EPD®

CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A.

CIVITY - EMU
for Friuli Venecia Giulia Region
Environmental Product Declaration according to ISO 14025

CAF provides a sustainable development testimony, capitalizing knowledge to **lead and innovate** in the development of their own state-of-the-art technology which promotes **efficiency, safety and comfort** in our products.

A new generation of train that guarantees maximum power efficiency and full passenger ride comfort. **Versatile, with Personality and Environmentally Friendly.**

PCR review has been organised by:
EPD Technical Committee
Joakim Thornéus (chair)
Swedish Environmental Management Council

The quality auditing of this declaration and that the information is in line with ISO 14025:2006 was:
□Internal ■External

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Record No. S-P-00354. Date: 2014.07.17
Valid until 2017.07.17
UN CPC 495

EPDs of the same product category, but of different programmes may not be comparable.

CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A.

CAF'S COMMITMENT

Railways and the environment.
On track for efficiency.

CAF, CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES, S.A. is an international leader in the design, manufacture, maintenance and supply of equipment and components for railway systems. Founded at the beginning of the 20th century, based on the tradition of old foundries, CAF's maintains its original headquarters. Since then has grown into the international company it is today with over 7,000 qualified professionals, a quarter of whom are degree holders.

This education level combined with a commitment to R+D+I and the know-how built up from over 100 years of experience, has meant that CAF has continued to lead and innovate their own state-of-the-art technology which has significantly improved efficiency, safety and comfort of its products and of the sector itself. This technology includes solutions such as the GREENTECH energy efficiency family with the EVODRIVE kinetic energy recovery system, the FREEDRIVE for catenary-free running, or the EDRIS energy consumption controller, and others for the control of fleets and their maintenance such as AURA, NAOS for traffic and energy control, together with AURIGA the ERTMS wayside and onboard system of the CAFs group.

CAF integrates Corporate Social Responsibility into the company's general policy, and is fully aware of the potential impact of industrial activities on the environment. For this reason the organisation includes Environmental protection as one of its primary objectives.

CAF's environmental management is aimed at controlling and minimizing environmental impact from emissions into the atmosphere, residues and energy consumption, with the principle aim of preserving natural resources. To achieve this CAF has implemented a sustainability function into the production processes, making the most of natural resources and generating energy via renewable methods. The CAF group operates photovoltaic solar, small scale wind and sustainable mobility business, with a hydroelectric plant, and photovoltaic panels at their facilities to meet the energy requirements: The implemented environmental management system has been certified in accordance with ISO 14001 since 2001.

In order to provide more efficient and more environmentally friendly means of transport, CAF is currently implementing the "Product Sustainability Function", introducing ecodesign methods in the engineering processes to optimise and control, the environmental impact of products throughout their entire operating cycle.

As a result, CAF developed this verified EPD® of their Civity train, EMU for the **Friuli Venezia Giulia Region**.

CIVITY EMU
For Friuli Venezia Giulia Region

This CIVITY EMU is a regional electric train for the transport of passengers on Italian and Slovenian railway lines.

It is a two-way EMU, with two driver's cabs. The unit is formed of 5 cars connected by means of shared bogies, one being a motor car, with the end cars being cabbed.

The train is accessed via electrically operated sliding steps doors which deploy an access step during the open/close cycle. The end cars are equipped with PRM WCs for persons with reduced mobility, a baby changing area and emergency buttons. The vestibule on car is fitted with a lift ramp for PRMs and can accommodate 2 wheelchairs. The other end car has an area for pushchairs and bicycles.

Train, traction, brake and the other main equipment control is achieved through the use of microprocessors. Service brake is started using the electric brake capacity. Supplemented by pneumatic brake, as necessary. There is also a purely pneumatic emergency brake.

The train is fitted with a high performance passenger saloon HVAC system, which is independent from the cab HVAC equipment.

General characteristics

Track gauge:	1,435mm
EMU Length:	91,600mm
Cab car length:	21,500mm
Intermediate car length:	16,200mm
End Bogie wheelbase:	2,500mm
Shared Bogie wheelbase:	2,700mm
Exterior width:	2,880mm
End bogie area floor height:	1,090mm
Intermediate area floor height:	600mm
Shared bogie area floor height:	890mm
New wheel diameter:	850mm
Doors per side:	1 per car
Seats:	282+2 PRM
Tip up Seats:	15

Performance

Power supply voltage:	3000Vdc
Maximum speed:	160km/h
Auxiliary converter power:	182kVA
Total installed traction power:	3120kW
Start-up acceleration:	1.2 m/s^2
Mean service deceleration:	1 m/s^2
Mean emergency brake deceleration rate:	1 m/s^2

CIVITY
Flexibility and Adaptability

Civity is adapted to the European market and compliant with TSI, EN and UIC regulations.
Civity is a platform design which can be configured to suit customer requirements, the operator can specify: the number of cars (from 3 up to 8), the number of Doors (1 or 2 each side), the traction system (diesel, electric, hybrid...), the floor height (from 600 mm. ...). Civity has multiple configurations and multifunctional areas, with flexibility on interior design.

