<table>
<thead>
<tr>
<th>Owner of the Declaration</th>
<th>voestalpine AG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programme holder</td>
<td>Institut Bauen und Umwelt e.V. (IBU)</td>
</tr>
<tr>
<td>Publisher</td>
<td>Institut Bauen und Umwelt e.V. (IBU)</td>
</tr>
<tr>
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<tr>
<td>Issue date</td>
<td>23/11/2017</td>
</tr>
<tr>
<td>Valid to</td>
<td>22/11/2022</td>
</tr>
</tbody>
</table>

voestalpine heavy plates
aldur®
alform®
durostat®
toughcore®

voestalpine Grobblech GmbH

www.ibu-epd.com / https://epd-online.com
1. General Information

voestalpine Grobblech GmbH

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Declaration number
EPD-VOE-20170157-IBC1-EN

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

Issue date
23/11/2017

Valid to
22/11/2022

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

Dr. Burkhart Lehmann
(Managing Director IBU)

2. Product

2.1 Product description / Product definition
The products of voestalpine Grobblech GmbH are found in a wide variety of applications. For the placing of structural steels on the market in the EU/EFTA (with the exception of Switzerland) Regulation (EU) No. 305/2011 applies. The products need a Declaration of Performance (DoP) taking into consideration /EN 10025/ and the CE marking.

For the application and use the respective national regulations apply. In Austria, for example, it is the /building regulations of the individual states/ as well as the technical stipulations based on these regulations.

2.2 Application
Rolled plates and hot- or cold-formed heads manufactured by voestalpine Grobblech GmbH are found in the following applications:

- Piping systems for large oil and gas pipelines
- Manufacture of oil platforms (offshore industries)
- Boiler and apparatus construction
- Steel construction and bridge building
- Vehicle and crane assembly (high-strength and wear-resistant steels)

2.3 Technical Data
This EPD refers to all products of voestalpine Grobblech GmbH (alform®, aldur®, durostat®, toughcore®) in a variety of different steel grades, dimensions, shapes and as-delivered conditions. Specific information on tolerances in the different fields of application can be found in /EN 10029/ and /EN 10163/.

The data given in the DoP apply.

Constructional data

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>7850</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Modulus of elasticity</td>
<td>210000</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Coefficient of thermal expansion</td>
<td>11</td>
<td>10⁻⁶ K⁻¹</td>
</tr>
<tr>
<td>Thermal conductivity</td>
<td>48</td>
<td>W/(mK)</td>
</tr>
<tr>
<td>Melting point</td>
<td>1535</td>
<td>°C</td>
</tr>
<tr>
<td>Minimum yield strength</td>
<td>165</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Minimum tensile strength</td>
<td>270</td>
<td>N/mm²</td>
</tr>
<tr>
<td>Minimum elongation</td>
<td>14</td>
<td>%</td>
</tr>
</tbody>
</table>

Product standards
/EN 10025: Parts 2–6/: Hot rolled products of structural steels, technical terms of delivery and CE marking
/EN 10225/: Weldable structural steels for fixed offshore structures
2.4 Delivery status
In contrast with hot-rolled steel strip, the products of voestalpine Grobblech GmbH are not supplied as coils, but as plates. The maximum length and width dimensions are 18 by 4 meters.

2.5 Base materials / Ancillary materials
The products of voestalpine Grobblech GmbH consist of 100 % hot-rolled steel (approx. 75 % crude steel and 25 % scrap and alloying elements) produced by voestalpine Stahl GmbH. The precise composition of the steel depends on the respective application and the steel grade.

2.6 Manufacture
The starting material for the production of heavy plates at voestalpine is crude steel made in the primary route (blast furnace, LD steelmaking plant) at the Linz site. The molten crude steel is cast into slabs using a continuous casting method. After cooling, the slabs are reheated in pusher-type furnaces to 1100–1250 °C. As opposed to hot-rolled steel strips, a four-high rolling configuration, a type of reversing rolling, is used for heavy plates. The four-high mill stands always consist of two work rolls and two backup rolls, with a total of four rolls on each stand. The material is rolled back and forth until it reaches the desired width and length. The product is further processed at the Linz site of voestalpine Grobblech GmbH, among other things, into boiler heads. The plates are formed in a press into heads with desired shapes and sizes.

