ENVIRONMENTAL PRODUCT DECLARATION

IN ACCORDANCE WITH ISO 14025 AND EN 15804+ A2:2019

PANDROL

e1883RAIL CLIP

Sumitomo Corporation

Enriching lives and the world

Declaration number: S-P-03000

Version 1.0
Issued on 2021-11-15
Valid until 2026-11-14

The International EPD® System, www.environdec.com

The environmental impacts of this product have been assessed from cradle to gate with options.

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

This EPD has been verified by an independent third party.

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

Introduction

This EPD provides environmental performance indicators for Pandrol's e1883 18mm rail clips supplied to users in Japan. This is a cradle-to-gate with options EPD in accordance with the requirements of EN 15804+ A2:2019, covering modules A1 - A3, A4, C and D defined in that standard. The declared unit is one rail clip.

The EPD is based on a life cycle assessment (LCA) study which used data collected from facilities manufacturing 18mm and 20mm rail clips during the year 2020. Background data were taken from the ecoinvent database (v3.6). The EPD presents details of the LCA, a description of the product life cycle it covers, values for the environmental indicators specified by EN 15804 and a brief explanation of those results.

Pandrol's e1883 rail clip EPD	
EPD programme	The International EPD® System
EPD programme operator	EPD International AB - Box 210 60 - SE 100-31 - Stockholm - Sweden- www.environdec.com
EPD owner	Pandrol - Gateford Road - Worksop - Notts S81 7AX - UK https://www.pandrol.com/
Product name	rail clips e1883(coated) & e1883CP (with corrosion protection)
CPC code	4953 / 4954
Declared unit	One rail clip
System boundaries	Cradle-to-gate with modules C & D
Declaration No	S-P-03000
Date of publication	2021-11-15
EPD valid until	2026-11-14
EPD Version	1.0
Procedure for data follow-up during EPD validity	involves third party Verifier: yes ☐ no ■
EPD geographical scope	Japan
EPD based on Product Category Rules	The CEN standard EN 15804:2012 + A2:2019 serves as the core PCR
	The International EPD® System's PCR 2019:14 Construction products, v1.1, 2020-09-14 & PCR 2013:19 Railways, v2.11, 2013-10-18
PCR review conducted by	The Technical Committee of the International EPD® System Chair: Claudia Peña; contact via info@environdec.com
Verification	Independent verification of this EPD and data, according to ISO 14025/2006: ☐ internal certification ■ external verification
Third party verifier	Marcel Gómez Ferrer. Marcel Gómez Consultoría Ambiental. info@marcelgomez.com - Recognized Individual Verifier
Accredited or approved by	The International EPD® System
LCA conducted by	EuGeos Limited, UK - www.eugeos.co.uk
LCA software	openLCA
Background data	ecoinvent V3.6

EPDs within the same product category but from different programmes may not be comparable.
EPDs of construction products may not be comparable if they do not comply with EN 15804.For further information about comparability, see EN 15804 and ISO 14025.

Company profile

Our story

Pandrol defines the industry standard across rail fastening systems and aluminothermic welding. We operate in over 100 countries worldwide, with 1,700 employees based across 40 locations.

Part of the Delachaux Group, a family owned company since 1902, our products and services extend to designing, developing and manufacturing equipment to make constructing and maintaining railways more efficient. Our smart control systems increase productivity, monitor track conditions and improve the overall track life cycle.

We also provide a full range of products for urban transportation systems, including products such as aluminium/steel conductor rail systems, rigid catenary systems.

Over 400 railway systems worldwide have adopted our innovative solutions, market-leading products and advice. Our company promise is focused on delivering an unrivalled customer experience by maximising rail infrastructure availability, safety and lifetime value.

We take pride in our history, expertise and commitment to quality, and work collaboratively with our customers to create a safer future for rail infrastructure.

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Sumitomo Corporation

Enriching lives and the world

Sumitomo Corporation Group conducts business activities throughout a wide range of industries on a global scale and aims to achieve prosperity and realize dreams through sound business activities. Since its foundation in 1919, we have made steady growth through enhancing our ability to create new value together with stakeholders such as business partners and clients, across business networks around the world.

Sumitomo Corporation has been the distributor of Pandrol fastening system in Japan since 1987, and distributed Pandrol products including track maintenance machinery and accessories for Japanese customers and also Asian projects.

