ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	**ArcelorMittal Europe - Long Products**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-ARM-20170033-IBD1-EN
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Valid to	20.02.2022

Structural steel sections in HISTAR® grades
ArcelorMittal

Institut Bauen und Umwelt e.V.

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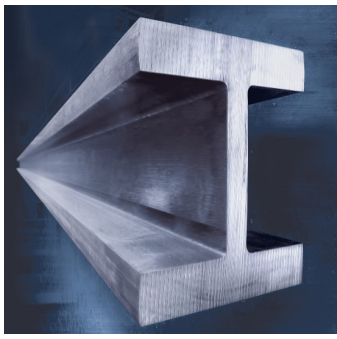

1. General Information

ArcelorMittal

Programme holder
IBU - Institut Bauen und Umwelt e.V.
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10178 Berlin
Germany

Declaration number
EPD-ARM-20170033-IBD1-EN

This Declaration is based on the Product Category Rules:
Structural steels, 07.2014
(PCR tested and approved by the SVR)

Issue date
21.02.2017

Valid to
20.02.2022

Prof. Dr.-Ing. Horst J. Bossenmayer
(President of Institut Bauen und Umwelt e.V.)

Dr. Burkhart Lehmann
(Managing Director IBU)

Structural steel sections in HISTAR® grades

Owner of the Declaration
ArcelorMittal Europe-Long Products
Differdange plant
Rue Emile Mark
L-4503 Differdange
Luxembourg

Declared product / Declared unit
1 ton of structural steel in HISTAR® grades

Scope:
The declaration applies to 1 ton of structural steel produced by ArcelorMittal Europe - Long Products. The Life Cycle Assessment is based on data collected from the ArcelorMittal Differdange plant. It covers 100% of the annual production from 2014.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Verification

The CEN Norm /EN 15804/ serves as the core PCR
Independent verification of the declaration according to /ISO 14025/
☐ internally ☒ externally

Dr. Frank Werner
(Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

HISTAR® steels are high strength structural steel grades with low alloy content and minimum yield strengths of 355 or 460 MPa (megapascal). This EPD applies to 1 ton of structural steel sections in HISTAR® grades.

For the placing of the product on the market in the EU/EFTA (with the exception of Switzerland) the /Regulation (EU) No. 305/2011 (CPR)/ applies. The product needs a Declaration of Performance taking into consideration /ETA-10/0156/ and the CE-marking. For the application and use the respective national provisions apply.

2.2 Application

Structural steel sections are intended for bolted, welded or otherwise connected constructions of buildings, bridges and other structures, as well as in composite steel and concrete structures. For example:

- Single-story buildings (industrial and storage halls, etc.)
- Multi-story buildings (offices, residential, shops, car parks, high rise, etc.)
- Bridges (railway, road, pedestrian, etc.)
- Other structures (power plants, stadiums, convention centers, airports, stations, etc.)

2.3 Technical Data

This EPD is valid for sections of various HISTAR® grades and different forms of delivery. Performance data of the product in accordance with the Declaration of Performance with respect to its Essential Characteristics according to /ETA-10/0156/.

Constructional data

Name	Value	Unit
Density	7850	kg/m^3
Modulus of elasticity	210000	N/mm^2
Coefficient of thermal expansion	12	$10^{-6}K^{-1}$
Thermal conductivity	48	W/(mK)
Melting point	1536	°C
Shear modulus	81000	N/mm^2

Specific information on dimension tolerances, constructional data, as well as mechanical and chemical properties can be found in the relevant literature and/or the standards /EN 1993/, /ETA-10/0156/ and /ASTM A913/A913M/.

- **Design standards**: The standards of /EN 1993/ and /EN 1994/, respectively of /ANSI/AISC 360-10/ apply to the design of steel structures and composite steel and concrete structures. They include the requirements regarding serviceability, bearing capacity, durability and fire resistance of steel structures (/EN 1993/, /ANSI/AISC 360-10/) and composite steel and concrete structures (/EN 1994/, /ANSI/AISC 360-10/).
- **Product standards**: /ETA-10/0156/, /ASTM A913/A913M/.
- **Fabrication standards**: /EN 1090-2/, /AISC 303-10/, /AWS D1.1/D1.1M/. The Standard /EN 1090-2/ applies to the execution of steel structures and includes the requirements for factory production control.