2.7 Environment and health during manufacturing
The production site of the voestalpine Steel Division is certified pursuant to /EMAS/, /ISO 9001/ and /ISO 14001/ as well as /OHSAS 18001/. In compliance with /EMAS/ provisions, voestalpine continually publishes environment-related facts and figures pertaining to the production site. Investments are being made continually in the expansion of environmental protection measures at the Linz site in an effort to reduce air and water emissions to a minimum. Compliance with all statutory emission limit values has been verified. All production systems approved in accordance with applicable environmental impact analyses are also inspected on a regular basis as part of environmental audits. voestalpine was the first steelmaking company to be awarded the Green Bands seal of approval for special commitment in the areas of global environmental protection and sustainability.

2.8 Product processing/Installation
Materials are processed up to the final product in compliance with all pertinent standards.

2.9 Packaging
Heavy plates are delivered in unpackaged condition (additional edge protection in some cases).

2.10 Condition of use
No changes to the material grade are to be expected while heavy plates are being used. Maintenance and inspection requirements are dependent on the material design and its place of application.

2.11 Environment and health during use
No effects to the health of humans or animals, nor harmful air, soil and water emissions are expected during the use of heavy plates.

2.12 Reference service life
Heavy plates produced by voestalpine Grobblech GmbH can be used in such a wide variety of applications that a reference useful life is not indicated. The useful life of the product is generally limited by the maintenance intervals of the end user.

2.13 Extraordinary effects
Fire
Heavy plates are not flammable according to the requirements of /EN 13501/. No flammable gases or vapors are released. Fire resistance is heavily dependent on the field of application and the load.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building material class</td>
<td>A1</td>
</tr>
<tr>
<td>Burning droplets</td>
<td>-</td>
</tr>
<tr>
<td>Smoke gas development</td>
<td>-</td>
</tr>
</tbody>
</table>

Water
In light of the low solubility of steel in water, no negative consequences are expected for the environment under the influence of water, e.g. flooding.

Mechanical destruction
Unforeseeable mechanical effects on the declared product would have no environmental impact because of the plasticity of steel.

2.14 Re-use phase
The declared products aldur®, alform®, durostat® and toughcore® can be reused, e.g. for sheet pilings in the construction industry, or as a valuable secondary raw material in the steelmaking industry. Steel is a permanent material that can be recycled as many times as necessary.

2.15 Disposal
The declared product can be entirely recycled. The waste code is in accordance with /European Waste Catalog (EWC)/: 17 04 05 (iron and steel). The type of waste is to be equated with waste catalog code 35103 pursuant to the /Waste Catalog Ordinance/ applicable in Austria.

2.16 Further information
Please find more information about the product on our website at http://www.voestalpine.com/grobblech/.
3. LCA: Calculation rules

3.1 Declared Unit
This EPD refers to a declared unit of 1 ton of heavy plate produced by voestalpine. This includes heavy plates in a variety of different applications; however, the EPD does not refer to roll-bonded clad products.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared unit</td>
<td>1</td>
<td>t</td>
</tr>
<tr>
<td>Density</td>
<td>7850</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Conversion factor to 1 kg</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

The analysed products do not differentiate with respect to their basic composition. Their base material is weldable structural steel such as that produced by voestalpine Stahl GmbH.

3.2 System boundary
The life cycle assessment of average heavy plates produced by voestalpine refers to a cradle-to-gate analysis with options. The following lifecycle phases are taken into consideration in the analysis:

Module A1–A3 | Product stage
The product stage includes upstream burdens of raw materials (coal, iron ore, pellets, etc.) and the corresponding transports to the Linz production site. Material and energy flows required in the coking plant, sintering plant, blast furnaces, steelmaking plant and heavy plate rolling mill were recorded on site. Electricity is provided at the Linz site in a power station where furnace gases are used as fuel. Since more energy is used than is supplied by this company-owned power station, natural gas and electricity is additionally procured from Austrian networks.

