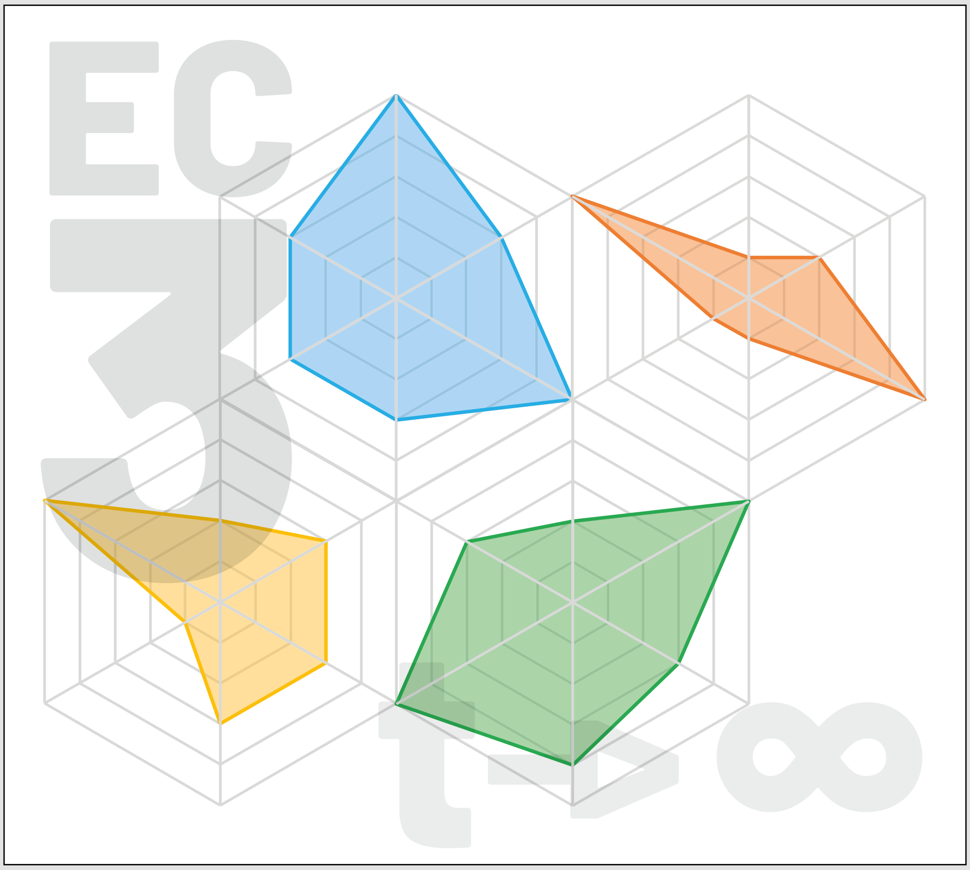
Merkblatt 820e

Guideline on the selection of stainless steels



Informationsstelle Edelstahl Rostfrei

About Informationsstelle Edelstahl Rostfrei

The Informationsstelle Edelstahl Rostfrei (ISER) is a joint organisation of companies and institutions from the following sectors

- Stainless steel production (national and european),
- Stainless steel processing,
- Surface finishers,
- Stockholders and service centres,
- Alloying elements industry,
- Services and publishers.

ISER‘s tasks include provision of company-neutral information on properties and applications of stainless steel. The focus of the activities is on

- Practice-oriented, target group-specific technical publications,
- Online information platform,
- Public relations for professional journals and public media,
- Trade Fair participations,
- Performance of training events,
- Establishment of competence centres „Stainless-Steel-Processing“
- Supplier directories,
- Individual reply to technical questions.

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Postfach 102205, D-40013 Düsseldorf
Phone: +49 (0) 211 6707-835
Fax: +49 (0) 211 6707-344
E-mail: info@edelstahl-rostfrei.de
Internet: www.edelstahl-rostfrei.de

Author:
Dr.-Ing. Sebastian Heimann

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Fig. 4: Thomas Pauly
Fig. 6: BAM, Berlin
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Content

1 Foreword to the Second Edition

There is a large number of stainless steels in the market. Standard EN 10088-1 alone, the European list of stainless steels, specifies the compositions of more than 180 grades listed in European standards. This variety of stainless steels leads to a large number of property combinations that open up a very wide range of applications. In order to facilitate the selection of a suitable grade from this abundance with the right properties for an application, our leaflet Merkblatt 820 was developed in 2022. 38 varieties were compared and graded with regard to six of their properties and presented with these grades in radar charts.

