Mainline track
Concrete track NBT

ENVIRONMENTAL PRODUCT DECLARATION

EPD®
THE INTERNATIONAL EPD® SYSTEM

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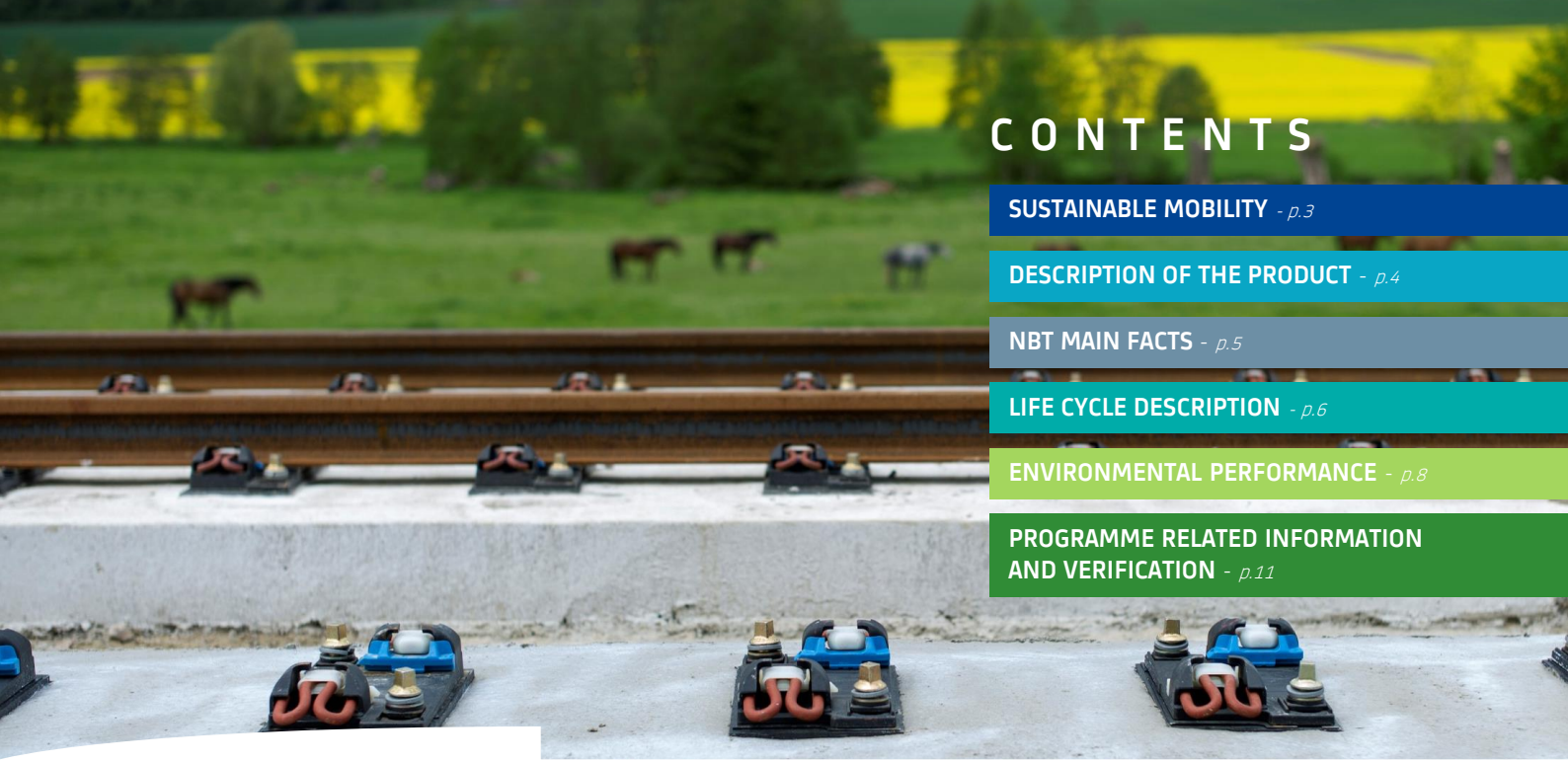
ALSTOM
Designing fluidity



CONTENTS

Edito

ALSTOM, AT THE FOREFRONT OF SUSTAINABLE MOBILITY

As a promoter of sustainable mobility, Alstom places environmental issues at the heart of its R&D strategy, constantly designing solutions and products which are less energy-consuming, quicker to install, cheaper to maintain, and with higher lifespan and reduced carbon footprint.

