EPD®
THE INTERNATIONAL EPD® SYSTEM

Environmental Product Declaration

In accordance with ISO 14025:2006 for:

CR400AF-Z 350km/h Fuxing Intelligent EMU
from CRRC Qingdao Sifang Co., Ltd.

Programme	The International EPD® System, www.environdec.com
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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.

中国中车 CRRC

Company information

As the core enterprise of CRRC Corporation Limited, CRRC Qingdao Sifang Co., Ltd. (short for CRRC Sifang) is China's industrialization base of manufacturing high-speed trains, the leading enterprise to design and manufacture the top-grade passenger train, urban rail transit vehicle manufacturer and the important export manufacturing base of the national rail transportation equipment.

CRRC Sifang features an integral system of independent development, large-scale manufacturing, and top-level service. CRRC Sifang leads railway sector in researching, developing, and manufacturing high-speed trains, intercity trains, and mass transit vehicles. The first Chinese 200 km/h, 300 km/h and 380 km/h high-speed trains, the first "Fuxing" EMU, and the first intercity train were all manufactured here.

Now CRRC Sifang has developed a serialized product portfolio covering high-speed trains and intercity trains at different speed levels and with different compositions. Among them, the "Fuxing" EMU (CR400AF) has reached commercial operation at 350km/h and completed the rendezvous test at 420km/h.

CRRC Sifang provides proven solutions for rail transit and has exported its rail transit equipment to more than 20 countries around the world.

Environmental Sustainability

Environmental action

The concept of sustainable development of "green, environmental protection and energy conservation" has become the universal consensus of the international community. As the pioneer in rail transit equipment R&D and manufacturing industry, CRRC Sifang actively integrates into the national "carbon peak and carbon neutrality" action, commits to green, intelligent, safe and fast rail transit equipment manufacturing, adheres to the low-carbon and green development concept, and builds a first-class enterprise responsible for ecological environment. Focus on:

Low-carbon product design: Carry out intelligent, modular, lightweight and low noise design to reduce energy consumption of vehicle operation and environmental impact.

Upgrade of manufacturing technology: Promote green manufacturing process, lean production and clean production.

Energy efficiency: Speed up the cleaning up, integration and optimization of energy-intensive and high-emission businesses.

Low-carbon solutions: Continue to explore a new model of manufacturing + service, expanding from a manufacturer of high-end equipment to a provider of entire life cycle management of product and green and low-carbon system solutions.

Enviromental management

CRRC Sifang has an environmental management system fully in place, 100% of manufacturing sites and regional centers are certified according to ISO14001:2015 Environmental Management Systems.

Product information

Product name:
350km/h Fuxing Intelligent EMU
Product identification:
CR400AF-Z

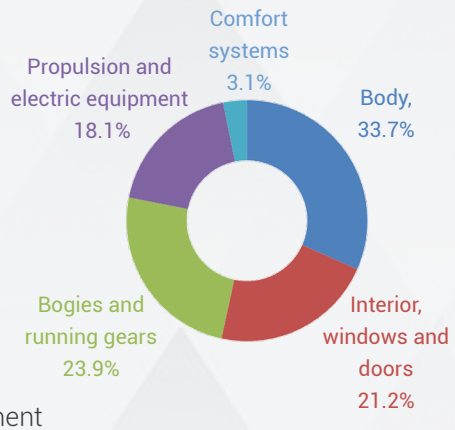
CR400AF-Z is a type of new generation intelligent EMU developed based on CR400AF technology platform. It adopts Ethernet train control network and 5G / Beidou vehicle-ground wireless transmission device to realize high-speed transmission of large volume data at a rate of hundreds of megabytes per second. Equipped with automatic train operation device, this type of train is capable of automatic operating, accurate stopping and automatic door opening at stations. Its technical characteristics includes intelligent operation, ride comfort and low environmental impact.