Flexible configuration

Starting with a minimum of 3 cars, a single unit can be made up of up to 8 vehicles, with motor or trailer intermediate cars added both swiftly and easily. Various units can be coupled together up to a maximum of 16 cars.

3-car trainset.

4-car trainset.

5-car trainset.

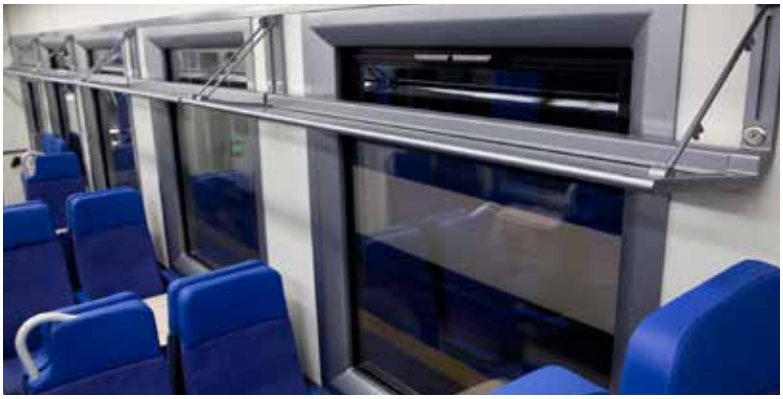
6-car trainset.

7-car trainset.

8-car trainset.

High reliability and durability

High levels of redundancy, together with modular and standards solutions, provide a high degree of reliability and reduction of events or delays of the fleet.
The use of state-of-the art equipment with optimized designs for weight and efficiency, coupled with improved electrical braking that enhances energy recovery and reduces the friction brake use and maintenance; results in lower consumption, operating and maintenance costs.



Higher capacity and efficiency

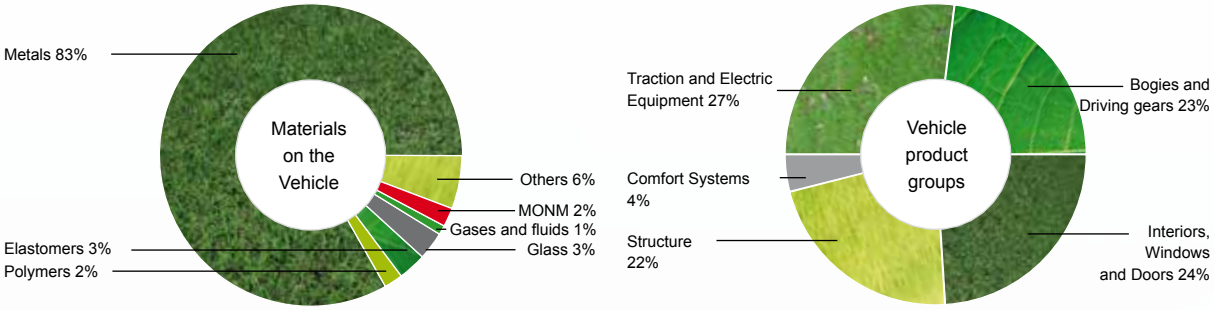
By installing all the train equipment on the roof allows Civity to maximize the amount of passenger space. Civity presents a higher capacity when compared with existing trains. Articulated Vehicles also enables weight reduction thanks to the shared bogies.
Altogether, higher capacity and weight reduction, results in reduced energy consumption per passenger.

LIST OF MATERIALS

In the design of the Civity train, materials have been selected, according to the functional, technical and regulatory requirements, as well as considering their recyclability and ease of dismantling at the end of their operating life. The following table shows the summarised inventory of the train materials, according to the ISO 22628 standard categories.