For more than 10 years, the company has systematically introduced eco-design in its engineering procedures. Various environmental dashboards have been implemented. They help us to quantify and improve the environmental impact of our solutions from development phase up to final use. Today, Alstom can rely on a team of more than 100 eco-experts to ensure the environmental performance of its portfolio and is able to develop innovative infrastructure solutions tackling key environmental challenges. Alstom is deploying these eco-design tools to rail infrastructure.

NBT, a main-line concrete track designed as a sustainable solution

Alstom has assessed the environmental footprint of NBT, a concrete track with optimised life-cycle costs and environmental criteria. This solution offers smaller footprint, optimised installation methodology and lower maintenance requirements, compared to other main-line track solutions.

Eric Marie
VP Systems & Infrastructure Platforms

SUSTAINABLE MOBILITY

Alstom, at the forefront of sustainable mobility

Alstom develops and offers a range of systems, equipment and services for the rail sector and considers its mission to support the transition towards global sustainable transport systems that are inclusive, environmentally-friendly, safe and efficient. As well as taking the life cycle into account, from concept to recycling including maintenance and energy consumption, Alstom offers innovative solutions that respect the environment and meet the mobility needs according to a socially responsible model. As a major player in ecological transport, sustainable development is at the heart of the Alstom's strategy.

Alstom has a an environmental management system fully in place and 100% of manufacturing sites and regional centers over 200 employees are certified according ISO14001.

Ecodesign approach

More than 10 years ago, Alstom systematically introduced eco-design in to its engineering procedures for that very purpose. It has given rise to environmental dashboards that focus on fundamental topics at the start of the development phase, the quantification of the environmental impact (life cycle assessments) and more ecological solutions. Today, more than 100 experts (eco-designers, experts for acoustic and energy-saving materials) endeavor to ensure the environmental performance of each solution.

Ecodesign approach addresses the design and development of products using a life cycle perspective. It aims at continually improving the environmental performance of products through the management of their significant environmental aspects. In this context, life cycle assessment (LCA) is a relevant tool to identify and thus to allow the reduction of products' environmental impacts.

Track solutions

Alstom track portfolio encompasses track systems adapted to each type of rolling stocks such as tramway, metro and main lines. It covers all infrastructure needs from new lines to extension, refurbishment and maintenance projects. Active in-house innovation programs on infrastructure products and solutions aims at improving construction time and life cycle cost as well as durability, carbon footprint and overall performance. Innovations included in this environmental declaration are Appitrack (Fast and Mechanical track laying) and NBT (Fully-mechanised slab track for main lines) solutions. Raw materials are a key driver of environmental impacts for railway transport service. Given the quantity of materials involved track solutions have a high role to play to limit and improve the overall environmental performance of railway systems.

See Alstom's annual registration document for more information on Alstom Sustainable Development Strategy, including eco-design on www.alstom.com

DESCRIPTION OF THE PRODUCT

This environmental declaration covers a mainline concrete track with specific design, NBT.

This track solution encompasses all the equipment and materials required to support and guide rolling stocks all along the railway line.

MAIN CHARACTERISTICS

Type of use:
Combined (passengers and freight)