Sumitomo Corporation and Pandrol jointly designed and developed e2009 series and e1883 series assemblies to meet the Japanese customers' technical requirements. Today, those assemblies are one of the most standard fastening systems installed in Japan and Asian projects.

Product information

e1883 rail clip

This EPD applies to Pandrol's 18mm rail clips distributed in Japan by Sumitomo:

- e1883 - 18mm rail clip, coated
- e1883CP - 18mm rail clip, with corrosion protection

Rail clips are forged steel items used as part of rail fastener assemblies which attach rails to railway sleepers; each rail fastener includes 2 clips.

e1883 - 18mm rail clip, coated

Rail clips are classified CPC 4953 and CPC 4954 under the UN CPC classification system v2.1.

Manufacture & supply

Rail clips are produced from steel at the company's Worksop site (UK). Spring steel bar is forged and heat-treated to meet the relevant performance criteria and finished clips are powder coated. e1883 CP clips are subject to an additional surface treatment in specialist facilities prior to final powder coating, to provide enhanced corrosion resistance.

Packaging & transportation

Rail clips are transported to Japan by road and sea in semi-bulk packaging containers on Europallet.

Installation

Installation of the rail clip in a rail fastener embedded in a sleeper takes place in-situ as part of the rail track installation.

Product use and maintenance

The service life of rail clips is dependent on traffic and the track maintenance regime applied, but is typically 20 years.

End-of-life

Rail clips must be removed to remove rails from sleepers. Being >95% steel, they are typically recycled with other ferrous metal items.

As wastes Pandrol's rail clips would fall under European Waste Catalogue (EWC) code 17 04 05 if the polymeric components were removed or regarded as “de-minimis” under locally-applicable regulations; otherwise they would fall under EWC code 17 09 04.

Reference service life

Railway track is a system with several constituent elements. Pandrol assumes the life of the track is 50 years. Typical life of components such as clips would be 20 years. Concrete sleepers and cast iron shoulders are assumed to have a 50 year life. Rail is assumed to have 30 year life. However, to optimise fastener system performance, the rail and rail set components should be subject to periodic maintenance and timely replacement. No specific reference service life for the product is applied in the LCA underpinning this EPD

Further product information

Detailed product information and datasheets can be found

- on our website: https://www.pandrol.com/
- or by email: marketing@pandrol.com

Contents declaration

The material composition of e1883 rail clips, including delivery packaging, is shown below:

Rail clip e1883, e1883CP	Weight (kg)	% of mass per declared unit	Recycled material (%)	Renewable material (%)
Alloy steel	0.69	96.8	100	0
Polyester (coating)	0.003	0.4	0	0
Zinc (CP clip only)	<0.005	<0.7	0	0

Packaging	Weight (kg)	% of mass per declared unit	Recycled material (%)	Renewable material (%)
Wood (pallet)	0.012	1.7	0	100
Plastic packaging (PP)	0.003	0.4	0	0

The mass of the declared unit is 0.715kg (one 18mm e1883 clip plus packaging).

Packaging amounts to approximately 0.015kg per functional unit, of which 80% is wood and the remainder polypropylene.

The declared unit contains 6g biogenic C, which is all in the packaging.

No substance included in the Candidate List of Substances of Very High Concern for authorisation under the REACH Regulations is present in the protection materials, either above the threshold for registration with the European Chemicals Agency or above 0.1% (wt/wt).

Residual risks and emergencies

There are no residual risks associated with the normal use of Pandrol's rail clips.

Environmental performance-related information

LCA information

This section of the EPD records key features of the LCA on which it is based.

Scope

This EPD covers the production stage (modules A1-A3), delivery to site (A4), interpreted here as the import warehouse in Japan where the clips enter the local production system, and end-of-life management (C & D) - see below; as permitted by EN 15804, modules A1-A3 are declared in aggregated form.

Product stage			Construction process stage		Use stage							End of life stage				Benefits & loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste treatment	Disposal	Reuse- recovery- recycling-potential
Modules declared X: included in LCA; ND: module not declared; NR: module not relevant																
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X
Geography																
It	Glo	GB	JP	-	-	-	-	-	-	-	-					
Specific data used																
>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation in products & sites																
Not applicable			-	-	-	-	-	-	-	-	-					

The scope includes all modules and processes required by PCR 2013:19 Railways v 2.11, International EPD® System. Indicators required by this PCR have been calculated in the LCA and are included in this EPD.