> Stainless steel is robust, hygienic, corrosion-resistant and recyclable, amongst other things. The combination of corrosion resistance and durability increases the service life of the products. These properties make it an ideal choice for a wide range of demanding industrial and consumer applications.

In this second edition of the leaflet, the number of steel grades has been increased to a total of 83. Martensitic, high-temperature and heat-resistant stainless steels have been added i.a..

Fundamentally new in this edition are explanations on material selection and durability in accordance with Eurocode 3 (DIN EN 1993-1-4, Annex A [1]). The procedure for material selection according to this standard applies to load bearing components in the construction industry, but is also generally suitable as a guide for the selection of stainless steels with regard to corrosion exposure.

The explanations of the procedure for material selection in accordance with Eurocode 3, Annex A given in this leaflet are primarily intended to aid understanding of the approach. Errors cannot be ruled out. Therefore, the standards should always be used as a basis for specific applications.

2 Radar Charts with Six Material Properties

Wear behaviour and processing properties of stainless steels are influenced both directly by the alloying elements added and by the microstructure resulting from the respective alloy composition. While pure iron is only present in a body-centred cubic lattice (ferrite) at room temperature and the face-centred cubic austenite structure only occurs at higher temperatures, higher alloyed steels and thus also the stainless steels can have both an austenitic and a ferritic structure as well as a mixture of both at room temperature, depending on the alloy composition and the heat treatment. In addition, a tetragonal-distorted body-centred cubic crystal structure, which is referred to as martensite, can be achieved by specific heat treatment.

According to these microstructures, the stainless steels are classified into

- **ferritic (Cr),**
- **martensitic (Cr, C/Ni),**
- **austenitic (Cr, Ni, Mo, sometimes Mn, N) and**
- **austenitic-ferritic (Cr, Ni, Mo, N)**

stainless steels.

The **substitution** of a material grade should always be **application-related** and carefully considered. Selective consideration of individual properties of a grade considered as a replacement could lead to far-reaching problems, quality loss and high cost.

The main alloying elements of these four groups are enclosed in brackets. Further information can be found in ISER brochures Merkblatt 803 and Merkblatt 821.

Typical, characteristic material properties can be assigned to the four main groups of stainless steels mentioned above. For example, austenitic grades are characterised by a particularly good forming capacity, while austenitic-ferritic steels (duplex steels) achieve higher strengths. By specific modifications of alloy compositions, it becomes possible to produce material grades that have comparable properties even across the boundaries of the main groups. However, this usually only applies to individual, selected properties and not to several at the same time. For this reason, a change to another material grade, for example to avoid an expensive alloying element, should not be made without close examination of the consequences for the existing area of application. This is because it is usually one of the main alloying elements (with the exception of chromium) that is to be changed, and thus a possible shift to another main group of stainless steels.

The individual properties of steel grades are often subdivided into „strengths“ and „weaknesses“. However, this appraisal should always be made regarding the area of application and should not be basis of a general appraisement. The characteristic of a property can be particularly helpful in one application, while in another case it makes the use of the steel grade impossible. For example, high strength is important to many applications, whereas the usually associated lower forming capacity is less important. For other applications, high strength can be a disadvantage if high forming capacity is required (high forming forces, low drawing capacity).

What „weaknesses“ does a material bring to the application that is selected because of its for the application absolutely necessary „strengths“? To what extent are the different properties of the grade important for the particular application? These questions should be asked while decision making.

Following diagrams are intended to provide assistance in the selection of stainless steels.
The notched bar impact energy is not shown in the diagrams. As the austenitic stainless steels are not susceptible to brittle fracture even at very low temperatures, they can be used e.g. in the construction industry down to - 40 °C without further proof. Ferritic stainless steels, on the other hand, tend to brittle fracture even at significantly higher temperatures. In the construction sector, therefore, at least an impact energy of 40 J must be verified for them with ISO-V specimens at - 40 °C. The verification must be carried out in accordance with information given in the German technical approval Z-30.3-6 [2]. With their notched impact strength and the position of their transition temperature, the austenitic-ferritic stainless steels lie between the two aforementioned groups due to their microstructure. Proof, as with ferrites, must also be provided in the construction sector.
Due to the volatility of prices of alloying elements, cost is here not discussed further.

The radar charts list the material properties **corrosion resistance, strength, formability, weldability, thermal expansion** and **thermal conductivity** for the most common stainless steel grades with a simple grading system. The grades from one to five indicate whether the respective property is rather high or low in comparison to the listed steel grades. However, they should not and cannot represent a valuation of the property, as it was already explained earlier in the text with the reference to supposed „strengths“ and „weaknesses“.