Intended use:
Mainline

100% open section

Total length of line:
100 km

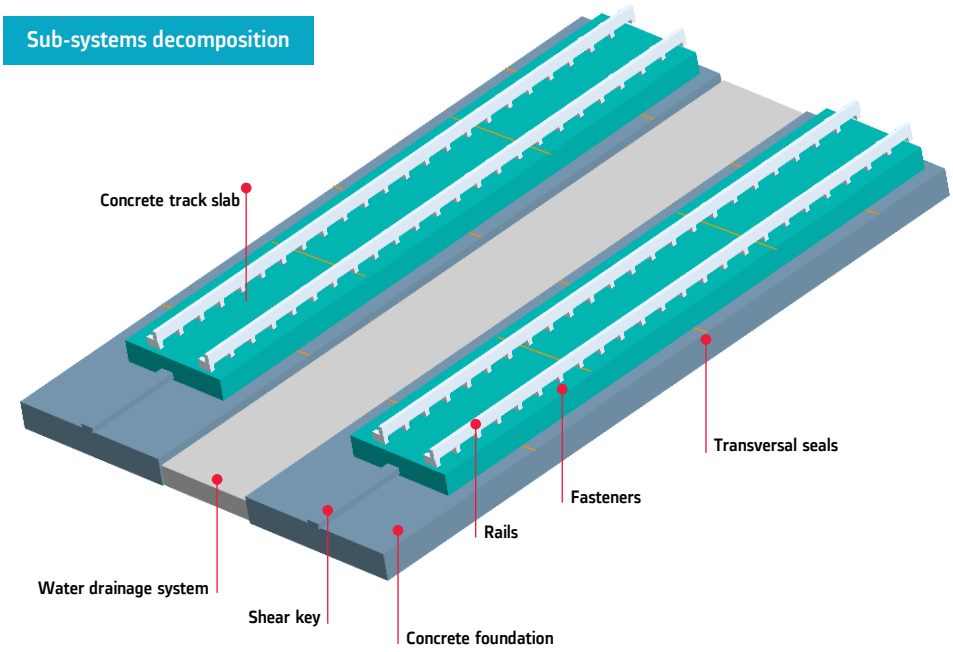
Track gauge:
1435mm

Design speed:
Up to 250km/h

Lifetime:
100 years

NBT is composed of two superimposed concrete slabs (a foundation layer and a steel-reinforced track slab) tied together via a shear key on top of the foundation slab, with transversal joints for concrete crack control.

Sub-systems decomposition



Rails: Common rail used for high speed line (60 E1). NBT is designed to integrate all others track equipment such as switch and crossing with using the same rail profile

Transversal seals: Polyurethane (PUR) and polyethylene (PE) based seals realized in the concrete layers every 4,8 m to ensure crack control. Foundation and track slab are cut staggered to avoid the superposition of seals.

Concrete track slab: Concrete slab tied together with the foundation via a shear key on top of the foundation slab and directly supporting the track. It is made C35/45 reinforced concrete

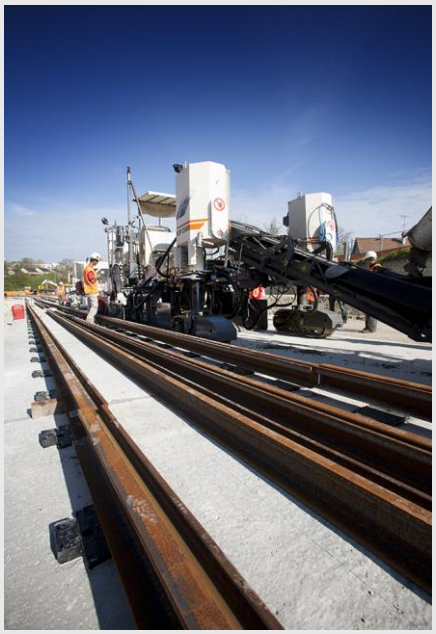
Concrete foundation: Sub-structure lying on the track platform and made of C25/30 concrete

Fasteners: Direct fastening systems directly inserted in the slab track.

Water drainage system: Concrete and geotextile system enabling rain water evacuation

MAIN FACTS

Apptitrack technology: Alstom's service-proven fully mechanised track-laying and fasteners insertion solution



HISTORY

Alstom co-developed NBT for main-line owners seeking a concrete track i.e. a railway track with extensive lifespan and high infrastructure availability, which can be installed as faster than standard concrete track, and be operated for mixed traffic (both passenger-dedicated and freight transport).

In 2013, **NBT was successfully deployed** between Gisors and Serqueux, a 160km/h main line of the French rail network owner: SNCF Réseau.

KEY BENEFITS

NBT offers a small physical footprint that allows optimizing the design of the civil works including opportunities to reduce tunnel diameters and deploy lighter bridges, leading to less civil works and thereby lower investment costs.