Materials Used Civity - EMU 5	Vehicle Materials (UPSTREAM)					
	Structure	Interior, Windows and Doors	Bogies and Running gears	Traction and Electric Equipment	Comfort Systems	TOTAL
Metals	21,07%	13,64%	22,24%	22,19%	3,70%	**82,85%**
Polymers	0,00%	1,42%	0,06%	0,61%	0,29%	**2,39%**
Elastomers	0,14%	1,58%	0,47%	1,18%	0,05%	**3,42%**
Glass	0,03%	3,02%	0,01%	0,06%	0,00%	**3,12%**
Gases and Fluids	0,00%	0,26%	0,10%	0,25%	0,04%	**0,65%**
MONM*	0,00%	1,71%	0,00%	0,00%	0,00%	**1,72%**
Others	0,33%	2,86%	0,29%	2,32%	0,05%	**5,85%**
TOTAL	**21,57%**	**24,50%**	**23,18%**	**26,61%**	**4,14%**	**100%**

* Modified natural organic materials



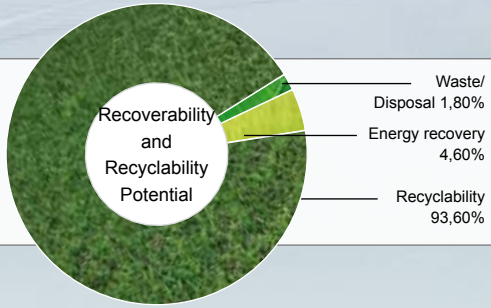
In accordance with their policy, CAF meets the environmental requirements right from the very first stages of their projects. When designing the Civity train, CAF has observed and demanded that their suppliers apply the "Railway Industry Substance List" (www.unife-database.org) to eliminate the use of regulated materials that could affect the environment or people's health.

The supply chain declarations prove that the Civity train contains no substances catalogued as SVHC (Substances of very High Concern) in accordance with regulation 1907/2006/EC – REACH.

POTENTIAL RECOVERABILITY AND RECYCLABILITY PROFILE

The recyclability potential has been assessed according to the methodology of standard ISO 22628. The Civity train reaches high recyclability and recoverability rates.

Recoverability and Recyclability Potential according to ISO 22628	
Recyclability Rate	93,60%
Recoverability Rate	98,2%



PRODUCT ENVIRONMENTAL IMPACT

Noise

The Civity train homologation is carried out in accordance with TSI Noise requirements
(2011/229/CE)

Outside noise emited	dB(A)
Stationary noise	< 68
Starting noise	< 82
Pass-by noise (80 km/h)	< 81

Energy Consumption

The Civity train energy consumption during operation has been simulated in accordance with standard CLC/TS 50591. A vehicle occupation capacity of 448 passengers has been considered in accordance with the Operational Mass in standard EN 15663.

The energy consumption results are calculated with catenary reception extreme values. Two possible scenarios are considered: One where the required energy during braking is regenerated on the catenary (100% receptivity) and another where all the energy is dissipated (0% receptivity).

To calculate the environmental impact of the electricity consumption during the entire service life of the train, the routes and operating days specified in the contract have been considered. Italian official electricity production Mix has been taken as reference, as this is where the train provides most of his service.

Electric Consumption per Functional Unit	[Kwh/1pass.1km]
Manufacturing Phase	0,0000423
Use Stage 0% receptivity	0,024
Use Stage 100% receptivity	0,017

The electric consumption for a passenger travelling 10 km is equivalent to approximately 6 minutes of clothes ironing or 16 minutes playing videogames.

Parts for bogie, wheels and axels made of steel are manufactured by CAF in its own foundry where recycled scrap is employed as core material. The benefit for the environment of recycling material has not been taken into acoount in this assessment.