The minimum yield strength $R_{p0.2}$ required by the relevant standards was chosen as the characteristic value for **strength** (see also p. 14, “Key to Figure 1 to Figure 3”).

For **formability**, the minimum elongation at fracture A required by the relevant standards was used as characteristic value.
A general quantification of the **corrosion resistance** of stainless steels is difficult. Surface corrosion, which can often be noticed in unalloyed structural steels without corrosion protection, is only possible with stainless steels in some acids and strong alkaline solutions. Basically, localised corrosion occurs (e.g. pitting corrosion, stress corrosion cracking, crevice corrosion, intergranular corrosion), for which, however, there is no all-embracing key figure.
In order to have a quantitative basis for the comparison of stainless steels, the Pitting Resistance Equivalent (PRE) is used as a measure of resistance to pitting and crevice corrosion. Nevertheless, this formula has been empirically determined and can by no means be considered as an electrochemistry law with defined boundary conditions. PRE is calculated according to the following formula and applies to the atmospheric range at non-elevated temperature:

$$PRE = \%Cr + 3.3 \times \%Mo + (X) \times \%N$$

The arithmetic mean values of the limits specified in DIN EN 10088-1:2024-04 [3] and SEW 390:1991-11 [4] for the alloying elements chromium (Cr), molybdenum (Mo) and nitrogen (N) were used for %Cr, %Mo and %N respectively.
The nitrogen factor X was set to zero for grades with less than 3 % Mo, to 30 for all other grades with 3 % Mo or more and to 16 for duplex steels.

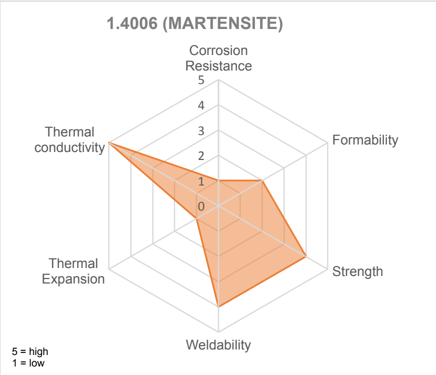
Stainless steel is often the more cost-effective material. Several life cycle studies show that the total cost of stainless steel is lower than cost of competing materials in many applications; in certain cases, cost savings can be between 30 % and 40% due to lower repair and maintenance cost. Renewable energy solutions such as solar energy, biofuels and wind energy require components and materials that can be sustainably sourced and have low life cycle cost. Stainless steel is an optimal choice in these areas.

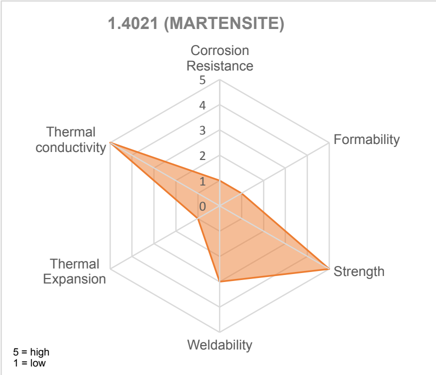
The grades for the corrosion resistance of steel grades 1.4305 and 1.4598 were each reduced by one as the addition of sulphur has a negative effect on the corrosion resistance (see also section 4.7). As the PRE does not take this into account, the corrosion resistance of these two materials would be incorrectly categorised in comparison with the other grades. This is also the reason why they are not listed in the diagrams „Strength over Corrosion Resistance" and „Formability over Corrosion Resistance" (Figure 1 and Figure 2) with their calculated PRE-value.
For the properties thermal expansion (mean thermal expansion coefficient between 20°C and 100°C and for the heat resistant grades between 20°C and 200°C, respectively) and thermal conductivity, the corresponding characteristic values from DIN EN 10088-1:2024-04 [3] and SEW 390:1991-11 [4] were used.

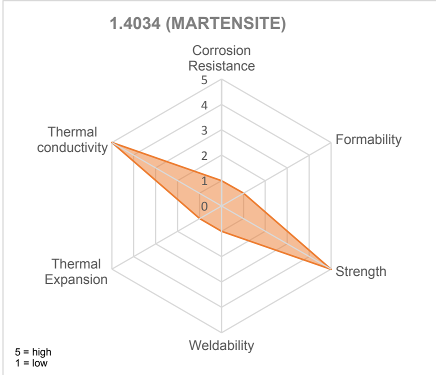
The grades listed in this data sheet have **coefficients of thermal expansion** between $10 \cdot 10^{-6}\ K^{-1}$ und $17 \cdot 10^{-6}\ K^{-1}$.
The **thermal conductivity** values (at 20°C) are between 8,6 W/(m K) and 30 W/(m K).