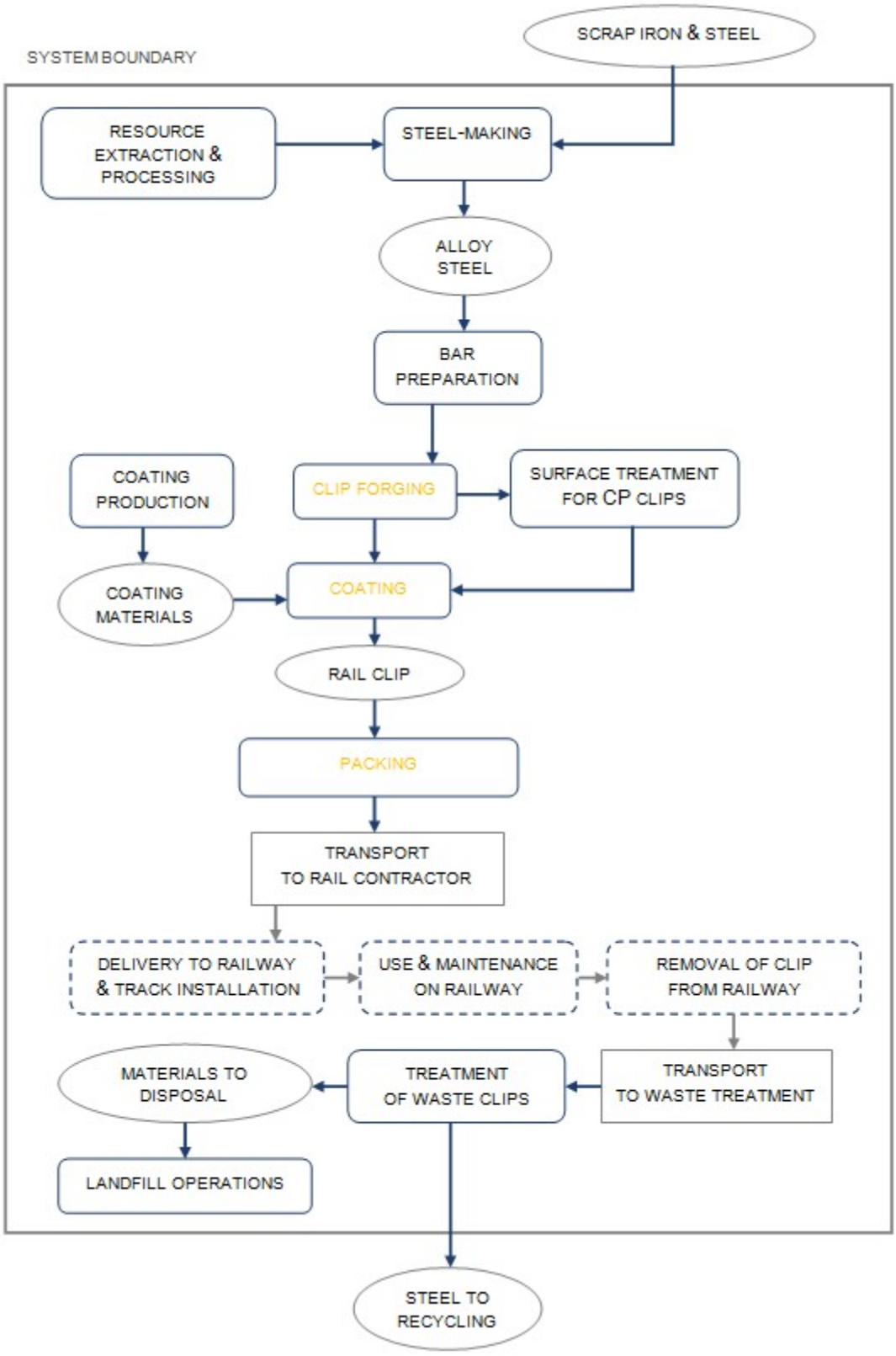
Module A5 is interpreted as being the manufacture of railway sleepers, it is omitted from this EPD and assumed to be assessed as part of the sleeper life cycle.

Declared unit

The declared unit is one rail clip.

System boundaries

The product life cycle covered by this EPD is illustrated below.