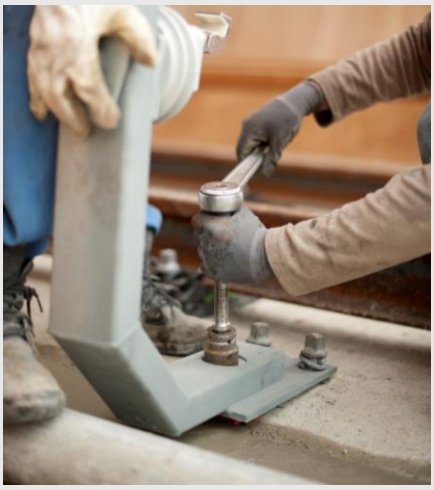
Thanks to the use of Appitrack technology, **NBT is the only slab track design on the market capable of being built at the nominal rate of 300 meters per day,** up to 500 meters per day with optimal logistical resources.

Appitrack use also improves environment, health and safety conditions by reducing working crews' sizes, limiting noise and dust generation, and allowing cleaner worksites.

The main advantage of NBT is its durability: the track's main structural elements are designed for a life of 100 years, enabling infrastructure owners to reduce maintenance and renewal costs and therefore **optimize life cycle costs:**

- Maintenance activities are restricted to running rail (grinding, replacement) and fasteners (some parts to be replaced, i.e. under rail pads)
- Increased revenue for operators is ensured due to higher availability of the track and compatibility with mixed traffic (passenger and freight)

LIFE CYCLE DESCRIPTION



Environmental impacts of Alstom reference solution for NBT has been characterized through the realization of a LCA in accordance with ISO 14040: 2006.

EIME software and associated EIME database are used to perform this life cycle impact assessment. Version 2016 of the database has been used.

Function and functional unit

The function of the NBT track infrastructure is to provide rolling support and guide trains at the required speed on railways main-lines.

The functional unit is to provide the track function for 1 km of NBT double track, over 100 years of infrastructure service life. Only full NBT concrete track without transition zone nor tunnel or viaduct sections is considered in this LCA.

Life cycle boundaries

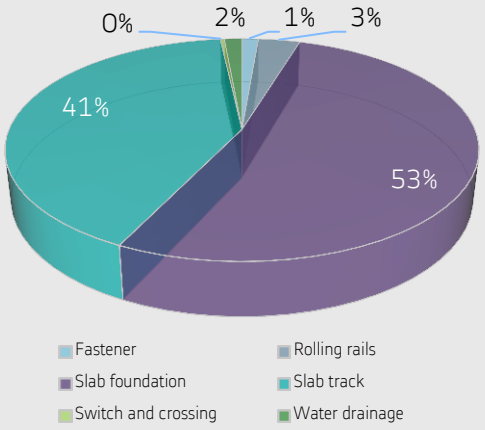
The whole life cycle of the solution is considered, in other words, the LCA is a "cradle to grave" LCA that take into account all life cycle phases form the extraction of raw materials which compose the different equipment to the end of life waste management. Transports along the supply chain and to the construction site are included as well as all construction activities (tools, electricity, vehicles and consumable).

Maintenance activities mainly consist of inspections, repair and replacement of equipment as well as periodical grinding of the track. Finally, deconstruction, collection and treatment end of life materials have been considered.

The European grid mix has been used for the electricity consumption for the production of parts, construction and maintenance needs.

LIFE CYCLE DESCRIPTION

Share of mass by sub-system



Bill of materials

Materials used for the construction of the NBT infrastructure as well as for maintenance and reinvestments have been inventoried. In line with NBT track design only rails, switch and crossings and fasteners are replaced which represents 12% of total raw materials demand. Total weight associated to the solution is 7 108 T/km, Top four materials and corresponding quantities per km of double NBT track are:

Top 4 materials

79% RECYCLABILITY RATE

99% RECOVERABILITY RATE

A recyclable solution

The main components of the solution are concrete, metallic and plastic materials which allow a high recyclability potential. Concrete end of life is based on Supplier information and is in line with target value of French Energy transition law.

Moreover such track solution are very likely to be renewed rather than to be completely dismantled, limiting the quantity of end of life waste generated.

Hazardous substances

No substances meeting the criteria of Substances of very high concern (SVHC) in REACH regulation article 33 have been identified in the solution.