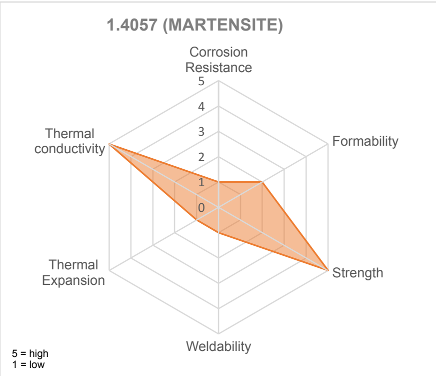
A high welding suitability means that no restrictions need to be observed, while a very low welding suitability rating means that welding is not recommended. Scores in between mean that more or fewer restrictions must be observed.
In the final figures in section 2.5, the corrosion resistance, strength and formability are plotted in different ways for common grades.

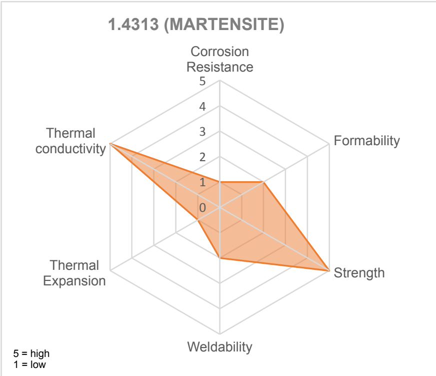
2.1 Martensitic Stainless Steels

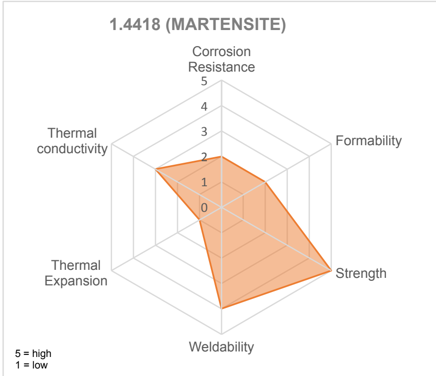


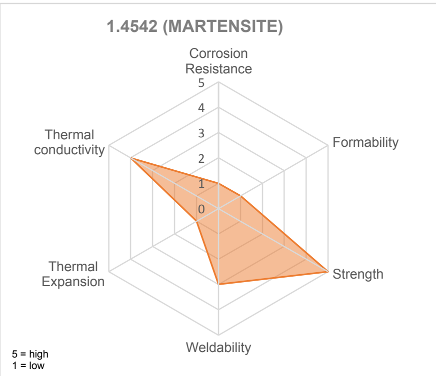


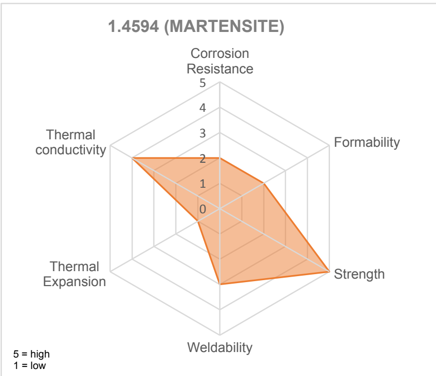


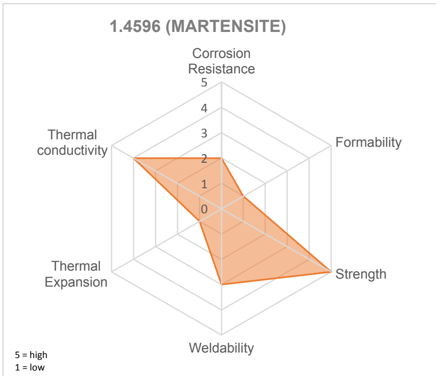


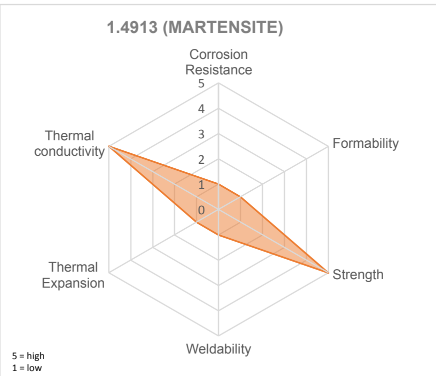


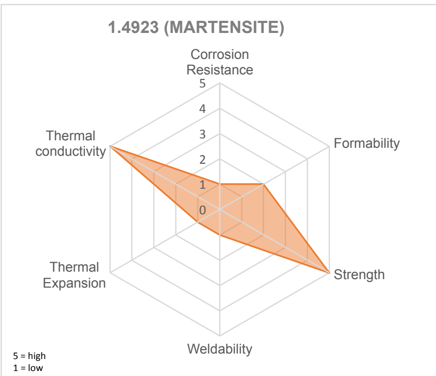












2.2 Austenitic Stainless Steels

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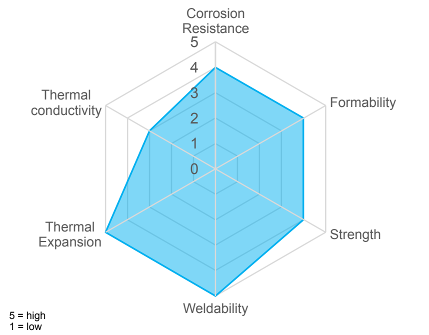

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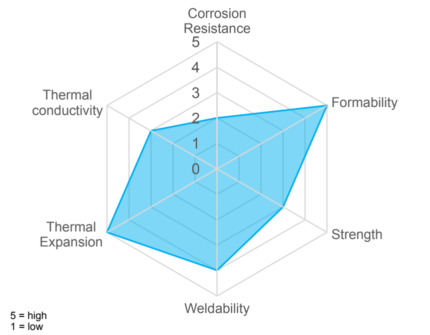

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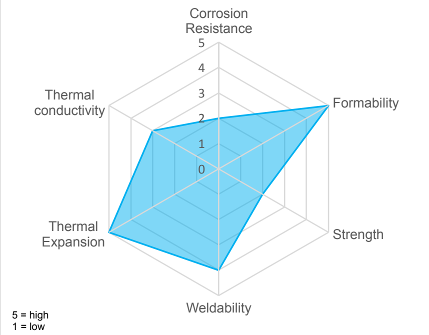

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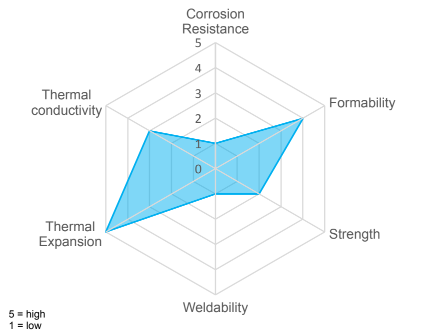

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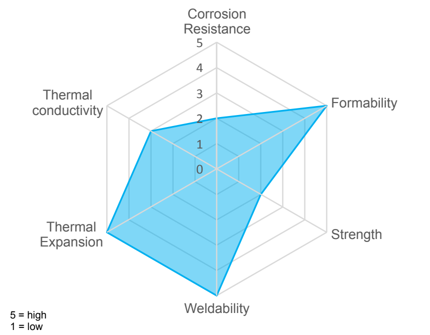

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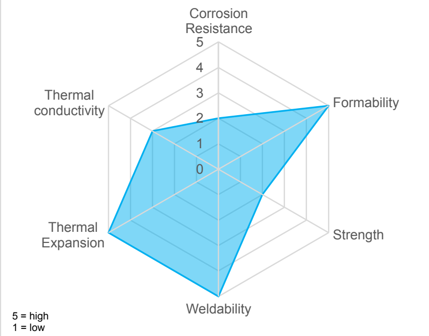

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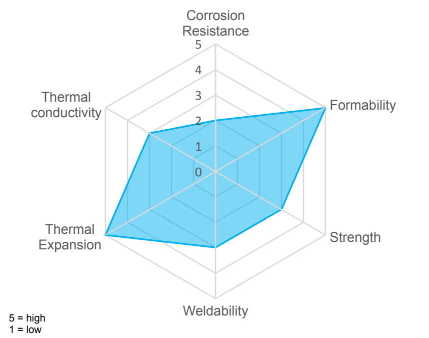

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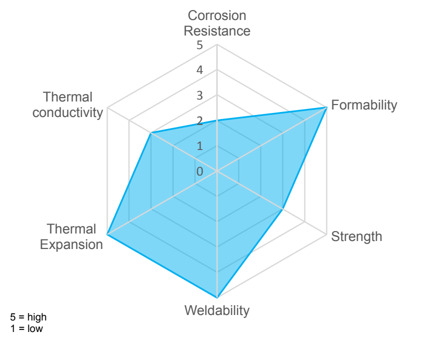

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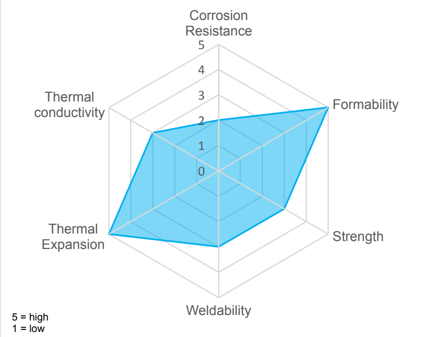