RAIL CLIP LIFE-CYCLE

The system boundary of the EPD is defined using the modular approach set out in EN 15804. The system includes production of all raw materials and components from basic resources; transport of those materials at all stages up to the import warehouse; the production of fuels and energy carriers and their delivery to manufacturing sites; the treatment of all wastes. The upstream processing of recycled material inputs that have passed the end-of-waste state is outside the system boundary.

Cut-off criteria

The collected data covered all raw materials, consumables and packaging materials; associated transport to manufacturing sites; process energy and water use; direct production wastes; emissions to air and water.

According to EN 15804 and the PCR, flows can be omitted (cut off) from a core process in the LCA up to a maximum of 1% of the total mass of material inputs or 1% of the total energy content of fuels and energy carriers; various material inputs amounting, in combination, to <0.1% of total input materials were omitted from the LCA underpinning this EPD. In total, less than 5% of materials and energy per module have been omitted.

Data sources and data quality

Data characterising manufacturing of the rail clip and delivery to the import warehouse in Japan were collected for a continuous 12-month period between 01/01/2020 and 31/12/2020. Data characterising surface treatment of the CP rail clip were collected from operators of the process and scaled to 12 months.

The data have been updated within the last 5 years. These data were checked to ensure that sufficient materials and water are included within the inputs to account for all products, wastes and emissions.

Background data

Background (generic) data were taken from the ecoinvent database (v3.6); this fulfils the EN 15804 requirement that generic data used in the LCA have been updated within the last 10 years. The quality of generic data has been reviewed and datasets adjusted to better reflect actual operations in Pandrol's supply chain using specific data.

Data quality has been reviewed for processes that contribute significantly to the overall LCA.

Other data were judged fit for purpose. No environmental impact potential stemming from proxy data exceeds 10% for any impact category.

Allocation

In the background data, the ecoinvent default allocation is applied to all processes except those in which secondary materials are used, where the "cut-off" allocation is applied. This ensures that secondary materials are free of upstream burdens that arise prior to their reaching the "end of waste" state, in accordance with Section 6.3.4.2 of EN 15804. In treatment of data for Pandrol's facility, allocation of inputs and outputs is avoided as far as possible. Where it is unavoidable – for example for site-wide utilities – physical allocation is applied on a per unit basis.

Assumptions and estimates

Inputs to and outputs from the system are accounted for over a 100-year time period; long-term emissions are therefore omitted from the impact assessment part of the LCA.

Electricity supplied to Pandrol's Worksop facility has been modeled as the residual mix calculated for the UK by the Association of Issuing Bodies for the year 2018 (2019 information not available). Electricity used for steel processing at Pandrol's supplier has been modeled as the relevant national supply mix.

The "primary energy used as material" indicators (PERM; PENRM) are calculated using - as characterisation factors - published values for constituent materials which can yield energy on combustion, where available, and from published calorific values where PE(N)RM values are not available. Calculations of PERM are based on NCV of 52MJ/kg for polypropylene, 42MJ/kg for other polymers, 16MJ/kg for cardboard, 14MJ/kg wood.

"Primary energy as fuel" indicators (PENRE, PERE) are calculated as the total primary energy demand minus primary energy used as material.

For Module C1, the removal of rail clips of sleepers is assumed to be independent of the removal of sleepers. Modules C2, C3 and C4 are modelled using scenarios, reflecting rail and road transport to a treatment site (C2); reuse of 10% of sleepers and crushing of the remainder (C3), followed by recycling of the steel elements. Relevant parameters are shown in the table below.

The benefits reported in Module D are calculated for **net** flows of materials across the system boundary (materials to be recycled or recovered leaving the modelled system at any point minus recycled materials used in all modules declared in the EPD). Because the steel raw material is 100% recycled, even though a high recycling rate for clips at the end of life is assumed (98%), the calculated net flow of recycled material is negative (the system generates less material for recycling than the recycled material it consumes. As a result no benefits are calculated in Module D and the environmental indicators are reported as 0. Nevertheless, rail clips should be recycled – like other ferrous metal items.

The "polluter pays" and the modularity principles have been followed.