2.4 Delivery status
The dimensions of the declared products may vary according to the intended application.

2.5 Base materials / Ancillary materials
The manufacture is based on the recycling of scrap as the principal raw materials: Electric Arc Furnace (EAF) route. Alloying elements are added on the form of ferroalloys or metals (most common elements are Manganese, Chromium and Vanadium). Other elements such as Nitrogen or Copper may be present in the steel, depending on the steel designation/grade. No substances listed on the “Candidate List of Substances of Very High Concern for Authorisation” by the European Chemicals Agency /EC 1907-2006/ are contained in the steel in declarable quantities.

2.6 Manufacture
The route to produce steel is the EAF route: steel scrap is melted in an electric arc furnace to obtain liquid steel, which is then refined in a ladle furnace with addition of ferroalloys and metals to obtain the required steel characteristics.
The steel is then casted at a continuous caster to obtain semi-finished products as beam blanks. The semis are then rolled to the desired size.
HISTAR® grades achieve the required mechanical properties through in-line treatment (quenching and self-tempering). At the end of the operation, the section is cut to the required length and labeled.

Quality control: /ISO 9001/ Monitoring according to the product standard, e.g. /EN 10025-1/.
Energy: /ISO 50001/

2.7 Environment and health during manufacturing
Environmental, occupational health, safety and quality management are in accordance with the following norms:
- /ISO 14001/
- /OHSAS 18001/

2.8 Product processing/Installation
Processing the material to its final shape and length has to be done depending on the generally recognized rules of engineering (or structural calculation) and the manufacturer’s recommendations.
Standard safety measures should be applied during handling and use of the product. Any instructions from the manufacturer concerning special operations (e.g. welding) have to be applied.

2.9 Packaging
Structural steel sections are delivered unpacked.

2.10 Condition of use
During use no changes in material composition shall occur. Maintenance requirement will depend on specific design and application.

2.11 Environment and health during use
Under normal conditions of use, steel sections do not cause any adverse health effects nor release other emissions to indoor air.
No environmental impact to water, air or soil is expected due to the extremely low metal release from steel and the low maintenance requirements.

2.12 Reference service life
A reference service life for structural steel sections is not declared. These are construction products with many different applications purposes. The lifetime therefore will be limited by the service life of the work.

2.13 Extraordinary effects

Fire
The material is class A1, i.e. not flammable per /EN 13501/.
The material does not emit fumes or fire-gases.
The critical temperature for the integrity of the structure is substantially depending on component loading and restraining conditions.

Fire protection

Name	Value
Building material class	A1
Burning droplets	-
Smoke gas development	-

Water
No environmental impact to water, air or soil is expected due to the extremely low metal release from steel and the low maintenance requirements.
In case of flooding no impacts are to be expected.

Mechanical destruction
In case of mechanical destruction, no risks are expected to occur in terms of environment and human health.

2.14 Re-use phase
General:
Depending upon the type of installation, it is possible to recover and reuse up to 100% of steel sections. If not reused, steel sections are 100% recyclable.
Currently, 99% of the used steel is regained after dismantling, thanks to the magnetic properties of steel according to the /European Commission Technical Steel Research/ and the /German Ministry of Environmental Affairs/.

Reuse:
Steel sections can be reused several times. Currently, around 11% of the products are reused according to /European Commission Technical Steel Research/ and /German Ministry of Environmental Affairs/.

Recycling:
Structural steel can be recycled to the same (or higher/lower) quality of steel depending upon the metallurgy and processing of the recycling route. Steel sections can be recycled without any problem after dismantling, and recycling routes are well established. Currently, around 88% of the products are recycled according to /European Commission Technical Steel Research/ and /German Ministry of Environmental Affairs/.

2.15 Disposal
Due to its high value as a resource, steel scrap is not disposed of, but instead fed to re-use or recycling in a well-established cycle. However, in case of dumping due to collection loss, no environmental impacts are expected.
Waste code according to the list of waste pursuant to /Directive 2008/98/EC/ of the European Parliament and of the Council is: 17 04 05 - iron and steel

2.16 Further information
Additional information on structural steel and constructing with steel can be obtained from http://sections.arcelormittal.com.

3. LCA: Calculation rules

3.1 Declared Unit
The declaration refers to the functional unit of 1 ton of structural steel in HISTAR® grades as specified in Part B requirements on the EPD for Structural Steel.