Parameter	Value
Total train length (8-car)	208.95 m
Car width	3360 mm
Car height above rail	4050 mm
Door per side	13
Number of seats	578
Number of wheelchair spaces	1
Number of toilets	12
Total weight (8-car)	449322 kg
Power supply voltage	AC25 kV
Maximum speed	350 km/h
Life cycle (year)	30

Product groups	Mass (kg)	Percentage (%)
Body	1.51E+05	33.7%
Interior, windows and doors	9.50E+04	21.2%
Bogies and running gears	1.08E+05	23.9%
Propulsion and electric equipment	8.15E+04	18.1%
Comfort systems	1.39E+04	3.1%
SUM	4.49E+05	100%

CR400AF-Z consists of 8 cars with a total weight of 449.32t. According to the PCR, the train can be distinguished into five main product groups:

- body
- interior, windows and doors
- bogies and running gears
- propulsion and electricequipment
- comfort systems



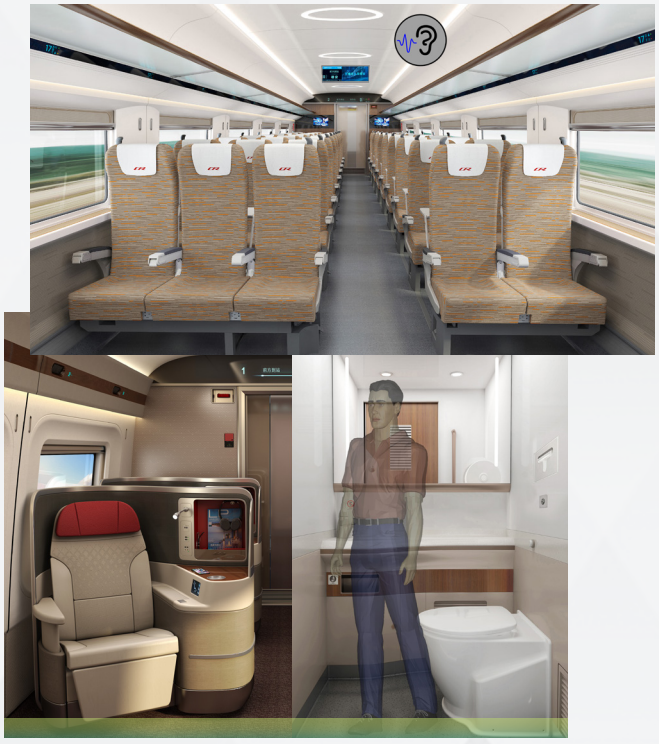
Feature of CR400AF-Z

Low environmental impact design

Adopting streamline head, regenerative braking, variable speed air conditioning and intelligent lighting, energy consumption is reduced.

Comfortable environment

Business seats are designed in the shape of Chinese Tai Chi with open overall space and private personal space, so that passenger space utilization rate is increased.



Intelligent service

Intelligent services such as automatic monitoring of interior air pressure fluctuations , intelligent interactive terminals and wireless screen mirroring for seats of business class and intelligent lighting in the toilet can enhance the riding experience.

ENERGY CONSUMPTION

According to the online operational data in 2021,
17.28 kwh was used for transporting 1 km.
According to information from Beijing Railway Bureau, the rated mileage is 650,000 km per year.
The total distance in 30 years is 19,500,000 km.
The total electricity amount used is 33,6960,000 kwh.

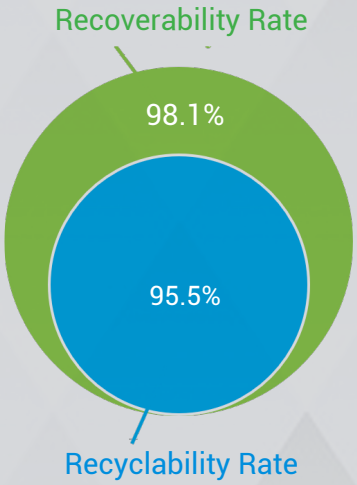
NOISE EMISSIONS

The noise type test has been carried out according to ISO 3095:2013.

Noise type	dB(A)	Location
Standstill noise	60	@7.5m, 1.2m
Starting noise	75	@7.5m, 1.2m
Pass-by noise at 300 km/h	91	@25m, 3.5m
Pass-by noise at 350 km/h	93	@25m, 3.5m

RECYCLABILITY & RECOVERABILITY

The recoverability and recyclability were calculated according to UNIFE-UNI-LCA-001.