Scenario	Transport to site (A4)	Transport to waste treatment (C2)
Parameters	**Quantity (unit)**	**Quantity (unit)**
Vehicle type	lorry; container ship	lorry; train
Vehicle load capacity	16t; n/a	10t; n/a
Fuel type and consumption	diesel, 0.3 l/km; HFO 2.5g/tkm,	diesel, 0.2 (l/km); n/a
Volume capacity utilisation factor	1	1; 1
Capacity utilisation (including empty returns)	38%; 100%	33% ; n/a
Distance to site	275 km; 11100 km	100 (km road); 100 (km rail)
Bulk density of transported products	7800 kg/m^3 assumed	7800 kg/m^3 assumed

Environmental indicators and interpretation

This EPD contains environmental information about Pandrol's 18mm rail clips supplied to Japan in the form of quantitative indicator values for a number of parameters, which encompass calculated environmental impact potentials, resource and energy use, and waste generation. The indicators were calculated using the methods specified in EN 15804:2013+A1 and EN 15804:2019+A2; the parameters are listed below along with the abbreviations used for them in the tables of indicator values that follow.

Parameter	Abbreviation	Units
Environmental impacts (as per EN 15804:2019+A2)		
Climate change – GWP fossil	GWP-fossil	kg CO_2 eq
Climate change – GWP biogenic	GWP-biogenic	kg CO_2 eq
Climate change – GWP land transformation	GWP-luluc	kg CO_2 eq
Climate change – GWP total	GWP-total	kg CO_2 eq
Climate change - GWP fossil & land transformation [1]	GWP-GHG	kg CO_2 eq
Acidification potential	AP	mol H^+ eq
Eutrophication – freshwater	EP-freshwater	kg P eq & kg PO_4^{3-} eq
Eutrophication – marine	EP-marine	kg N eq
Eutrophication – terrestrial	EP-terrestrial	mol N eq
Photochemical ozone formation	POFP	kg NMVOC eq

Ozone depletion	ODP	kg CFC-11 eq
Depletion of abiotic resources – minerals & metals [2]	ADPMM	kg Sb eq
Depletion of abiotic resources – fossil fuels [2]	ADPFF	MJ, ncv
Water (user) deprivation potential [2]	WDP	m^3 world-eq deprived

1 - GWP-GHG includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. This indicator is closely comparable to the GWP indicator originally defined in EN15804:2012+A1:2013

2 - The results of this environmental impact indicator shall be used with care because either the uncertainties associated with the results are high or there is limited experience with the indicator

Parameter	Abbreviation	Units
Environmental impacts (as per EN 15804:2013+A1)		
Global warming potential	GWP	kg CO_2-eq
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11-eq
Acidification potential of land and water	AP	kg SO_2-eq
Eutrophication potential	EP	kg PO_4^{3-} eq
Formation potential of tropospheric ozone photochemical oxidants	POCP	kg ethene-eq
Abiotic depletion potential for non-fossil resources	ADPE	kg Sb-eq
Abiotic depletion potential for fossil resources	ADPF	MJ
Resource use		
Renewable primary energy as energy carrier	PERE	MJ
Renewable primary energy resources as material utilisation	PERM	MJ
Total renewable primary energy use (sum of the two parameters above)	PERT	MJ
Non-renewable primary energy as energy carrier	PENRE	MJ
Non-renewable primary energy resources as material utilisation	PENRM	MJ
Total non-renewable primary energy use (sum of the two parameters above)	PENRT	MJ
Use of secondary material	SM	kg
Use of renewable secondary fuels	RSF	MJ
Use of non-renewable secondary fuels	NRSF	MJ
Net use of fresh water	FW	m^3
Wastes		
Hazardous waste disposed	HWD	kg
Non-hazardous waste disposed	NHWD	kg
Radioactive waste disposed	TRWD	kg
Output flows		
Components for re-use	CFR	kg
Materials for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

e1883 18mm rail clip (coated) - Environmental indicators

Environmental indicator results for all declared modules are shown in the following tables for the declared unit of one e1883 18mm rail clip (coated); the A1 - A3 modules are shown on an aggregated basis.