Declared unit

Name	Value	Unit
Declared unit	1	t
Density	7850	kg/m^3
Conversion factor to 1 kg	1000	-

Structural steel in HISTAR® grades is produced at the ArcelorMittal plant located in Differdange in Luxemburg.The product weighting procedure depends on client demand. HISTAR® steel sections are sold by length and the theoretical weight is used.

3.2 System boundary
Type of the EPD: cradle-to-gate with options. Module A1-A3, Module C3 and module D were considered.

Modules A1-A3 of the structural steel production, include:

- The provision of resources, additives and energy
- Transport of resources and additives to the production site
- Production processes on site including energy, production of additives, disposal of production residues, and consideration of related emissions.
- Recycling of production/manufacturing scrap. Steel scrap is assumed to reach the end-of-waste status once is shredded and sorted, thus becomes input to the product system in the inventory.

Module C3 takes into account the sorting and shredding of after-use steel, as well as the non-recovered scrap due to sorting efficiency which is landfilled. A conservative value of 1% landfill is considered.

Module D refers to the end-of-life of the structural steel, including reuse and recycling.

3.3 Estimates and assumptions
For all input and output material the actual transport distances were applied or assumptions were taken.

3.4 Cut-off criteria
All information from the data collection process has been considered, covering all used and registered materials, thermal energy, electrical energy and diesel consumption. Measurement of onsite emissions took place and those emissions were considered. The specific emissions that are linked to the provision of thermal and electrical energy are considered in the specific processes.
Data is collected through recommended templates developed by Worldsteel association and its experts for LCI purpose /Worldsteel 2011/. Data were cross-checked with the previous years' data to identify potential data gaps. No processes, materials or emissions that are known to make a significant contribution to the environmental impact of the products studied have been omitted. On this basis, there is no evidence to suggest that inputs or outputs contributing more than 1% to the overall mass or energy of the system, or that are environmentally significant have been omitted. It can be assumed, that all neglected processes contribute less than 5% to the impact assessment categories.
Note: The required machines for manufacturing and other infrastructure are not considered in the LCA.

3.5 Background data
For life cycle modelling of the considered products, the GaBi 6 Software System for Life Cycle Engineering, developed by thinkstep AG, is used /GaBi 6 2015/. The GaBi-database contains consistent and documented datasets which can viewed in the online GaBi-documentation /GaBi 6 2013D/.
To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

3.6 Data quality
All relevant background datasets are taken from the /GaBi 6/ software database.
Regarding foreground data, this study is based on high quality of primary data, collected by ArcelorMittal for the period of 2014. Data were delivered in form of excel tables and manually integrated in GaBi model with 2 iterations of data quality check:

- First iteration is for raw manufacturing data

- Second iteration is for cradle to gate data and including End-of-Life recycling potential.

3.7 Period under review

The considered primary data for the input and output of energy and materials were collected in the year 2014.

3.8 Allocation

The allocation method used here was developed by the World Steel Association and EUROFER to be in line with /EN 15804/. The methodology is based on physical allocation and takes account of the manner in which changes in inputs and outputs affect the production of co-products. The method also takes account of material flows that carry specific inherent properties. This method is deemed to provide the most representative partitioning of the processes involved. Economic allocation was not considered, as EAF slag is considered a low-value co-product under /EN 15804/ and must undergo processing before being used as aggregate, thus Economic allocation would most likely be based on estimates. Worldsteel and EUROFER also highlight that companies purchasing and processing slag work on long-term contracts which do not follow regular market dynamics of supply and demand.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account. The used background database has to be mentioned.

4. LCA: Scenarios and additional technical information

Current practice for the average structural steel in HISTAR® grades product consist of 11% reuse, 88% recycling and 1% landfill according to the /European Commission Technical Steel Research/, the /German Ministry of Environmental Affairs/.

End of life (C3)

Name	Value	Unit
Landfilling	1	%

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Name	Value	Unit
Recycling	88	%
Reuse	11	%

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 ton of structural steel in HISTAR® grades

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO_2-Eq.]	5.24E+2	2.03E+0	8.73E+1
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	6.14E-7	1.22E-9	-6.82E-8
Acidification potential of land and water	[kg SO_2-Eq.]	1.90E+0	6.30E-3	3.46E-1
Eutrophication potential	[kg $(PO_4)^{3-}$-Eq.]	1.48E-1	6.96E-4	2.74E-2
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.67E-1	4.89E-4	6.28E-2
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	2.63E-4	6.22E-7	-4.08E-5
Abiotic depletion potential for fossil resources	[MJ]	5.76E+3	2.27E+1	7.21E+2