ENVIRONMENTAL PROFILE OF THE PRODUCT LIFE CYCLE

Environmental profile for the functional unit [1pass.1km]	Material and Component Production [UPSTREAM]	Transport and vehicle assembly [CORE]	Vehicle use [DOWNSTREAM]				TOTAL	
			Energy consumption		Maintenance	End of Life	0% Receptivity	100% Receptivity
			0% Receptivity	100% Receptivity				
RENEWABLE RESOURCES CONSUMPTION								
Materials [kg/pass.1km]								
Water	3,79E+00	2,50E+01	1,55E+02	1,11E+02	1,31E+00	2,19E-03	1,85E+02	1,42E+02
Carbon Dioxide	5,78E-06	9,16E-06	2,80E-04	2,02E-04	1,00E-05	7,29E-09	3,05E-04	2,27E-04
Wood	4,25E-06	8,78E-07	1,97E-05	1,42E-05	6,36E-06	6,06E-09	3,11E-05	2,57E-05
Others	3,05E-03	4,56E-04	2,48E-01	1,79E-01	1,44E-03	5,21E-06	2,53E-01	1,84E-01
Energy [MJ/pass.1km]								
Hydroelectric	3,90E-04	3,03E-05	1,82E-02	1,31E-02	1,43E-04	2,90E-07	1,88E-02	1,37E-02
Biomass	5,82E-05	1,01E-05	2,65E-04	1,91E-04	9,50E-05	7,13E-08	4,28E-04	3,54E-04
Wind	7,06E-06	2,63E-05	4,77E-03	3,44E-03	7,89E-06	2,18E-08	4,81E-03	3,48E-03
Solar	2,25E-07	6,53E-06	7,56E-03	5,45E-03	5,11E-07	4,01E-10	7,56E-03	5,45E-03
Geothermic	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NON RENEWABLE RESOURCES CONSUMPTION								
Materials [kg/pass.1km]								
Limestone	1,63E-05	1,65E-06	5,22E-05	3,76E-05	1,20E-05	8,66E-08	8,23E-05	6,77E-05
Iron	1,96E-05	8,07E-07	3,08E-05	2,22E-05	1,78E-05	4,57E-08	6,90E-05	6,04E-05
Resources from ground	6,56E-05	1,54E-05	3,59E-04	2,59E-04	8,16E-05	2,29E-06	5,24E-04	4,24E-04
Others	1,64E-07	1,02E-06	4,34E-04	3,13E-04	4,79E-06	1,81E-08	4,40E-04	3,19E-04
Energy [MJ/pass.1km]								
Uranium	6,08E-04	1,91E-04	1,33E-03	9,57E-04	4,06E-04	1,80E-06	2,53E-03	2,16E-03
Fuel Oil	9,09E-04	1,55E-04	8,93E-03	6,44E-03	6,33E-04	1,66E-05	1,06E-02	8,15E-03
Coal	8,33E-04	1,27E-04	3,95E-02	2,85E-02	5,54E-04	1,31E-06	4,10E-02	3,00E-02
Lignite	2,33E-04	3,16E-05	5,01E-04	3,61E-04	1,44E-04	5,32E-07	9,10E-04	7,70E-04
Natural Gas	6,75E-04	2,56E-04	1,06E-01	7,66E-02	6,55E-04	2,48E-06	1,08E-01	7,82E-02
WASTE [kg/pass.1km]								
Hazardous	6,63E-08	2,08E-06	8,82E-07	6,35E-07	5,28E-06	1,66E-06	9,97E-06	9,72E-06
Non Hazardous	4,60E-06	1,53E-05	1,17E-05	8,40E-06	6,93E-04	4,27E-05	7,67E-04	7,64E-04
Total	4,67E-06	1,74E-05	1,25E-05	9,04E-06	6,98E-04	4,44E-05	7,77E-04	7,74E-04
ENVIRONMENTAL IMPACT [/pass.1km]								
Global Warming Potential (kg CO2 eq.)	2,27E-04	6,15E-05	1,06E-02	7,67E-03	1,91E-04	1,11E-05	1,11E-02	8,16E-03
Acidification Potential (kg SO2 eq.)	3,20E-06	1,92E-07	4,72E-05	3,41E-05	1,67E-05	6,56E-09	6,74E-05	5,42E-05
Eutrophication Potential (kg PO4 eq.)	1,39E-06	6,26E-08	9,16E-06	6,60E-06	7,97E-07	2,15E-09	1,14E-05	8,85E-06
Photochemical Oxidation Power (kg etileno eq.)	1,96E-07	8,51E-09	1,91E-06	1,37E-06	7,12E-07	2,14E-10	2,82E-06	2,29E-06
Ozone Depletion potential (kg CFC-11 eq.)	2,31E-10	4,72E-12	1,39E-09	1,01E-09	1,46E-09	1,88E-13	3,10E-09	2,71E-09