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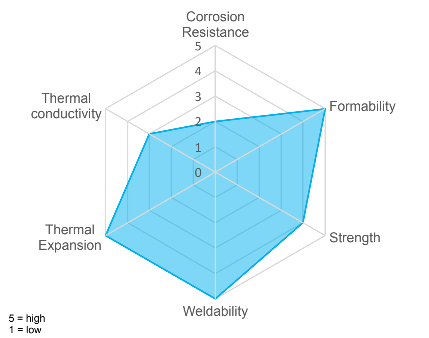

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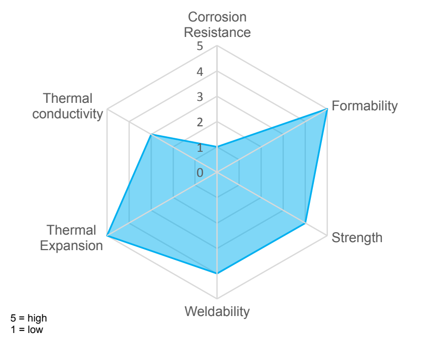

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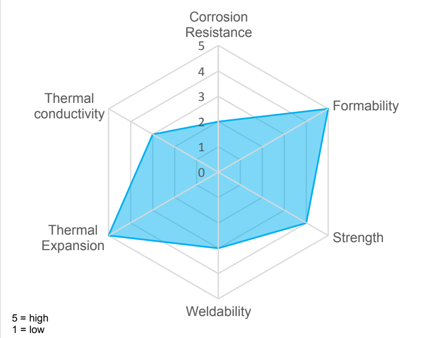