RESULTS OF THE LCA - RESOURCE USE: 1 ton of structural steel in HISTAR® grades

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	8.24E+2	8.76E+0	-1.62E+2
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	8.24E+2	8.76E+0	-1.62E+2
Non-renewable primary energy as energy carrier	[MJ]	9.17E+3	3.41E+1	2.86E+2
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	9.17E+3	3.41E+1	2.86E+2
Use of secondary material	[kg]	1.08E+3	0.00E+0	-8.44E+1
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m^3]	3.82E+0	1.36E-2	-3.25E-1

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 ton of structural steel in HISTAR® grades

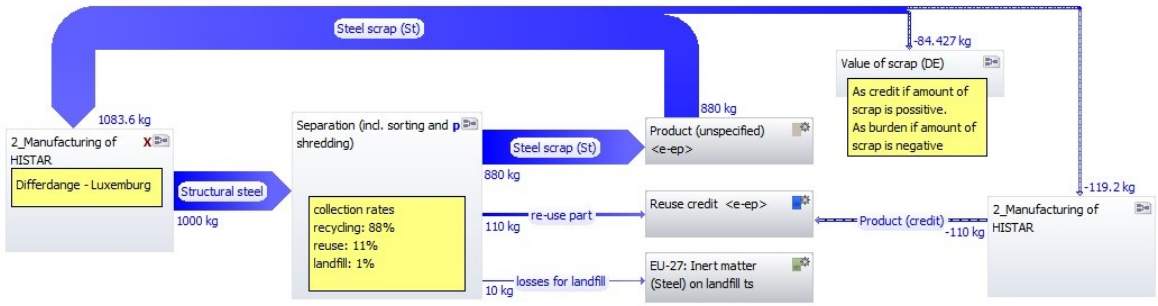
Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	6.11E-6	3.34E-7	1.16E-6
Non-hazardous waste disposed	[kg]	6.99E+0	1.00E+1	1.29E+0
Radioactive waste disposed	[kg]	1.35E+0	4.54E-3	-1.72E-1
Components for re-use	[kg]	0.00E+0	1.10E+2	0.00E+0
Materials for recycling	[kg]	0.00E+0	8.80E+2	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	0.00E+0