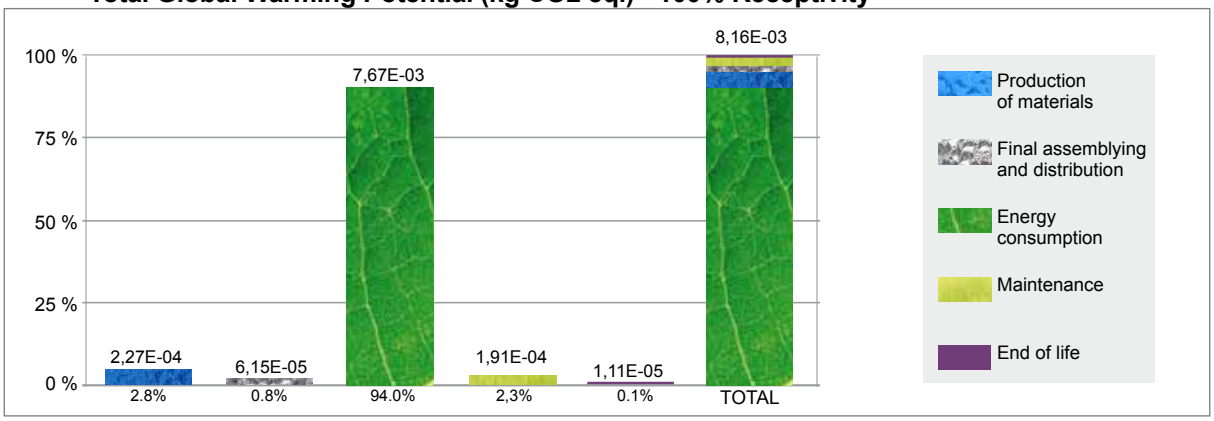
The quality of the compiled data has been analysed with a Pedigree Matrix analysis (Pedigree Matrix - Weidema and Suhr Wesnaes, 1996). It has been verified that the quality of the data is “extremely high” in the CAF train assembly process and in the Civity train composition, and it is “high” quality for the environmental assessment basis data.

ENVIRONMENTAL PROFILE OF THE PRODUCT LIFE CYCLE

Consumption during use, particularly energy consumption during the 30 years of operating life, causes the main environmental effects of a Civity train, as shown in the adjoining graph which uses the reference environmental indicator "Global Warming Potential", for a 100% catenary receptivity scenario.

Under a Life Cycle approach, cost and environmental impacts reduction of the operation use have been core targets of the Civity design process. A low specific energy consumption per passenger has been achieved, thanks to the lightness and large capacity of the train, together with a low consumption of maintenance material, as a result of the reliability and durability of the components, and the modularity and standardisation of the solutions employed.

Total Global Warming Potential (kg CO2 eq.) - 100% Receptivity



"In 2010 Italian CO2 emissions were 6.9 metric tons per capita. Source: http://data.worldbank.org)"

INFORMATION REGARDING
THE ENVIRONMENTAL DECLARATION

This environmental declaration was made following the requirements of the reference document “PCR 2009:05. Product category rules for preparing an environmental product declaration for Rail Vehicles. UNCPC CODE: 495” published by Environdec (www.environdec.com) and is based on the data of the CIVITY, EMU for the Friuli Venezia Giulia region, for all the stages of the products life cycle (production of raw materials and components, assembly of the vehicle, distribution, use and end of life).

The functional unit in this study is the transport of 1 passenger over 1 km and the operating life of the vehicle analysed has been set at 30 years.

The Civity train environmental impact study has been quantified by means of an Life Cycle Analysis in accordance with standards ISO 14040 and ISO 14044. The method of the characterisation of the environmental impact of the compiled operating life inventory was CML 2001. For an overall view, the LCA aggregated RECIPE methodology has been used. The LCAManager software was used to handle the operating life cycle inventory and to calculate the environmental impact.

Information regarding the materials and production of the vehicle has been obtained directly from the Management Systems of CAF and the information provided by the suppliers themselves. Data from the Ecoinvent database (version 2.2) has been used for the environmental definition of the processes and materials.

For vehicle assembly, the effect of the procurement of materials and constituent components have been considered, as well as their transport to the assembly plant, the assembly itself, handling of the waste from both the assembly and dismantling of the vehicle and the transport of the vehicle from CAF’s Beasain plant to the commissioning location in Trieste (Italian region of Friuli Venezia Giulia).

For the environmental impact of the energy consumption during assembly, the Spanish electricity production Mix has been taken into account, with data provided by the Spanish Electrical Grid (Red Eléctrica Española) for the year 2011 (year on which the train was manufactured).
For the environmental impact characterization of the energy consumption during use phase an average of 260 000 km per year has been considered, and the Italian electricity production Mix has been taken into account, according to data provided by Terna energy transmission company for 2013 (biggest Italian transmission company and the most up to date data available on publication of this declaration.)

