Environmental declaration: STDS AF

Smart Train Detection System (audio frequencies)

PEP Ecopassport®

STDS AF is an electronical system for railways or metro lines, installed to detect the presence of the train on track and communicate the occupancy status to the central computer. This paper presents the ecological footprint of an Italian configuration of the STDS AF. The Life Cycle Analysis (LCA) has been performed in accordance with ISO 14040[1] and ISO 14044[4]. Environmental declaration was made according to ISO 14025

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 an environmental management system fully in place: 100% of manufacturing sites and regional centers over 200 employees are certified according ISO 14001.

More than 10 years ago, Alstom systematically introduced eco-design into 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. Eco-design 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.

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Product description

STDS AF is an electronical system for railways or metro lines installed to detect the presence of the train on track and communicate the occupancy status to the central computer.

STDS AF generates and receives modulated signals to and from the track to detect the presence of the train (Train Detection function) and communicates the status of the track, clear/occupied, to Signaling Computer through dual vital redundant Ethernet link. It also provides diagnostic info (measures of signals and dedicated alarms for hardware faults) to support maintenance activities on the product itself and the trackside devices. It is adaptable to any type of interlocking or subsystem. This equipment is composed of electronical devices mounted in a cabled rack.

This ALSTOM Smart Train Detection System is a new generation of Train Detection equipment with innovative architecture:

- Immunity to new trains emission and adaptability to track environmental variations
- High availability due to hot module redundancy
- Long Track Circuit management (up to 2000 m)
- Extended range of Operating frequencies
- High power efficiency
- Multi-Track topology
- Concentrated and distributed installation (Section & Joint Management)
- Replace the existing track circuity families

A Life Cycle Assessment was done for this product, according to principles given by the ISO 14040[(1)] standard. The objectives of this study were:

- To characterize the environmental performance of the product,
- To develop a flexible communication, that is adaptable to each configuration and customer,
- To compare the environmental performance of this product with the previous version of DTC24 (Digital Track Circuit) to value the improvement of the environmental footprint of the product (see p6).

The reference product studied is Alstom reference “STDS AF”.

This document is presenting the environmental footprint of STDS AF according to the ISO 14025[(5)] standard.

Bill of materials

The weight of the product is 22 kg (including packaging); 100% of the estimated (from our experience and knowledge on components) or known weight (from our databases of datasheets and material declarations) is modeled. This following distribution doesn't take into account the packaging. The material repartition is the following:

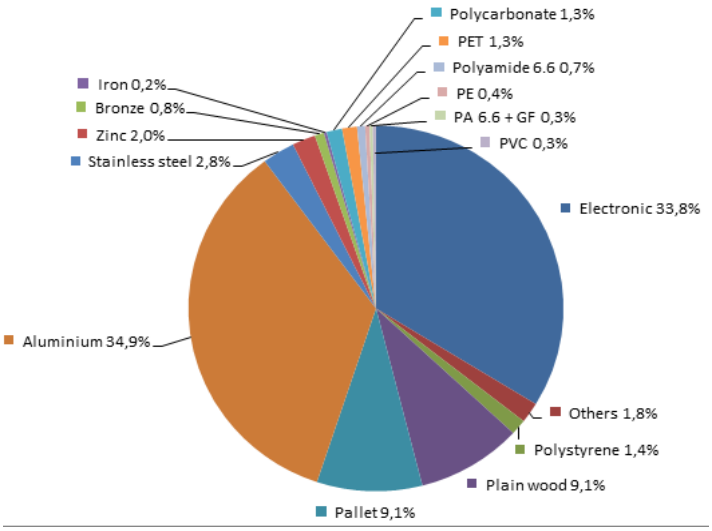

Figure 1: STDS AF bill of materials

Manufacturing

The STDS AF was specified by Bologna site, certified according to ISO 9001[2] and ISO 14001[3] for site and product design activities. Bologna site is progressively implementing an eco-design approach to reduce the environmental footprint of their products. The product is made in Kwidzyn (Poland).

To model the manufacturing phase, raw materials and main processes on metallic and plastic parts were taken into account. The upstream transportation from suppliers to the assembly site was included. European modules were selected giving priority to ELCD data (European reference Life Cycle Database).

Dangerous substances have not been added to the model. Only the dangerous substances already contained in the modules are included. Alstom performs separately hazardous substances analysis depending on the geographical context to comply with the regulations.