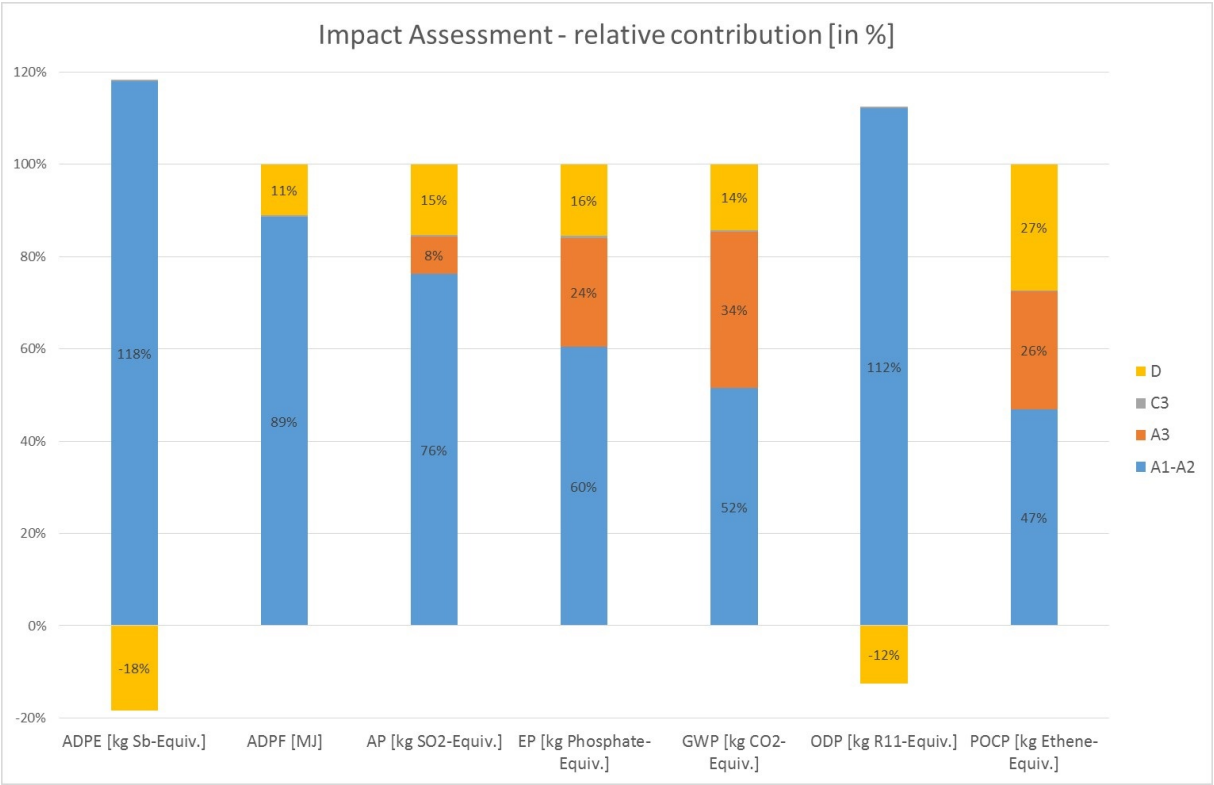
6. LCA: Interpretation

Per ton of HISTAR® steel produced, 1083 kg scrap is used. After use, 880 kg steel is recycled, 110 kg steel is reused, and 10 kg is landfilled.
A potential environmental benefit is calculated for the end-of-life stage (module D) for all the considered impact categories.

The reuse of 110kg creates a potential environmental benefit. Nevertheless, as shown in screenshot below, the net amount of scrap is 880-1083+119 = -84 kg.
The system has a net scrap consumption of 84 kg, which causes a burden.

1_Life Cycle ArcelorMittal HISTAR
GaBi Prozessplan: Mass [kg]
Es werden die Namen der Basisprozesse angezeigt.





The graph above shows the relative contribution of the production stages (Module A1-A3), waste sorting and treatment (Module C3) and the benefits and loads beyond the product system boundary (Module D). For all the selected categories, the production stage (A1-3) provides the largest contribution to the results. Module D results in a noticeable potential benefit for Ozone Depletion Potential (**ODP**) and Abiotic Depletion Potential Elements (**ADPE**). Overall, C3 has a negligible contribution.

The most relevant and significant emissions from steel production (A1-3) are: CO_2 and CH_4 for Global Warming Potential (**GWP**); SO_2 and NO_x for Acidification Potential (**AP**)**;** NO_x for Eutrophication Potential (**EP**); CO, SO_2, NO_x, and NMVOC for Photochemical Ozone Creation Potential (**POCP**).

Production of upstream materials and energy needed in the steelmaking (A1-2) causes 52% of Global Warming Potential (**GWP**). Beside materials & energy, onsite emission (A3) contributes as well to about 34% of the overall results.

For Ozone Creation Potential (**POCP**), production stage (A1-A3) has an impact share of around 73% while for Abiotic Depletion Potential Elements (ADPE), the impact share is around 118%, with other categories between these two values.

For Ozone Depletion Potential (**ODP**) the product stage has a share of 112% and module D provides a potential benefit. The main contributors to **ODP** are R11- (trichlorofluoromethane) and R114- (dichlorotetrafluoroethane), both of which are emissions from the pre-chains of power generation processes, in particular nuclear power generation where haloalkanes are used in cooling processes. **ODP** is therefore related to power consumption, especially the nuclear share of the grid mix. The potential benefit in module D is dedicated to the 11% reuse of the product.

Acidification Potential (**AP**) and Eutrophication Potential (**EP**) are strongly dominated by the extraction and processing of raw materials and the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport.

Abiotic Depletion Potential Elements (**ADPE**) is dominated by the use of non-renewable elements in the production of ancillary materials/pre-products e.g. copper and molybdenum.

Abiotic Depletion Potential Fossil (**ADPF**) is dominated by the generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport.

7. Requisite evidence

7.1 Weathering performance
The rusting rate of unalloyed steel is depending on the position of the component and the conditions of the surrounding atmosphere (corrosively categories according to /EN ISO 12944-2/).
If required, the surfaces of fabricated structural components are usually protected with anticorrosion material in order to prevent any direct contact with the atmosphere. The weathering of this protection depends on the used protection system.

This EPD covers semi-finished structural steel of hot-rolled construction products. Further processing and fabrication depends on the intended application. Therefore further documentation is not applicable.

8. References

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EN 15804
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