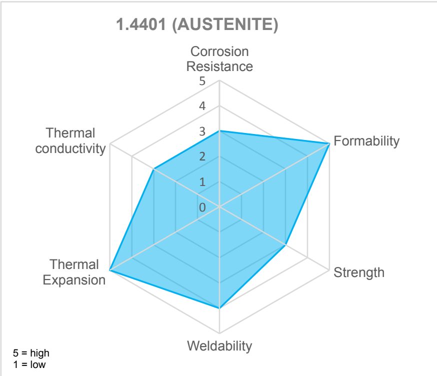
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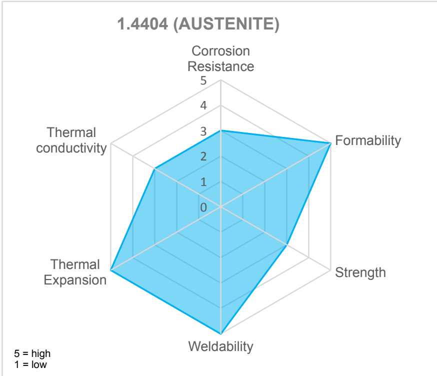
4
3
2
1
0
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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Formability
Strength
Weldability
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Thermal conductivity
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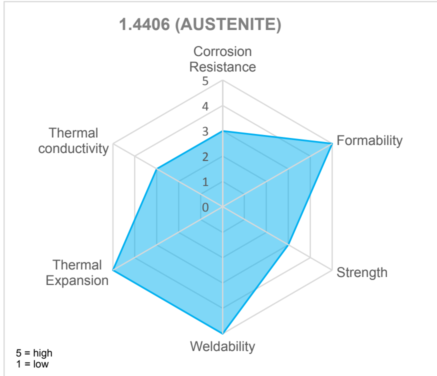
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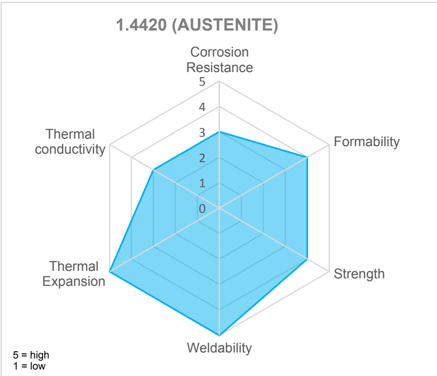
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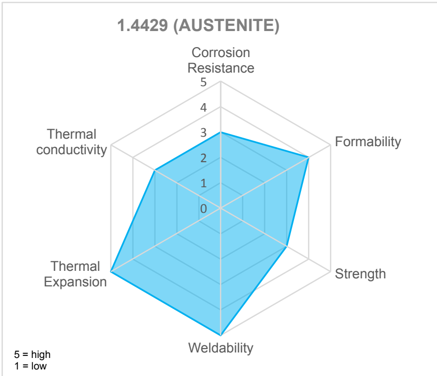
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Strength
Weldability
Thermal Expansion
Thermal conductivity
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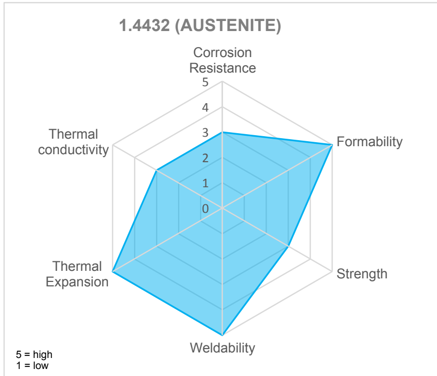
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Strength
Weldability
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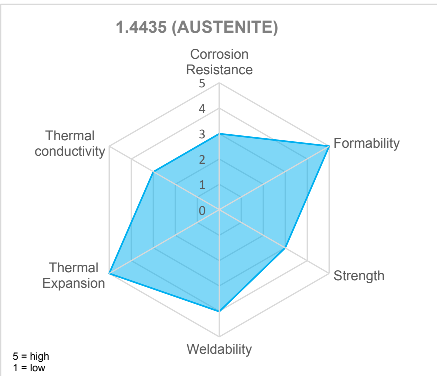
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Strength
Weldability
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Thermal conductivity
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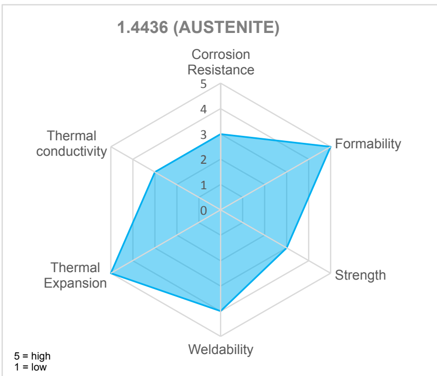
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Formability