Maintenance

Each maintenance activities are considered in this LCA:

- Use of engine and vehicles for inspection on site
- Electricity consumption of trains for on board monitoring
- Grinding
- Replacement of parts including raw materials, production, transport and installation
- Cleaning of the water drainage system

ENVIRONMENTAL PERFORMANCE

Use of resources

FLOW PER FUNCTIONAL UNIT	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
NON-RENEWABLE RESOURCES					
Material resources	**kg**	**7,72E+06**	**2,34E+06**	**5,39E+05**	**1,06E+07**
Limestone	kg	5,92E+06	0,00E+00	0,00E+00	5,92E+06
Inert rock	kg	3,41E+05	1,71E+06	4,59E+05	2,51E+06
Calcium carbonate	kg	6,75E+05	7,93E+04	1,21E+04	7,67E+05
Iron	kg	1,97E+05	3,57E+05	2,46E+02	5,54E+05
Sodium chloride	kg	2,02E+04	1,37E+05	6,41E+04	2,21E+05
Clay	kg	1,91E+05	1,98E+03	1,46E+01	1,93E+05
Other	kg	3,76E+05	5,97E+04	3,65E+03	4,40E+05
Energy resources	**MJ**	**8,42E+07**	**2,56E+08**	**2,94E+06**	**3,51E+08**
Uranium	MJ	6,81E+07	6,91E+05	2,10E+08	278 890 611
Natural gas	MJ	7,73E+06	6,12E+05	2,89E+07	37 323 214
Hard coal	MJ	5,16E+06	4,22E+05	8,44E+06	15 409 377
Crude oil	MJ	2,91E+06	8,99E+05	7,90E+06	13 954 514
Other	MJ	3,23E+05	3,19E+05	1,07E+06	5,88E+06
RENEWABLE RESOURCES					
Material resources	**kg**	**1,74E+06**	**9,19E+06**	**2,98E+06**	**1,39E+07**
Air	kg	1,70E+06	9,12E+06	2,98E+06	1,38E+07
Other	kg	3,67E+04	3,67E+04	3,67E+04	3,67E+04
Energy resources	**MJ**	**2,95E+05**	**1,10E+05**	**1,16E+06**	**1,56E+06**
Solar power	MJ	1,41E+05	1,89E+04	5,64E+05	7,24E+05
Hydro power	MJ	8,39E+04	5,89E+04	3,42E+05	4,85E+05
Wind power	MJ	5,72E+04	3,09E+04	2,39E+05	3,28E+05
Other	MJ	1,29E+04	1,75E+03	1,36E+04	2,82E+04
SECONDARY RESOURCES					
Secondary material	**Kg**	**2,51E+04**	**0,00E+00**	**0,00E+00**	**2,51E+04**
Secondary energy	**MJ**	**0,00E+00**	**0,00E+00**	**0,00E+00**	**0,00E+00**

Water use

FLOW PER FUNCTIONAL UNIT	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Total water use in the life cycle	**kg**	**2,28E+08**	**3,07E+07**	**8,52E+08**	**1,11E+09**
Direct use in the core process	kg	0	2,65E+07	0	0

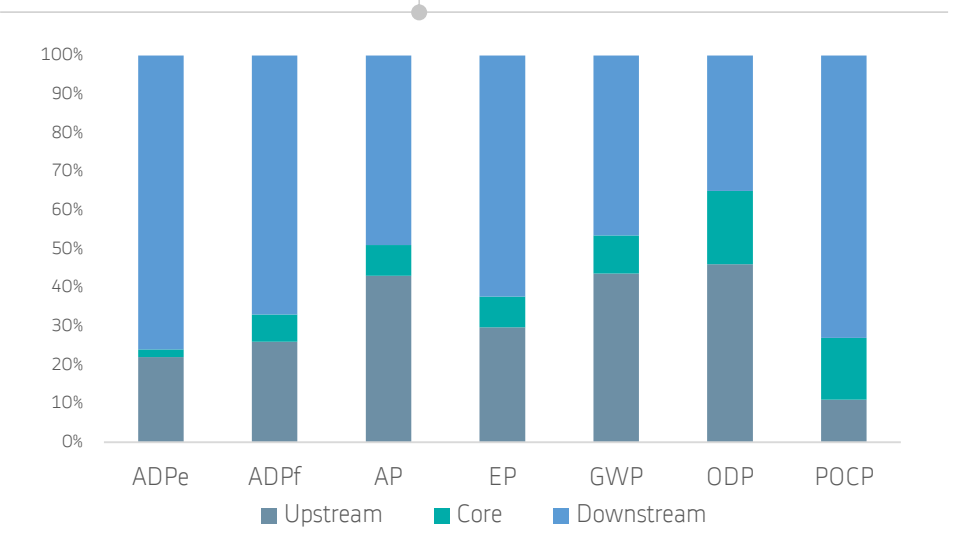
Waste

FLOW PER FUNCTIONAL UNIT	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Non-hazardous waste	**kg**	**4,35E+05**	**6,87E+05**	**3,36E+06**	**4,48E+06**
Hazardous waste	kg	3,59E+05	1,24E+04	2,50E+04	4,42E+04
Radioactive waste	**kg**	**9,28E+03**	**1,84E+03**	**9,39E+02**	**1,42E+03**