Distribution

For the calculation of transportation impacts, the following data was considered: delivery from Kwidzyn (Poland) production area to Italian installation sites by truck (27 tons), corresponding to a worst-case distance of 3000 km between the two logistic platforms.

Installation

The infrastructure is not taken into account in this phase because it is part of the Infrastructure activity of Alstom. The packaging end-of-life is taken into account according to the recyclability potential of the materials and the reuse of the pallet.

Use

The STDS AF does not generate any emission of particles during use.

The use scenario considered for the analysis is the following:

- Number of days per years: 365
- Number of hours per day: 24
- Lifetime: 20 years

- Typical power consumption: 70 W (measured)
- Typical energy consumption: 0.07 kW × 20 years × 365 days × 24 hours = **12264 kWh**

The use phase doesn't need mandatory spare parts.

This scenario is a delivery to an Italian site, for the Italian market. For this phase, the Italian electric model has been selected (EIME® Module ELCD-0122, "ELCD-0045, Electricity Mix; AC; consumption mix, at consumer; 1kV - 60kV; IT").

STDS AF implements EcoPower feature to limit power consumption. The principle of EcoPower is to dynamically reduce the amplitude of the generated signal basing on the measure of the transmitted current and restoring its level when necessary. In this way STDS AF adapts its power consumption to the real needs of the external environment and allows reducing the energy consumption up to 30% regarding the previous system. The word "Eco" is chosen to show the economy on power. The reduction is assessed comparing to the previous generation of the product, without sacrificing performances and functionalities, thanks to the new design (hardware optimization) and to the software (EcoPower function management).

End of life

The end of life phase has been modeled according to the recommendations in the "Sheets of good practices" manual of April 17, 2012 of Bureau Veritas CODDE© ("F file: Modeling end of life treatment of waste of electronic and electrical equipment") and ECO-DEEE methodology. A European scenario was chosen to model the end-of-life phase.

Life cycle analysis results

The EIME® software ("Environmental Improvement Made Easy") version v5.8.1 and its database CODDE 2018-11 were used to perform this life cycle analysis.

The environmental impacts were calculated for manufacturing, distribution, installation, use and for the end-of-life.

Table 1: Indicators for PEP Ecopassport - PCR 3 - 2015 and STDS AF results

Environmental impacts		Results					
Indicators	**Unit**	**Total**	**Manufacturing**	**Distribution**	**Installation**	**Use**	**End of life**
A for PEP	**kg SO2 eq.**	1.48E+01	8.62E-01	2.01E-02	1.39E-03	1.39E+01	5.59E-03
ADPe for EN15804	**kg antimony eq.**	5.29E-02	5.23E-02	1.43E-09	1.24E-08	5.97E-04	2.09E-08
ADPf for EN15804	**MJ**	8.84E+04	3.28E+03	9.60E+01	4.36E+00	8.50E+04	2.64E+01
AP for DHUP	**m³**	3.93E+05	4.61E+04	2.71E+02	1.27E+01	3.46E+05	2.42E+02
EP for EN15804	**kg PO4--- eq.**	1.41E+00	1.39E-01	5.43E-03	3.20E-04	1.26E+00	2.91E-03
GWP for EN15804	**kg CO2 eq.**	6.85E+03	3.55E+02	7.81E+00	3.10E-01	6.48E+03	9.44E+00
ODP for EN15804	**kg CFC-11 eq.**	1.66E-04	5.41E-05	5.52E-06	6.28E-10	1.05E-04	1.14E-06
POCP for EN15804	**kg ethylene eq.**	1.18E+00	8.19E-02	4.53E-04	9.90E-05	1.10E+00	4.09E-04
WP for DHUP	**mÂ³**	1.78E+05	3.61E+04	1.15E+03	5.10E+01	1.41E+05	4.37E+02
Net use of fresh water	**m³**	3.27E+04	1.20E+01	9.36E-03	2.78E-25	3.27E+04	6.56E-03
Total primary energy	**MJ**	1.15E+05	5.08E+03	9.63E+01	4.38E+00	1.10E+05	3.29E+01

Environmental impacts

The relative contribution of the impacts per life cycle phase is presented in the Figure 2:

