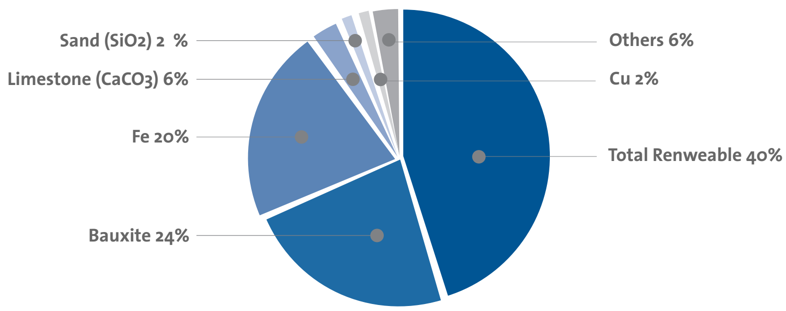
ENERGY CONSUMPTION



ENERGY RESOURCES SHARING



RAW MATERIAL SHARING



Total consumption	Life Cycle Modules				Total life cycle
	Upstream	Core	Downstream		
			Use phase	End of life	
Energy (MJ)	0.5886600	0.2734262	28.0168509	0.0000317	28.878969
Raw materials (g)	13.3015	0.1597	25.4396		38.9008

WASTES data for transport of 1 passenger for 100 km	Life Cycle Modules				Total life cycle
	Upstream	Core	Downstream		
			Use phase	End of life	
Hazardous (g)	0.060	0.140	3.160	0.044	3.404
Non hazardous (g)	84.220	2.410	91.330	6.382	184.342
Total (g)	*84.280*	*2.550*	*94.490*	*6.426*	*187.746*

Other information data for transport of 1 passenger for 100 km	Life Cycle Modules				Total life cycle
	Upstream	Core	Downstream		
			Use phase	End of life	
Water use (l)	44.768	0.45229	22.400	0.0000001763	67.6203
Electricity consumption - manufacturing (kWh)	0.03124	0.01638	2.49729	-	2.54491
Use of recycled resources (g)	0.01		0.01		0.02

Pollutant emissions expressed in terms of potential environmental impacts

ENVIRONMENTAL IMPACTS data for transport of 1 passenger for 100 km	Life Cycle Modules				Total life cycle
	Upstream	Core	Downstream		
			Use phase	End of life	
GWP (kg CO_{2eq})	0.026002	0.018007	1.739833	0.000077527	1.783920
ODP (kg CFC-11_{eq})	0.0000000016032	0.000000000005	0.0000000010	0.0000000000015	0.0000000026
AP (kg SO_{2eq})	0.000249	0.000152	0.017391	0.000000023	0.017791
EP (kg PO_{4eq})	0.000015	0.000082	0.000646	0.000000005	0.000743
POCP (kg C_2H_{4eq})	0.000015	0.000010	0.000943	0.000000016	0.000967

Additional Information

Metro Energy Consumption

Under the hypothesis assumed in the simulation, MLA Metrobus Brescia electricity consumption is of 7.794 kWh/km. In order to evaluate environmental impact due to downstream use phase Italian electric mix has been adopted. Number of passengers used in the calculation corresponds to 314. The load factor is 0.275 (L2).

Noise emissions

Apart from wheels, among the main sources of noise and vibrations systems installed on board are the following: HVAC, air compression circuit, traction engine, reducer, auxiliary converter, traction converters, compressed air system, trumpets.
Following table represents active noise sources in different operating conditions of the train.

	INDOOR NOISE Operating conditions		
	Stationary conditions	V max Open field	V max Tunnel
Noise caused by interaction between wheels and boogie	OFF	ON	ON
Noise caused by interaction between wheels and rail	OFF	ON	ON
Auxiliary equipment			
HVAC	ON	ON	ON
Engine and reducer	OFF	ON	ON
Compressor	ON	ON	ON
Traction converter	OFF	ON	ON
Auxiliary converter	ON	ON	ON

The noise analysis that was conducted on the vehicle according to ISO 3095 and ISO 3381 has reported the following results:

- Indoor noise (open field) measured in the centre of the compartment:
  - In stationary conditions with all auxiliary systems on: $L_pA_{eq}T \lesssim 69$ dB(A)
  - Speed of 80 km/h: $L_pA_{eq}T \lesssim 74$ dB(A)
- Outdoor noise (open field) measured at 7.5 m from the centre of the track
  - In stationary conditions with all auxiliary systems on: $L_pA_{eq}T \lesssim 70$ dB(A)
  - Speed of 80 km/h: $L_pA_{eq}T \lesssim 84$ dB(A)

Acceleration sound pressure level hasn't been yet estimated because the product is still in production and measurement cannot be executed.