ENVIRONMENTAL PERFORMANCE

Environmental impacts

INDICATOR PER FUNCTIONAL UNIT		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Global warming potential	GWP	kg CO_2e	2,02E+06	4,48E+05	2,18E+06	4,65E+06
Acidification potential	AP	kg SO_2e	6,42E+03	1,14E+03	7,36E+03	1,49E+04
Eutrophication potential	EP	kg PO_4^{3-}e	9,32E+02	2,37E+02	1,98E+03	3,15E+03
Photochemical oxidant creation potential	POCP	kg C_2H_4e	1,14E+02	1,57E+02	7,38E+02	1,01E+03
Emission of ozone-depleting gases	ODP	kg CFC 11e	1,05E-01	4,38E-02	7,97E-02	2,29E-01
Depletion of abiotic resources-elements	ADPe	kg Sbe	1,15E+00	1,22E-01	4,00E+00	5,27E+00
Depletion of abiotic resources-fossil fuels	ADPf	MJ	2,00E+07	5,15E+06	5,09E+07	7,60E+07



Contribution of each phase to the environmental impacts

Configurations

- Life cycle description information and environmental performance results published in this EPD corresponds to the reference design configuration developed by Alstom.
- To know the performance associated to other possible configurations of the solution please contact Alstom.

ENVIRONMENTAL PERFORMANCE

DEFINITIONS

Global warming potential

This indicator calculates the contribution to global warming of the planet by the emission of greenhouse gases.
The result is expressed in kg equivalent CO_2.

Acidification potential

This indicator calculates the atmospheric acidification caused by the emission of gas with an acidifying effect.
The result is expressed in kg equivalent SO_2

Eutrophication potential

This indicator calculates the eutrophication of water caused by the emission of specific substances (discharge of phosphoric, nitrogenous and organic matter).
The result is expressed in kg equivalent phosphate.

Photochemical oxidant creation potential

The potential for creating tropospheric ozone is caused by the discharge of specific gases which have an oxidizing action under the effect of solar radiation. This indicator calculates the potential for the creation of photochemical ozone from the emission of about a hundred substances.
The result is expressed in kg equivalent ethylene.

Emission of ozone-depleting gases

This indicator calculates the contribution made by the discharge of specific gases responsible for ozone layer depletion.
The result is expressed in kg equivalent CFC-11.

Depletion of abiotic resources-elements

This Indicator calculates the depletion of natural non-fossil resources.
The result is expressed in kg equivalent of Sb.

Depletion of abiotic resources-fossil fuels

This Indicator calculates the depletion of natural fossil resources.
The result is expressed in MJ.