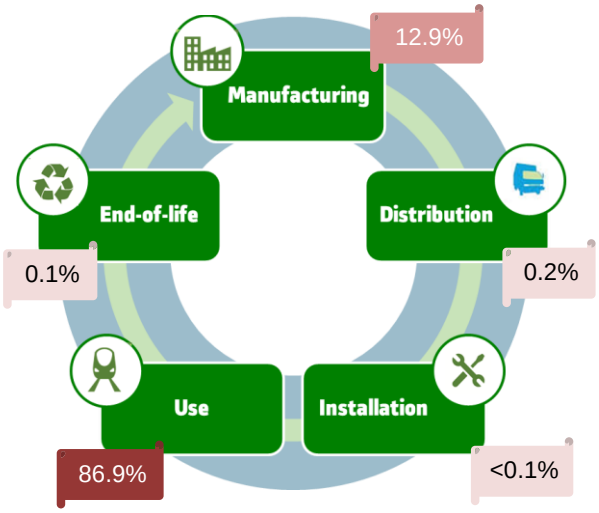

Figure 2: STDS AF relative contribution of impacts per life cycle phase

The use phase is predominant because of the energy consumption over the lifetime of the product. Impacts repartition also depends to the electricity mix of the installation country. The manufacturing phase is also significant: this is mainly due to the manufacturing of electronic components that contain rare earths. For these reasons, distribution, installation and the end-of life phases are not significant.

The relative contribution of the impact of each phase on the life cycle analysis is presented in the Figure 3:

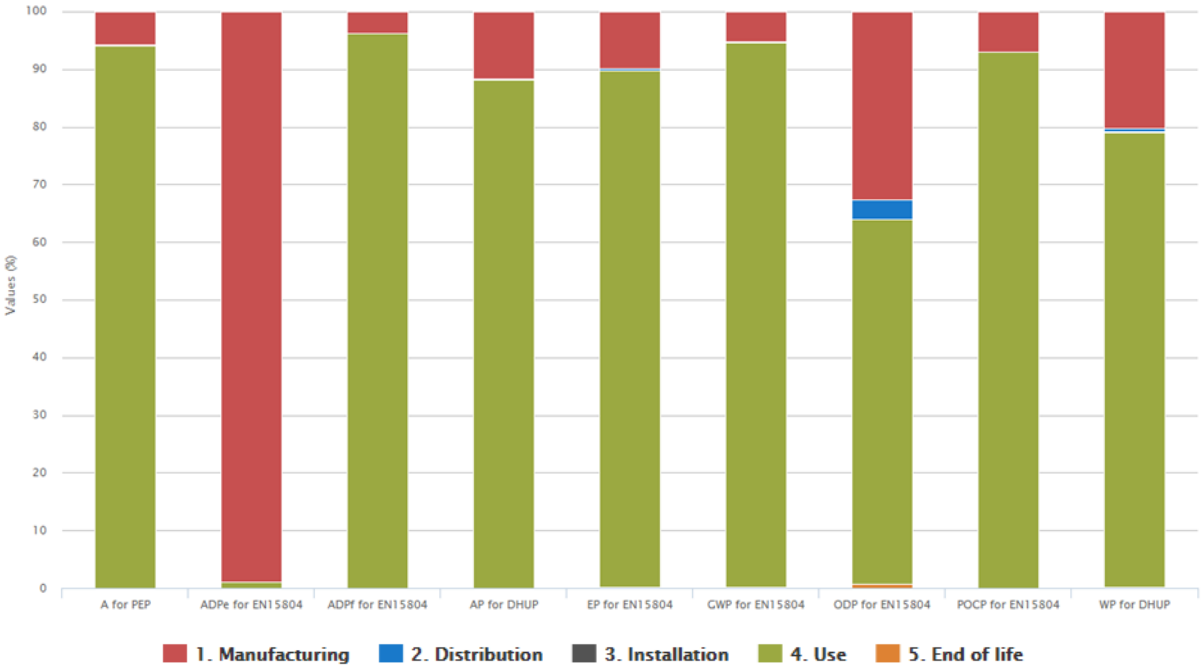

Figure 3: Repartition of STDS AD impacts according to life cycle phases

Then, a tracking was performed in order to identify the most impacting aspects of the STDS AF:

- Use phase: energy consumption of the electronic modules
- Manufacturing phase: Printed Wired Board (PWB), integrated circuits (TSSOP and SSOP type), transistors, and the metallic parts made of aluminium.

Comparison with previous track circuit generation

STDS AF has been designed to be the replacement of the ALSTOM existing track circuity families:

- DTC-24
- SDTC
- Jade

It is fully compatible with all their track field elements and frequencies.