e1883 18mm rail clip								
ENVIRONMENTAL IMPACTS (EN 15804:2019+A2)	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq	1.06E+00	1.71E-01	0.00E+00	1.91E-02	0.00E+00	7.37E-05	0.00E+00
GWP-biogenic	kg CO_2 eq	-2.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-07	0.00E+00
GWP-luluc	kg CO_2 eq	2.03E-03	1.10E-04	0.00E+00	1.21E-05	0.00E+00	2.19E-08	0.00E+00
GWP-total	kg CO_2 eq	1.04E+00	1.71E-01	0.00E+00	1.91E-02	0.00E+00	2.21E-02	0.00E+00
GWP-GHG	kg CO_2 eq	1.07E+00	1.71E-01	0.00E+00	1.91E-02	0.00E+00	7.37E-05	0.00E+00
AP	mol H^+ eq	3.61E-03	4.58E-03	0.00E+00	8.86E-05	0.00E+00	3.48E-07	0.00E+00
EP-freshwater	kg P eq	4.45E-05	8.95E-07	0.00E+00	2.67E-07	0.00E+00	8.88E-10	0.00E+00
EP-freshwater	kg PO_4^{3-} eq	1.37E-04	2.74E-06	0.00E+00	8.19E-07	0.00E+00	2.72E-09	0.00E+00
EP-marine	kg N eq	6.70E-04	1.12E-03	0.00E+00	2.75E-05	0.00E+00	6.68E-08	0.00E+00
EP-terrestrial	mol N eq	7.65E-03	1.24E-02	0.00E+00	3.00E-04	0.00E+00	7.39E-07	0.00E+00
POFP	kg NMVOC eq	2.61E-03	3.23E-03	0.00E+00	8.79E-05	0.00E+00	3.03E-07	0.00E+00
ODP	kg CFC-11 eq	1.32E-07	3.51E-08	0.00E+00	3.79E-09	0.00E+00	3.04E-11	0.00E+00
ADPMM	kg Sb eq	1.60E-05	1.92E-06	0.00E+00	5.71E-07	0.00E+00	6.74E-10	0.00E+00
ADPFF	MJ, ncv	1.76E+01	2.23E+00	0.00E+00	2.77E-01	0.00E+00	2.05E-03	0.00E+00
WDP	m^3 world-eq deprived	8.03E+01	8.22E-01	0.00E+00	1.33E-01	0.00E+00	6.30E-04	0.00E+00
ENVIRONMENTAL IMPACTS (EN 15804:2013+A1)	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
GWP	kg CO_2-eq	1.04E+00	1.70E-01	0.00E+00	1.89E-02	0.00E+00	7.24E-05	0.00E+00
ODP	kg CFC11-eq	1.16E-07	2.79E-08	0.00E+00	3.02E-09	0.00E+00	2.41E-11	0.00E+00
AP	kg SO_2-eq	3.03E-03	3.67E-03	0.00E+00	6.96E-05	0.00E+00	2.91E-07	0.00E+00
EP	kg PO_4^{3-} eq	4.00E-04	3.90E-04	0.00E+00	1.12E-05	0.00E+00	3.43E-08	0.00E+00
POCP	kg ethene-eq	2.50E-04	9.78E-05	0.00E+00	2.88E-06	0.00E+00	2.14E-08	0.00E+00
ADPE	kg Sb-eq	1.60E-05	1.92E-06	0.00E+00	5.71E-07	0.00E+00	6.74E-10	0.00E+00
ADPF	MJ	1.76E+01	2.23E+00	0.00E+00	2.77E-01	0.00E+00	2.05E-03	0.00E+00

e1883 18mm rail clip								
RESOURCE USE	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	1.38E+00	1.89E-02	0.00E+00	5.52E-03	0.00E+00	1.67E-05	0.00E+00
PERM	MJ	4.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.42E+00	1.89E-02	0.00E+00	5.52E-03	0.00E+00	1.67E-05	0.00E+00
PENRE	MJ	2.09E+01	2.26E+00	0.00E+00	2.83E-01	0.00E+00	2.07E-03	0.00E+00
PENRM	MJ	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.11E+01	2.26E+00	0.00E+00	2.83E-01	0.00E+00	2.07E-03	0.00E+00
SM	kg	8.91E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	1.24E-01	5.40E-04	0.00E+00	9.29E-05	0.00E+00	3.87E-07	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.75E-02	8.72E-05	0.00E+00	2.28E-05	0.00E+00	2.13E-06	0.00E+00
WASTES	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
HWD	kg	1.81E-01	2.57E-03	0.00E+00	5.30E-04	0.00E+00	1.93E-06	0.00E+00
NHWD	kg	1.67E+00	6.06E-02	0.00E+00	2.02E-02	0.00E+00	1.40E-02	0.00E+00
TRWD	kg	7.99E-05	1.58E-05	0.00E+00	1.73E-06	0.00E+00	1.37E-08	0.00E+00
OUTPUT FLOWS	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	8.88E-01	1.13E-03	0.00E+00	1.70E-04	6.86E-01	5.24E-07	0.00E+00
MER	kg	2.57E-03	5.97E-06	0.00E+00	1.15E-06	0.00E+00	4.24E-09	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