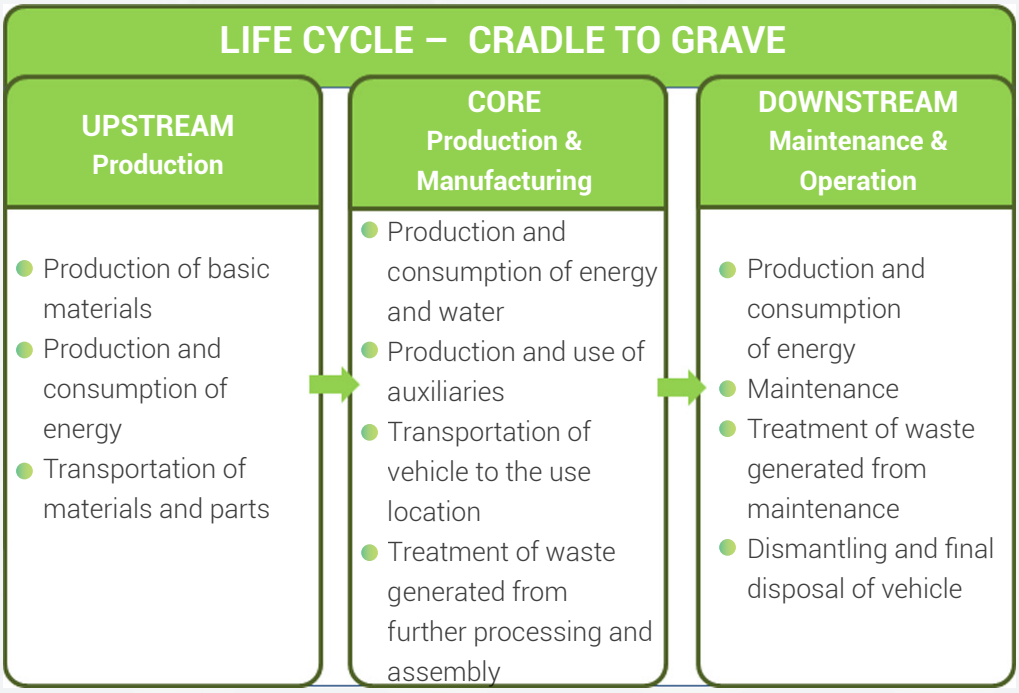
GWP EMISSIONS

Global Warming Potential of 23.2 g CO_2eq/pass km during operation phase (downstream), the total GWP emissions taking into account upstream, core, and downstream phases is 23.6 g CO_2eq/pass km.
The main contributor of the Global Warming potential is electricity consumption. In this study, Chinese average grid mix was used in the upstream, core and downstream.

LCA information

Functional unit:
CR400AF-Z to transport 1 passenger for 1 km.
Time representativeness: Year 2021
Database(s) and LCA software used:
Sphera (GaBi LCA Databases 2023 Edition) and Ecoinvent 3.8, Gabi 10.8

System diagram



Analysis Rule

Allocation

No co-product allocation was conducted in this study.

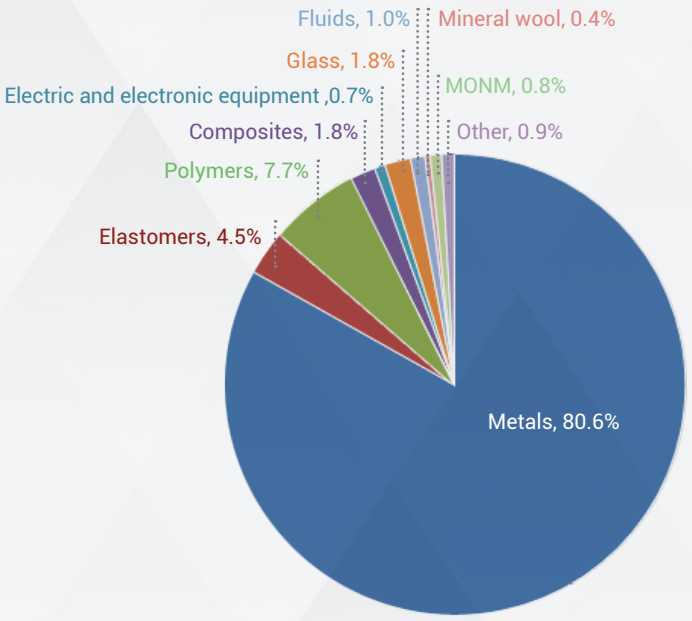
Cut-off

The cut-off was applied in material flows. The total amount of cut-off materials accounts for 0.6% of the total amount. No cut-off was applied in the energy flows.