Module C3 | Waste treatment
Product flows that reach Module D for recycling leave the product system in C3. Environmental impacts resulting from the grinding and sorting of steel scrap are not included.

Module C4 | Landfilling
Module C4 declares the environmental impacts incurred by landfilling (5 % of the product).

Module D | Credits and loads beyond the system boundary
The potential for substituting primary steel with a recycling scenario (95 % of the product) is set forth in Module D.

3.3 Estimates and assumptions
All assumptions are verified through detailed documentation and correspond to the best possible representation of reality based on the available data. Regional applicability of the used background data refers to average data under European or German conditions taken from the /GaBi database/. German data was used for the Austrian market whenever European or Austrian average data were not available.

3.4 Cut-off criteria
All inputs and outputs for which data are available are included in the LCA model. Data gaps are filled with conservative assumptions from average data (when available) or with generic data and are documented accordingly. Only data with a contribution of less than 1 % were cut off. Ignoring such data is justified based on the insignificance of the expected effect. Processes, materials or emissions known to make a significant contribution to the environmental effects of the products under examination have not been neglected. Data were collected from the models and recommendations developed by /worldsteel 2011/ and tested using available comparable values. It is assumed that the data have been completely recorded and that the overall total of ignored input flows do not amount to more than 5 % of the total energy and mass flows. Environmental impacts of machines, plant and infrastructure were not included.

3.5 Background data
Secondary data are used to depict the background system in the LCA model. These data originate from the /GaBi 8/ database developed by thinkstep AG.

3.6 Data quality
The foreground data collected at voestalpine Stahl GmbH are based on the quantities used and volumes produced annually. All process data were collected by voestalpine in the course of reporting to official agencies. Data on material and energy use originate from material-specific throughput measurements of various processes as well as from controlling. Data were collected in compliance with /worldsteel 2011/ provisions and were subjected to a supplementary plausibility check using material flow analyses of individual process steps. The technological, geographical and time-related representativeness of the database was kept in mind when selecting background data. Whenever specific data were missing, either generic datasets or representative average data were used instead. The implemented GaBi background datasets are not more than five years old.

3.7 Period under review
Foreground data were collected in the 2013 production year, and the data are based on the volumes produced on an annual basis. Product-specific data from the heavy plate rolling mill were taken into account for 2016.

3.8 Allocation
The primary data are allocated using the partitioning approach developed by /worldsteel 2014/ for calculating lifecycle inventories of coproducts in steel production, which is in line with the provisions of /EN 15804/. The so-called partitioning approach provides for the allocation of environmental effects to the steelmaking process and the emerging byproducts based on their physical relations. Material-inherent flow properties are thus taken into account. Externally recycled iron and steel waste products were cut off as a result of their low contribution to company revenue. Economic allocation is not considered to be expedient because the byproducts and coproducts are not directly tradable goods. Furthermore, long-term contracts for the sale of the byproducts exist, and the negotiated prices are therefore not subject to market dynamics. The power station at the Linz site supplies electricity and steam for a wide variety of processing systems.
An exergetic allocation factor was used to correctly assign the environmental effects of electricity and steam generation to individual process steps. The net flows are calculated by deducting the external steel scrap in A1-A3 and the purchased coating materials from the overall mass of the product.

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 GaBi background database was used to calculate the LCA.

4. LCA: Scenarios and additional technical information

The end-of-life scenario used in this LCA study is based on the following assumptions and thus complies with the specifications published in /oekobaudat 2016/:

<table>
<thead>
<tr>
<th>End of Life (C1-C4)</th>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Collected separately (steel)</td>
<td>1000</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>Recycling 95 %</td>
<td>950</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>Landfilling 5 %</td>
<td>50</td>
<td>kg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reuse, recovery and recycling potential (D)</th>
<th>Name</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net flow of steel scrap</td>
<td>756</td>
<td>kg</td>
</tr>
</tbody>
</table>

This scenario contains a recycling rate of 95 %. Since voestalpine externally purchases scrap for steel production, this is offset against the steel scrap for recycling (net flow).
5. LCA: Results

The following table contains the LCA results for a declared unit of 1 ton of heavy plate produced by voestalpine Grobblech GmbH.