The advantages are:

- Unique hardware covers all the specific installation configurations.
- Fully digital track circuit with higher immunity to new trains emission and the adaptability to track environmental variations.
- Both serial and parallel interfaces to IXL.
- High track circuit configurability (Concentrated and Distributed Installation).
- Low Power Consumption: STDS AF implements ALSTOM Eco-Power feature to limit power consumption. The principle of Eco-Power is to dynamically reduce the amplitude of the generated signal basing on the measure of the transmitted current and restore its level when necessary. In this way STDS AF adapt its power consumption to the real needs of the external environment and allow reducing the energy consumption up to 30%.
- Advanced Diagnostic:
  - Prediction of field elements faults and deterioration.
  - Architecture oriented to "Design for Serviceability".
  - Undue Occupation Analysis.
- Easy commissioning, installation and maintenance.

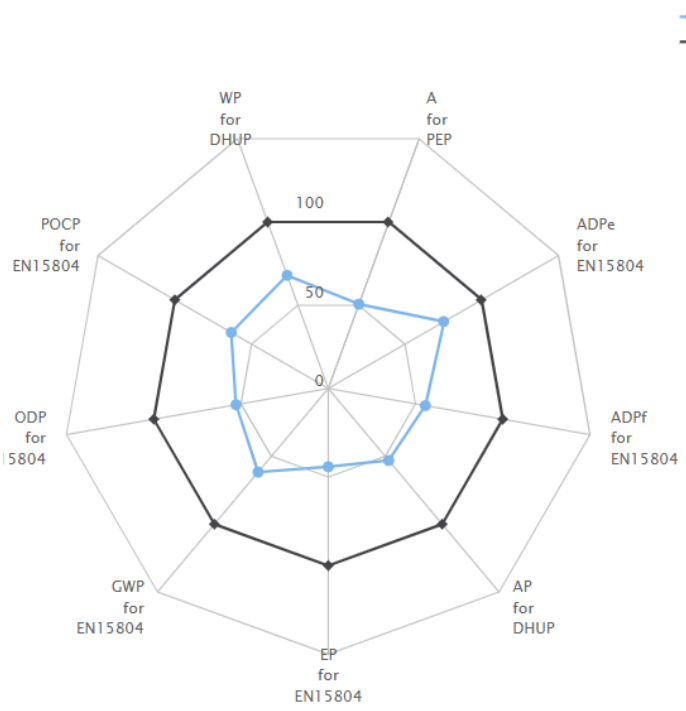

Figure 4: Comparison of STDS AF and DTC-24 manufacturing impacts

The STDS AF is a redesign of the DTC-24. The complete rack weighs only 17.7 kg whereas the previous version weighs 34 kg. That is a reduction by 48% of the weight.

The global reduction of the impacts on the manufacturing phase is 43%. In fact, the use of integrated circuit of new generation allows a high computation / functionality density, but increases impacts on the element resources (ADPe), because they include rare earth, hardly extractable.

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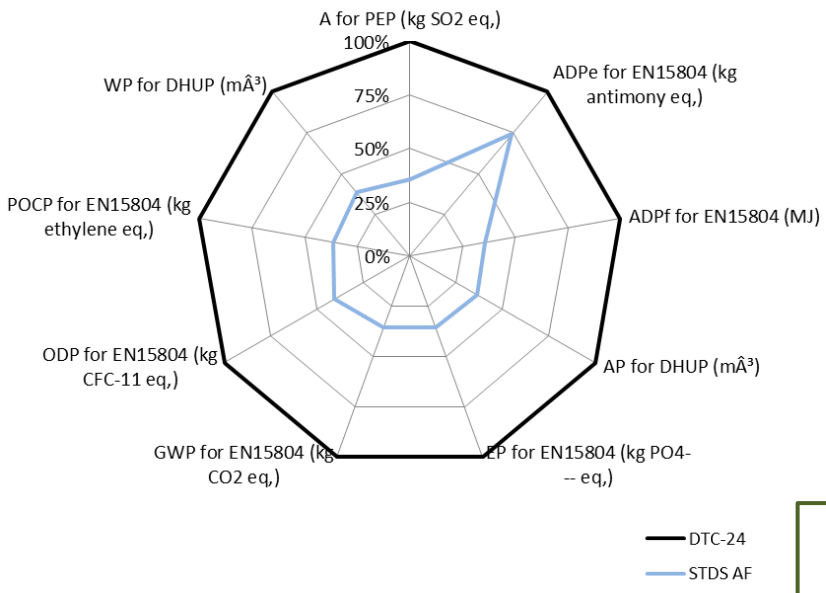