Assumption

The final disposal of hazardous waste was assumed to be incinerated and the non-hazardous waste was assumed to be landfilled.

Content declaration



Material composition

Metals: FE metals and Non-FE Metals.
Polymers: Thermoplastics, thermosets and carbon or natural fiber.
Glass: Glass & safety glass
Fluids: Oil, grease or similar and acids or cooling agents.
MONM : Modified organic natural materials
Others: Other inorganic materials (e.g. ceramics)

Material category	Amount (kg)
Metals (ferrous metals or non-ferrous metals)	3.62E+05
Elastomers	2.03E+04
Polymers (thermosets or thermoplastics)	3.45E+04
Composites (e.g. fibre reinforced polymers or others)	7.98E+03
Electric and electronic equipment	3.24E+03
Glass	7.53E+03
Safety glass	3.86E+02
Oil,greases or similar	4.00E+03
Acids,cooling agent or similar	3.78E+02
Other inorganic materials(eg.,ceramics)	3.83E+03
Mineral wool	1.60E+03
MONM	3.44E+03
SUM	**4.49E+05**

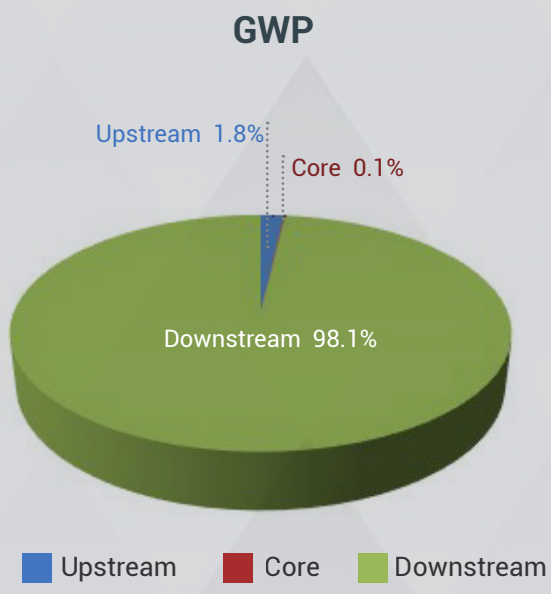
Results of the environmental performance indicators

Impact category indicators

Parameter		Unit	Upstream	Core	Downstream	TOTAL
Global warming potential (GWP)	Fossil	kg CO_2 eq.	4.09E-04	2.57E-05	2.32E-02	2.36E-02
	Biogenic	kg CO_2 eq.	9.10E-06	3.43E-07	-9.43E-06	2.26E-08
	Land use and land transformation	kg CO_2 eq.	1.13E-06	6.19E-09	1.50E-05	1.61E-05
	TOTAL	kg CO_2 eq.	4.19E-04	2.60E-05	2.32E-02	2.36E-02
Ozone layer depletion (ODP)		kg CFC 11 eq.	1.75E-11	2.62E-14	2.87E-12	2.04E-11
Acidification potential (AP)		mol H+ eq.	3.24E-06	9.06E-08	8.10E-05	8.43E-05
Eutrophication potential (EP)	Aquatic freshwater	kg P eq.	2.02E-07	2.63E-10	4.22E-08	2.45E-07
	Aquatic marine	kg N eq.	4.71E-07	5.57E-08	1.75E-05	1.80E-05
	Aquatic terrestrial	mol N eq.	4.93E-06	2.03E-07	1.90E-04	1.95E-04
Photochemical oxidant creation potential (POCP)		kg NMVOC eq.	1.47E-06	5.75E-08	5.18E-05	5.33E-05
Abiotic depletion potential (ADP)	Metals and minerals	kg Sb eq	4.12E-08	1.41E-11	1.41E-08	5.52E-08
	Fossil resources	MJ	5.56E-03	2.61E-04	2.38E-01	2.44E-01
Water deprivation potential (WDP)		m3 world eq. deprived	2.05E-04	8.28E-06	8.65E-03	8.86E-03

Around 98.1% of GWP comes from the energy consumption during train operation which is directly dependent on the type of power available on the network.