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

<table>
<thead>
<tr>
<th>PRODUCT STAGE</th>
<th>CONSTRUCTION PROCESS STAGE</th>
<th>USE STAGE</th>
<th>END OF LIFE STAGE</th>
<th>BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material supply</td>
<td>Manufacturing</td>
<td>Transport from the gate to the site</td>
<td>Assembly</td>
<td>Use</td>
</tr>
<tr>
<td>A1</td>
<td>X</td>
<td>X</td>
<td>MND</td>
<td>MND</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 ton of heavy plate

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1-A3</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming potential</td>
<td>[kg CO$_2$-Eq.]</td>
<td>2.13E+3</td>
<td>0.00E+0</td>
<td>8.03E-1</td>
<td>-1.29E+3</td>
</tr>
<tr>
<td>Depletion potential of the stratospheric ozone layer</td>
<td>[kg CFC11-Eq.]</td>
<td>1.04E-8</td>
<td>0.00E+0</td>
<td>8.84E-12</td>
<td>1.43E-8</td>
</tr>
<tr>
<td>Acidification potential of land and water</td>
<td>[kg SO$_2$-Eq.]</td>
<td>7.26E+0</td>
<td>0.00E+0</td>
<td>4.81E-3</td>
<td>-5.01E+0</td>
</tr>
<tr>
<td>Eutrophication potential</td>
<td>[kg (PO$_4^3-$)-Eq.]</td>
<td>6.84E-1</td>
<td>0.00E+0</td>
<td>6.55E-4</td>
<td>-4.20E-1</td>
</tr>
<tr>
<td>Formation potential of tropospheric ozone photochemical oxidants</td>
<td>[kg ethene-Eq.]</td>
<td>7.50E-1</td>
<td>0.00E+0</td>
<td>3.83E-4</td>
<td>-7.26E-1</td>
</tr>
<tr>
<td>Abiotic depletion potential for non-fossil resources</td>
<td>[kg Sb-Eq.]</td>
<td>7.81E-3</td>
<td>0.00E+0</td>
<td>2.77E-7</td>
<td>-1.30E-5</td>
</tr>
<tr>
<td>Abiotic depletion potential for fossil resources</td>
<td>[MJ]</td>
<td>1.94E+2</td>
<td>0.00E+0</td>
<td>7.30E+0</td>
<td>0.00E+0</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA - RESOURCE USE: 1 ton of heavy plate

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1-A3</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable primary energy as energy carrier</td>
<td>[MJ]</td>
<td>9.60E+2</td>
<td>0.00E+0</td>
<td>1.23E+0</td>
<td>3.84E+2</td>
</tr>
<tr>
<td>Non-renewable primary energy as material utilization</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Total use of renewable primary energy resources</td>
<td>[MJ]</td>
<td>9.60E+2</td>
<td>0.00E+0</td>
<td>1.23E+0</td>
<td>3.84E+2</td>
</tr>
<tr>
<td>Non-renewable primary energy as energy carrier</td>
<td>[MJ]</td>
<td>1.97E+4</td>
<td>0.00E+0</td>
<td>7.30E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Non-renewable primary energy as material utilization</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Total use of non-renewable primary energy resources</td>
<td>[MJ]</td>
<td>1.97E+4</td>
<td>0.00E+0</td>
<td>7.30E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of secondary material</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of non-renewable secondary fuels</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Use of net fresh water</td>
<td>[m³]</td>
<td>4.42E+0</td>
<td>0.00E+0</td>
<td>2.21E-3</td>
<td>-8.25E-1</td>
</tr>
</tbody>
</table>

### RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 ton of heavy plate

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1-A3</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous waste disposed</td>
<td>[kg]</td>
<td>4.69E-4</td>
<td>0.00E+0</td>
<td>2.47E-7</td>
<td>1.74E-3</td>
</tr>
<tr>
<td>Non-hazardous waste disposed</td>
<td>[kg]</td>
<td>2.46E+1</td>
<td>0.00E+0</td>
<td>5.07E+1</td>
<td>-1.38E+1</td>
</tr>
<tr>
<td>Components for re-use</td>
<td>[kg]</td>
<td>1.52E-1</td>
<td>0.00E+0</td>
<td>1.51E-4</td>
<td>2.35E-1</td>
</tr>
<tr>
<td>Materials for recycling</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>9.50E+2</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Materials for energy recovery</td>
<td>[kg]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Exported electrical energy</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
<tr>
<td>Exported thermal energy</td>
<td>[MJ]</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
<td>0.00E+0</td>
</tr>
</tbody>
</table>

6. LCA: Interpretation

The following interpretation contains a summary of the LCA results referenced to a functional unit of 1 ton of voestalpine heavy plate.

A comparison of the individual lifecycle phases results in a clear dominance of the production phase (Modules A1-A3). The environmental effects in the production phase are mainly dominated by the direct process emissions of steel production and the supply chain of purchased raw materials and energy carriers.
As a result of product recyclability, the material removed at the end of life can substitute primary steel. Module D shows the recycling potential of steel at the end of its product life. With the exception of the depletion potential of stratospheric ozone (ODP) and the abiotic depletion potential of non-fossil resources (ADP elementary), this results in credits from the substitution of primary steel for the impact categories investigated. The environmental impact of landfill disposal (C4) represents a minor contribution to the overall environmental impact of the product.

Global warming potential (GWP) from the production phase of heavy plate products (Modules A1-A3) can largely be attributed to the raw materials and energy carriers required in primary steel production in the blast furnaces, steelmaking plant, coking plant, sintering plant and heavy plate rolling mill, as well as to the greenhouse gases emitted during these processes. The greenhouse gases generated in the sintering plant, blast furnaces, heavy plate rolling mill and electric power plant contribute a large share of the direct emissions. As far as raw material supply is concerned, the emissions generated during the production of alloying elements, pellets, coal and coke contribute to global warming.

The main drivers of potential acidification (AP) and eutrophication (EP) are ore and pellet transports. The upstream supply chain of pellets used in production also contributes to acidification and eutrophication.

Analysis shows that direct emissions at the Linz production site are responsible for a large share of the potential formation of tropospheric ozone (POCP). Ship transports of pellets and lump ore for the blast furnaces also generate emissions that further contribute to the formation of summer smog.

The ozone depletion potential (ODP) arises above all from pellets used upstream in the blast furnaces and the alloying elements used in the steelmaking plant.

The upstream supply of alloying elements plays a major role in the abiotic depletion potential of non-fossil resources (ADPe).

The use of coke represents a main driver of potential abiotic depletion of fossil resources (ADPf) and of non-renewal primary energy use (PENRE). A majority of the renewable primary energy (PERE) is obtained from the Austrian grid network and is also deployed in the upstream supply of alloys.

In summary, the heavy plate rolling mill represents a material aspect with respect to its potential contribution to global warming. In the other environmental impact categories, the heavy plate rolling mill is of comparatively less significance.

7. Requisite evidence

This EPD refers to heavy plates produced by voestalpine Grobblech GmbH. Further processing steps in production are dependent on the intended application of the final product. Further documentation is not relevant in this respect. The rust rates of plain carbon steels depend heavily on their type and site of application. Heavy plates can be protected from corrosion by applying a roll-bonded cladding to surfaces.
8. References

Institut Bauen und Umwelt
Institut Bauen und Umwelt e.V., Berlin (pub.):
Generation of Environmental Product Declarations (EPDs);

General Principles
for the EPD range of Institut Bauen und Umwelt e.V. (IBU), 2015/10
www.ibu-epd.de

/ISO 14025/
DIN EN /ISO 14025:2011-10/, Environmental labels and declarations — Type III environmental declarations — Principles and procedures

/EN 15804/
/EN 15804:2012-04+A1 2013/, Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

ASTM (S)A 36, 2014
Standard specification for carbon structural steel

ASTM (SA) 283 Grade C,
Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

ASTM (S)A 572 Grade 50, Type 1
Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM (S)A 588 Grade A
Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPA] Minimum Yield Point, with atmospheric Corrosion Resistance

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