e1883CP 18mm rail clip (surface-treated)- Environmental indicators

Environmental indicator results for all declared modules are shown in the following tables for the declared unit of one e1883CP 18mm rail clip (surface-treated); the A1 - A3 modules are shown on an aggregated basis.

e1883CP 18mm surface-treated rail clip								
ENVIRONMENTAL IMPACTS (EN 15804:2019+A2)	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-fossil	kg CO_2 eq	1.20E+00	1.71E-01	0.00E+00	1.91E-02	0.00E+00	7.37E-05	0.00E+00
GWP-biogenic	kg CO_2 eq	-2.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-07	0.00E+00
GWP-luluc	kg CO_2 eq	2.17E-03	1.10E-04	0.00E+00	1.21E-05	0.00E+00	2.19E-08	0.00E+00
GWP-total	kg CO_2 eq	1.18E+00	1.71E-01	0.00E+00	1.91E-02	0.00E+00	2.21E-02	0.00E+00
GWP-GHG	kg CO_2 eq	1.20E+00	1.71E-01	0.00E+00	1.91E-02	0.00E+00	7.37E-05	0.00E+00
AP	mol H^+ eq	4.03E-03	4.58E-03	0.00E+00	8.86E-05	0.00E+00	3.48E-07	0.00E+00
EP-freshwater	kg P eq	4.88E-05	8.95E-07	0.00E+00	2.67E-07	0.00E+00	8.88E-10	0.00E+00
EP-freshwater	kg PO_4^{3-} eq	1.50E-04	2.74E-06	0.00E+00	8.19E-07	0.00E+00	2.72E-09	0.00E+00
EP-marine	kg N eq	7.60E-04	1.12E-03	0.00E+00	2.75E-05	0.00E+00	6.68E-08	0.00E+00
EP-terrestrial	mol N eq	8.67E-03	1.24E-02	0.00E+00	3.00E-04	0.00E+00	7.39E-07	0.00E+00
POFP	kg NMVOC eq	2.89E-03	3.23E-03	0.00E+00	8.79E-05	0.00E+00	3.03E-07	0.00E+00
ODP	kg CFC-11 eq	1.49E-07	3.51E-08	0.00E+00	3.79E-09	0.00E+00	3.04E-11	0.00E+00
ADPMM	kg Sb eq	8.30E-04	1.92E-06	0.00E+00	5.71E-07	0.00E+00	6.74E-10	0.00E+00
ADPFF	MJ, ncv	1.99E+01	2.23E+00	0.00E+00	2.77E-01	0.00E+00	2.05E-03	0.00E+00
WDP	m^3 world-eq deprived	8.34E+01	8.22E-01	0.00E+00	1.33E-01	0.00E+00	6.30E-04	0.00E+00
ENVIRONMENTAL IMPACTS (EN 15804:2013+A1)	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
GWP	kg CO_2-eq	1.17E+00	1.70E-01	0.00E+00	1.89E-02	0.00E+00	7.24E-05	0.00E+00
ODP	kg CFC11-eq	1.29E-07	2.79E-08	0.00E+00	3.02E-09	0.00E+00	2.41E-11	0.00E+00
AP	kg SO_2-eq	3.49E-03	3.67E-03	0.00E+00	6.96E-05	0.00E+00	2.91E-07	0.00E+00
EP	kg PO_4^{3-} eq	4.50E-04	3.90E-04	0.00E+00	1.12E-05	0.00E+00	3.43E-08	0.00E+00
POCP	kg ethene-eq	2.60E-04	9.78E-05	0.00E+00	2.88E-06	0.00E+00	2.14E-08	0.00E+00
ADPE	kg Sb-eq	8.30E-04	1.92E-06	0.00E+00	5.71E-07	0.00E+00	6.74E-10	0.00E+00
ADPF	MJ	1.99E+01	2.23E+00	0.00E+00	2.77E-01	0.00E+00	2.05E-03	0.00E+00