Strength
Weldability
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Thermal conductivity
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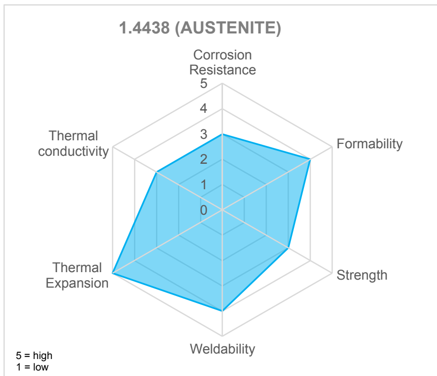
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Strength
Weldability
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Thermal conductivity
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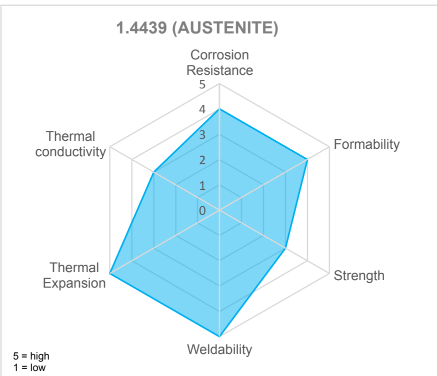
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Strength
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Thermal Expansion
Thermal conductivity
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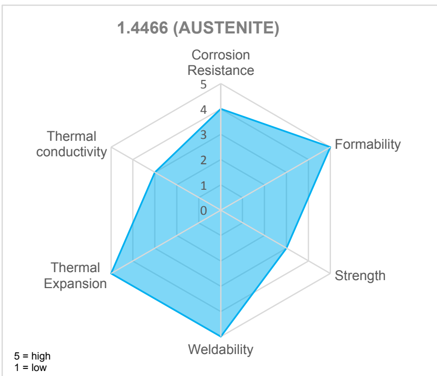
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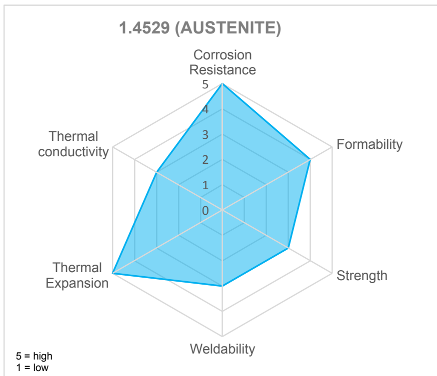
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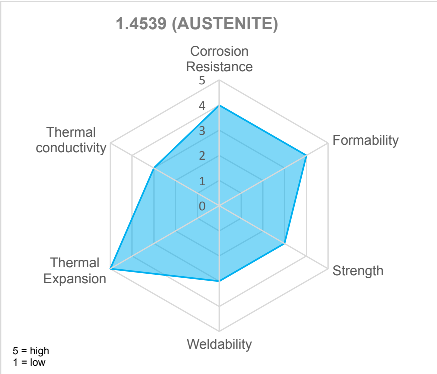
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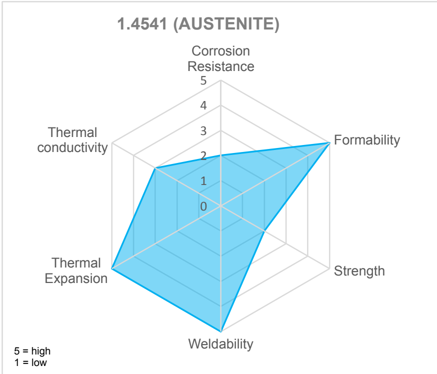
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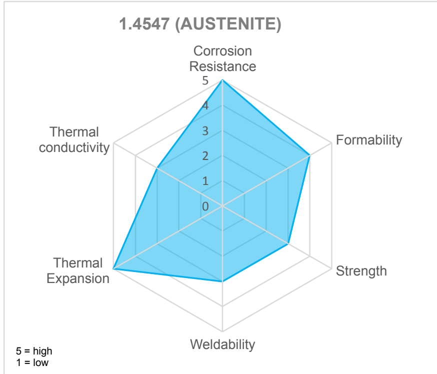
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Weldability
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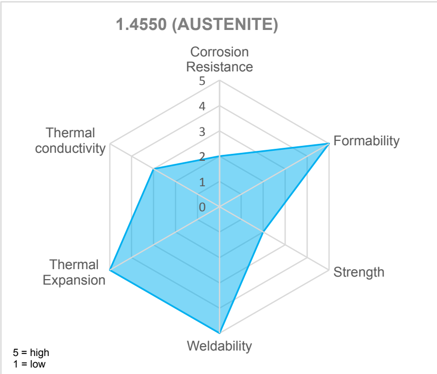
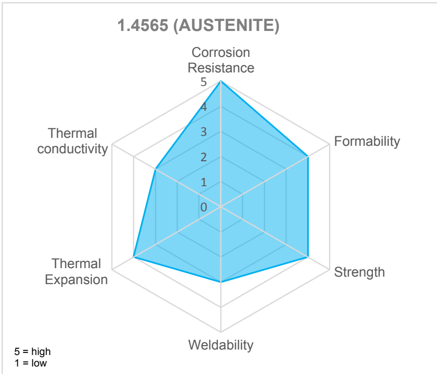
Thermal conductivity
5 = high
1 = low