Potential recyclability and recoverability

<table>
<tr><td></td><td colspan="2">Recovery</td><td>Undefined residue</td></tr>
<tr><td>Reuse (Component Parts)
0</td><td>Recycling (Materials)
103,689.98 kg</td><td rowspan="2">Energy recovery
(Materials)
3,660.78 kg</td><td rowspan="3">Waste
(Materials)
13,161.48 kg</td></tr>
<tr><td colspan="2">Recyclability rate</td></tr>
<tr><td colspan="3">Recoverability rate</td></tr>
<tr><td colspan="4">Vehicle mass</td></tr>
</table>

	Recyclability	Recoverability
End of life	89.3%	93.1%
Maintenance	82.9%	85.2%
Total life cycle	**86.0%**	**89.1%**

Lower recyclability percentage for spare parts substitution during maintenance activity is mostly due to the fact that brake pads are assumed to be not recyclable.

Environmental Philosophy of the Company

AnsaldoBreda S.p.A has developed and certified environmental (ISO 14001) and health and safety (OHSAS 18001) management systems.

AnsaldoBreda recognises as its strategic objectives:
- customer needs fulfilment, both on the product and service point of view
- the health and safety of its employees
- the safety, reliability and quality of its products.

Glossary

Acidification Potential (AP). Phenomenon by which atmospheric rainfall has a pH which is lower than average. This may cause damage in forests and cultivated fields, as well as in water ecosystems and objects in general. This phenomenon is due to the emissions of SO_2, of NO_x, and NH_3, which are included in the Acidification Potential (AP) index expressed in masses of SO_2 produced.

ATC. Automatic Train Control

ATO. Automatic Train Operation

ATP. Automatic Train Protection

ATS. Automatic Train Supervision

Eutrophication Potential (EP). Enrichment of the watercourses by the addition of nutrients. This causes imbalance in water ecosystems due to the overdevelopment encouraged by the excessive presence of nourishing substances. In particular, the Eutrophication Potential (EP) includes phosphorous and nitrogen salts and it is expressed in grams of oxygen (kg O_2).

Global Warming Potential (GWP). Phenomenon by which the infrared rays emitted by the earth's surface are absorbed by the molecules in the atmosphere as a result of solar warming and then re-emitted in the form of heat, thus giving rise to a process of global warming of the atmosphere. The indicator used for this purpose is GWP (Global Warming Potential). This mainly includes the emissions of carbon dioxide, the main greenhouse gas, as well as other gases with a lower degree of absorption of infrared rays, such as methane (CH_4), nitrogen protoxide (N_2O), chlorofluorocarbons (CFC), which are expressed according to the degree of absorption of CO_2 (kg CO_2).

HVAC. Heating, Ventilating, and Air Conditioning

MLA. Metro Leggera Automatica (Automatic Light Metro)

Ozone Depletion Potential (ODP). Degradation and depletion of the ozone layer in the stratosphere, which has the property of blocking the ultraviolet components of sunlight thanks to its particularly reactive compounds, originated by chlorofluorocarbons (CFC) or by chlorofluoromethanes (CFM). The substance used as a point of reference for assessing the ODP (Ozone Depletion Potential) is trichlorofluoromethane, or CFC-11.

Photochemical Ozone Creation Potential (POCP). Production of compounds which by the action of light are capable of encouraging an oxidising reaction leading to the production of ozone in the troposphere. The indicator POCP (Photochemical Ozone Creation Potential) includes especially VOC (volatile organic compounds) and is expressed in grams of ethylene (kg C_2H_4).

References

- Life cycle assessment of Automatic Light Metro Brescia
  Final report, Igeam S.r.l. and AnsaldoBreda S.p.A., December 2009
- AA072BT Rev 0 – Piattaforma MLA. Simulazione di tratta – July. 31st 2007
- Product Category Rules (PCR) for preparing an Environmental Product Declaration (EPD) for rail vehicles - UNCPC CODE: 495
- General Programme Instructions For Environmental Product Declarations, EPD, Version 1.0, 2008-02-29
- ISO 22628:2002
- EN 15380:2006
- EN 12663:2000
- Boustead Model 5.0 and Ecoinvent databases and suppliers for data used for calculation including database required by the PCR
- (1) Reference laws about hazardous substances
  - Regulation 1907/2006 "REACH" (Annex XVII)
  - Directive 94/62/EC on packaging and packaging waste and subsequent updates
  - Regulation (CE) 1005/2009 on ozone depletion substances
  - RoHS Directive 2002/95/CE
  - Regulation (CE) n. 648/2004
  - Directive 2002/72/CE
  - Directive 2001/41/CE
  - Directive 67/548/CEE

Information about the certifying body and about the PCR

PCR review, was conducted by:

Independent verification of the declaration and data, according to ISO 14025:
☐ Internal x External

Third party verifier:
RINA S.p.A. Certification Body (www.rina.org) - Via Corsica, 12 Genova - Italy

Validity until 2013/04/29

For further information refer to www.environdec.com

Please note that EPDs within the same product category but from different programmes may not be comparable.

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Printed on CYCLUS OFFSET
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