Indicators	STDS AF [%]	DTC-24 [%]
A for PEP	35.66	100
ADPe for EN15804	73.88	100
ADPf for EN15804	35.50	100
AP for DHUP	36.39	100
EP for EN15804	35.88	100
GWP for EN15804	35.86	100
ODP for EN15804	40.79	100
POCP for EN15804	36.20	100
WP for DHUP	38.95	100
Average	41.00	100

The global reduction on the whole life cycle is 59%. Indeed energy consumption was reduced by 65%!

Figure 5: Comparison of STDS AF and DTC-24 whole life cycle

Global reduction: -59%[§]

Conclusion

The train detection system (STDS AF) was considerably improved over previous generation (DTC-24). The redesign of the product had a huge impact with a reduction by 48% of the weight of the product (hardware improvement).

It has been highlighted that, for the Italian case, the use phase is predominant over all the others with approximately 87% of all the environmental impacts. The global results strongly depend on the Electricity mix of the installation country as shown in the comparative radar.

The reduction of energy consumption and the introduction of the EcoPower mode lead to a global power consumption of one third. Therefore a reduction of environmental footprint by 59% was achieved.

[§] The global reduction is calculated on the nine indicators of EIME indicator set

Glossary

(1) *EN ISO 14040:2006, "Environmental management – Life cycle assessment- Principles and framework"*
(2) *EN ISO 9001:2015, "Quality management systems – Requirements"*
(3) *EN ISO 14001:2015, "Environmental management systems – Requirements with guidance of use"*
(4) *EN ISO 14044:2006/A1:2018, "Environmental Management – Life Cycle Analysis – Requirements and Guidelines"*
(5) *EN ISO 14025:2010, "Environmental labels and declarations. Type III environmental declarations"*

Global warming	Indicator of potential global warming caused by emissions to air contributing to the greenhouse effect	kg CO2 eq.	GWP for EN15804
Ozone depletion	Indicator of emissions to air that contribute to the destruction of the ozone layer	kg CFC-11 eq.	ODP for EN15804
Acidification of soil and water	Indicator of the potential acidification of soils and water caused by the release of certain gases to the atmosphere	kg SO2 eq.	A for PEP
Eutrophication	Indicator of the contribution to eutrophication of water by the enrichment of the aquatic ecosystem with nutritional elements	kg$(PO4)^3$ eq.	EP for EN15804
Photochemical ozone creation	Indicator of emissions of gases that affect the creation of photochemical ozone in the lower atmosphere (smog) due to the effect of the rays of the sun.	kg C2H4 eq.	POCP for EN15804
Depletion of abiotic resources - elements	Indicator of the depletion of natural non-fossil resources	kg Sb eq.	ADPe for EN15804
Depletion of abiotic resources – fossil fuels	Indicator of the depletion of natural fossil resources	MJ	ADPf for EN15804
Water Pollution	Indicator of the quantity of water necessary to dilute the toxic elements poured into water in all the stages of the product life cycle.	mÂ^3	WP for DHUP
Air pollution	Indicator of the quantity of air necessary to dilute the toxic elements emitted into the air in all the stages of the product life cycle.	m^3	AP for DHUP
Net use of fresh water	Indicator of the quantity of water necessary on the product lifecycle	m^3	
Total primary energy	Indicator of the quantity of energy necessary on the product lifecycle	MJ	

Registration No: ALTR-00005-V01.01-EN	Drafting rules: «PCR-ed3-EN-2015 04 02»
Verified accreditation number: VH18	Information and reference documentation: www.pep-ecopassport.org
Date of issue: «10-2019»	Validity period: 5 years
Independent verification of the declaration and data, in compliance with EN ISO 14025:2010 Internal ☐ External ☒	
The PCR review was conducted by a panel of experts chaired by Philippe Osset (SOLINNEN)	
PEP are compliant with XP C08-100-1 :2016-12 The elements of the PEP cannot be compared with elements from another program	
Document in compliance with EN ISO 14025:2010 «Environmental labels and declarations. Type III environmental declarations	

For additional information you can contact:

Stefano CERBAI: Hardware Architect
stefano.cerbai@alstomgroup.com

Company:

ALSTOM FERROVIARIA SpA
http://www.alstom.com

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