e1883CP 18mm surface-treated rail clip								
RESOURCE USE	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	1.50E+00	1.89E-02	0.00E+00	5.52E-03	0.00E+00	1.67E-05	0.00E+00
PERM	MJ	4.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	1.54E+00	1.89E-02	0.00E+00	5.52E-03	0.00E+00	1.67E-05	0.00E+00
PENRE	MJ	2.34E+01	2.26E+00	0.00E+00	2.83E-01	0.00E+00	2.07E-03	0.00E+00
PENRM	MJ	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.36E+01	2.26E+00	0.00E+00	2.83E-01	0.00E+00	2.07E-03	0.00E+00
SM	kg	8.92E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	1.26E-01	5.40E-04	0.00E+00	9.29E-05	0.00E+00	3.87E-07	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3	1.87E-02	8.72E-05	0.00E+00	2.28E-05	0.00E+00	2.13E-06	0.00E+00
WASTES	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
HWD	kg	1.86E-01	2.57E-03	0.00E+00	5.30E-04	0.00E+00	1.93E-06	0.00E+00
NHWD	kg	2.06E+00	6.06E-02	0.00E+00	2.02E-02	0.00E+00	1.40E-02	0.00E+00
TRWD	kg	8.58E-05	1.58E-05	0.00E+00	1.73E-06	0.00E+00	1.37E-08	0.00E+00
OUTPUT FLOWS	**Unit**	**A1 - A3**	**A4**	**C1**	**C2**	**C3**	**C4**	**D**
CFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	8.89E-01	1.13E-03	0.00E+00	1.70E-04	6.86E-01	5.24E-07	0.00E+00
MER	kg	2.60E-03	5.97E-06	0.00E+00	1.15E-06	0.00E+00	4.24E-09	0.00E+00
EE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Biogenic carbon

Carbon dioxide (CO_2) is absorbed from the atmosphere by trees, so any wood-based product contains some carbon from this source. This carbon is considered as a negative emission in some carbon accounting systems.

The biogenic carbon in the wood contained in the declared unit in this EPD is shown below, and is associated with packaging only. Because module A5 is not declared, disposal of packaging and any resulting release of biogenic CO_2 to air are not included in the LCA.

Biogenic carbon content (per declared unit)	Unit	e1883 Quantity	e1883 CP Quantity
Biogenic carbon content in product	kg C	0	0
Biogenic carbon content in packaging	kg C	<0.01	<0.01

Note: 1 kg biogenic carbon is equivalent to 44/12 kg CO_2

Interpretation

Environmental impact potentials associated with the product stage (modules A1 – A3) are much greater than those associated with other modules.

Recycled iron and steel account for almost all of the secondary material input to the functional unit. The negative values for biogenic GWP in Modules A1-A3 are associated with uptake of CO_2 in wood for packaging.

Indicator values obtained for mineral resource depletion (ADPE, ADPMM), stratospheric ozone depletion (ODP), water use (NFW) and water deprivation (WDP) potential should be used with caution; all are subject to uncertainties in data or method which limit the scope for their use as the basis for comparisons.

No untreated wastes leave the modelled system, which includes waste treatment activities as required by EN 15804. The waste indicators HWD, NHWD and TRWD presented in this EPD therefore represent waste flows *within* the modelled system.

Module D indicates "the potential benefits of avoided future use of primary materials and fuels while taking into account the loads and processes associated with recycling and recovery processes beyond the system boundary". Module D therefore quantifies the potential benefits of recycling material in any future product - whether or not it is a rail clip.

The benefits reported in Module D are calculated for **net** flows of secondary materials across the system boundary (materials to be recycled leaving the system minus recycled materials used in manufacture, and other modules declared in the EPD). As a result of this convention, in cases where the proportion of recycled material in the product exceeds the current recycling rate for the constituent materials – as it does here – the Module D yields indicator values that can be interpreted as suggesting that environmental burdens follow from recycling, which could discourage recycling. To avoid this unintended outcome, indicator values of zero are reported for Module D in this EPD.

Additional environmental information

Pandrol already uses recycled materials in its fastener components and has in place a supply chain process that allows many millions of components annually to be shipped direct from its global approved suppliers into its customers to minimise the environmental impact of its transport routes.

Life cycle perspective features within the design process so environmental impact is considered as one of the inputs when developing innovative and modified products.

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