In this study, the dataset of Chinese average grid mix from Sphera database has been used for the power supply in the use phase. It was modeled based on the data from China Electric Power Yearbook (2019), when traditional electricity (coal) accounted for 54%. In this case, the impact indicator for Global Warming Potential (total) of the electricity is relatively high, at around 0.62 kg CO_2 eq. per kWh.



Definitions of environmental indicators

Ozone layer depletion (ODP)

The ozone layer absorbs ultraviolet radiation reaching planet Earth. Ozone depletion is caused by the emission of chlorides and bromides into the atmosphere because of human consumption of fluorocarbon compounds and other sources. This depletion leads to an increase in the amount of UV radiation on the Earth's surface, causing negative effects on human health and ecosystems, both aquatic and terrestrial. It is expressed in kg equivalent of CFC 11 eq.

Eutrophication potential (EP)

EP is the enrichment of nutrients in a certain place. Eutrophication can be aquatic or terrestrial. The indicator includes phosphorous and nitrogen salts and it is divided into freshwater (equivalent kg of P), terrestrial (equivalent mol of N) and aquatic marine (equivalent kg of N).

Abiotic depletion potential (ADP)

It is used to describe the decrease of natural, abiotic resources because of human activities. It is divided into 2 different subcategories: 1) metals and minerals, it is expressed in kilograms of Antimony (Sb) equivalent and 2) fossil resources which express a decrease in natural resources, fuels, that will be used as energy, it is expressed in net MJ.

Global warming potential (GWP)

Greenhouse emissions into the atmosphere absorb some of the infrared solar radiation reflected on the earth's surface resulting in a troposphere temperature increase. The global warming potential is an index, in equivalent kg of CO2, to measure the global warming contribution of a substance released into the atmosphere in a span of 100 years.

Acidification potential (AP)

The acidification potential is described as the ability of certain substances to build and release H+ - ions. The result is expressed in mol H+ eq. that includes emissions of SO2, of NOX and NH3

Photochemical oxidant creation potential (POCP)

This indicator measures the decomposition of volatile organic compounds (VOCs) in the presence of nitrogen oxides (NOx) and light. It is expressed in kg equivalent of NMVOC (non-methane volatile organic compounds).

Water deprivation potential (WDP)

Expresses the impact of a decrease in freshwater availability. It refers to a measure of the water available after human and aquatic ecosystem demand has been met. It is expressed in equivalent m^3.

Resource use indicators

Parameter		Unit	Upstream	Core	Downstream	TOTAL
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	1.59E-01	1.36E-04	1.09E-04	1.59E-01
	Used as raw materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	1.59E-01	1.36E-04	1.09E-04	1.59E-01
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	2.49E-01	3.65E-04	8.76E-04	2.50E-01
	Used as raw materials	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	2.49E-01	3.65E-04	8.76E-04	2.50E-01

Waste indicators (optional)

Parameter	Unit	Upstream	Core	Downstream	TOTAL
Hazardous waste disposed	kg	1.41E-09	8.40E-12	2.81E-10	1.70E-09
Non-hazardous waste disposed	kg	1.27E-05	1.20E-06	1.62E-04	1.76E-04
Radioactive waste disposed	kg	1.88E-08	3.84E-09	3.90E-06	3.92E-06

References

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Programme information

Programme	The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com info@environdec.com

Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
PCR: ROLLING STOCK (VERSION 3.0.5), PRODUCT CATEGORY CLASSIFICATION: UN CPC 495
PCR review was conducted by: UNIFE Sustainable Transport Committee, Alstom, Bombardier Transportation, CAF, Siemens, Talgo, Knorr-Bremse, Saft Batteries
Life Cycle Assessment (LCA)
LCA accountability: Yanjing ZHU, IVL Swedish Environmental Research Institute
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: Third party verifier: Daniel Böckin, Miljögiraff AB, daniel@miljogiraff.se. Approved by: The International EPD® System
Procedure for follow-up of data during EPD validity involves third-party verifier: ☒Yes ☐ No [Procedure for follow-up the validity of the EPD is at minimum required once a year with the aim of confirming whether the information in the EPD remains valid or if the EPD needs to be updated during its validity period. The follow-up can be organized entirely by the EPD owner or together with the original verifier via an agreement between the two parties. In both approaches, the EPD owner is responsible for the procedure being carried out. If a change that requires an update is identified, the EPD shall be re-verified by a verifier]

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