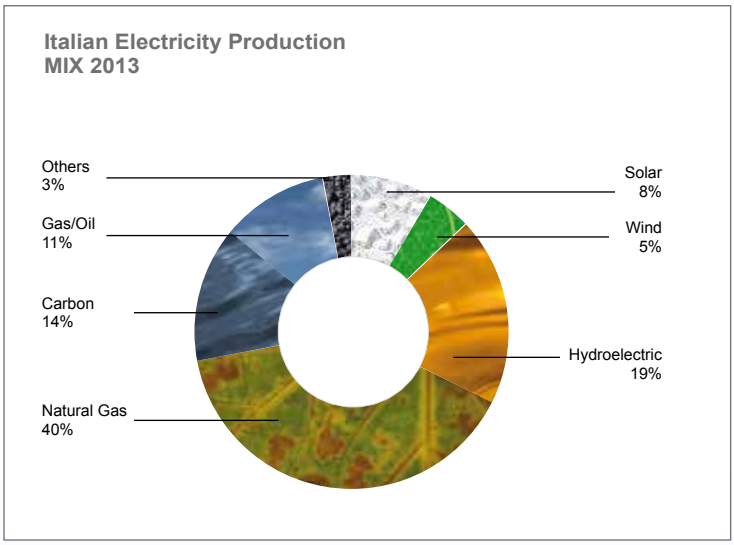
The maintenance of the train has been considered for the entire operating life, with inventories for the materials and spare parts of a Life Cycle Cost (LCC) of Civity study, which includes operation related consumables, such as the water consumed in the WCs or traction sand, but not those involved in train cleaning operations or passenger waste treatment and disposal.

In the end of life, and vehicle dismantling stage, ISO 22628 has been followed for the calculation of the recyclability potential. The potential advantage of recycling and recovery of the energy from incineration processes has not been accounted for in the study.

Reference Documentation

- ISO14040:2006. Environmental management. Life cycle assessment. Principles and framework
- ISO14044:2006. Environmental management. Life cycle assessment. Requirements and guidelines
- ISO 14025:2006 Environmental labels and declarations. Type III environmental declarations. Principles and procedures
- PCR 2009:05 Product category rules for preparing an environmental product declaration for Rolling Stock. v2.1
- ISO 22628:2002. Road vehicles. Recyclability and recoverability. Calculation method.
- TS 50591_2013 Specification and verification of energy consumption for railway Rolling stock.
- EN 15663:2009. Railway applications. Definition of vehicle reference masses.
- TSI Noise requirements. 2011/229/CE
- Railway Industry Substance List, versión 2011-03-01

DEFINITIONS:



Global Warming (potential):

Greenhouse effect 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):

Acidification results from the emission of sulphur dioxide and nitrogen oxides. In the atmosphere, these oxides react with the existing steam, forming acids which fall back to the earth in the form of rain or snow, or as dry deposits. Its effect on the earth generally shows itself in the form of reduced forest development and in aquifer ecosystems, such as lakes, acidification is apparent in the disappearance of some living organisms. Other objects such as constructions, monuments and buildings may also be damaged as a result of the effects of acid rain. Acidification potential measures an emitting substance's contribution to acidification expressed in sulphur dioxide equivalents (SO2).

Eutrophication (potential):

Eutrophication results in the enrichment of water ecosystems with organic compounds and nutrients, which give rise to an increased production of plankton, algae and other water plants with the resulting reduction in water quality. In this case the main sources related to this phenomenon are nitrogen and phosphorous. A secondary effect is the decomposition of dead organic material, a process which consumes oxygen and may result in anaerobic environments. The eutrophication potential, expressing in equivalent PO-43, quantifies nutrient enrichment via the release of a substance in water or land.

Ozone photochemical formation/ Photochemical oxidation (potential):

The photo-chemical formation of the ozone in the troposphere is mainly provoked by the decomposition of volatile organic compounds (VOCs) in the presence of nitrogen oxides (Nox) and light. The formation of ozone by means of this process can be quantified by using the so-called ozone photochemical formation potentials (POCPs) expressed in equivalent kg of ethane (C 2H4).

Ozone depletion (potential):

The ozone layer in the atmosphere protects the flora and fauna from harmful ultraviolet radiation from the sun. Some substances emitted into the atmosphere deplete this layer resulting in a higher level of UV radiation on the earth. The ozone layer depletion potential is the contribution of a substance compared with the impact caused by CFC-11.

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CONSTRUCCIONES Y AUXILIAR DE FERROCARRILES S.A.

PRODUCTION PLANTS: SPAIN - FRANCE - U.S. - BRAZIL - MEXICO

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