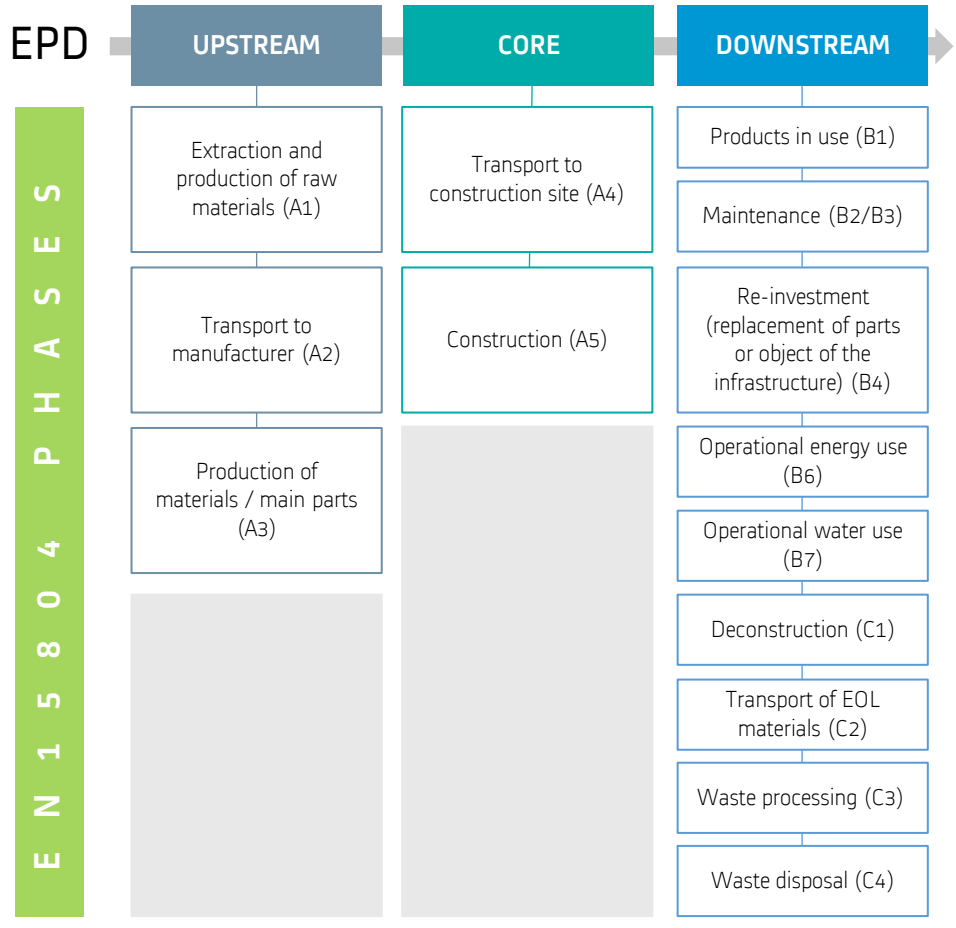
Additional information

Noise and vibration

Along the life cycle, the main activities that generate noise are construction and deconstruction activities with the use of heavy machinery. Impact related to noise should be dealt with, case by case, for each applicative project of NBT reference solution at global infrastructure level and as part of environmental impact statement if applicable.

Biodiversity and water management

Impact on biodiversity and water flow should be dealt with, case by case, for each applicative project at global infrastructure level (as part of environmental impact statement if applicable).



PROGRAMME RELATED INFORMATION AND VERIFICATION

Product category rules (PCR):
Railways, PCR 2013:19, version 2.01

PCR review was conducted by:
The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com/TC. The PCR review panel may be contacted via info@environdec.com.
Members of the Technical Committee were requested to state any potential conflict of interest with the PCR moderator or PCR committee, and were excused from the review.

Independent verification of the declaration and data, according to ISO 14025:2006:

☐ EPD Process Certification (internal) ☒ EPD Verification (external)

Third party verifier:
Damien PRUNEL,
Chef de projets - Consultant ACV & Ecoconception
BUREAU VERITAS LCIE
Services Analyse du Cycle de Vie et Ecoconception
170 rue de Chatagnon - ZI Centr'alp - 38430 Moirans - FRANCE
damien.prunel@fr.bureauveritas.com

Accredited by:
Recognized individual verifiers, approved by the International EPD System.

EPD®s within the same product category but from different programmes may not be comparable.

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EPD owner:	**ALSTOM** 48, rue Albert Dhalenne 93482 Saint-Ouen, Cedex France
LCA author:	**Fanny LEBAILLY** fanny.lebailly@alstomgroup.com
Programme operator:	**EPD International AB** info@environdec.com

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THE INTERNATIONAL EPD® SYSTEM

ALSTOM
Designing fluidity

France, Europe, Middle East & Africa
Alstom
48, rue Albert Dhalenne
93482 Saint-Ouen Cedex - France
Telephone: +33 1 57 06 90 00

Latin America
Alstom
Virgilio Wey Street, 150
Água Branca
05036-050 São Paulo/SP - Brazil
Telephone: +55 11 3617-8000

Asia Pacific
Alstom
No.66/02, Embassy Prime,
B Wing 3rd floor,
C V Raman Nagar,
Bangalore - 560 093
Karnataka - India
Telephone: +91 80 4641 2400

North America
Alstom
641 Lexington Avenue - 28th floor
New York, NY 10022 - USA
Telephone: +1 212 692 5320

www.alstom.com