1.4550 (AUSTENITE)
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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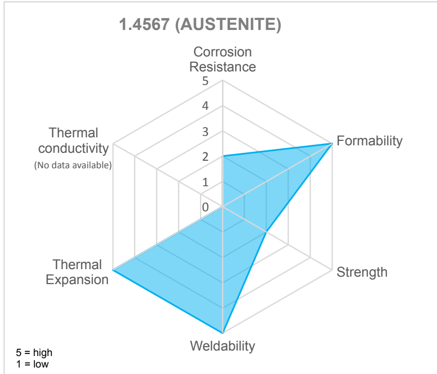
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
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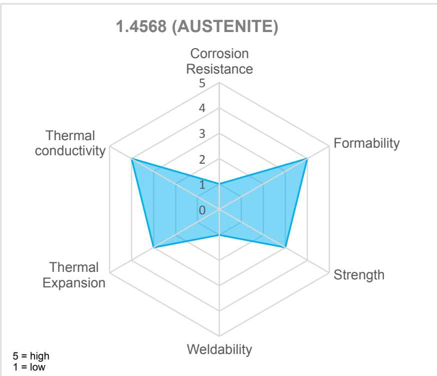
1 = low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Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
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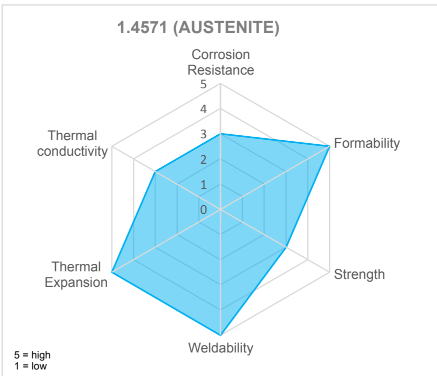
1 = low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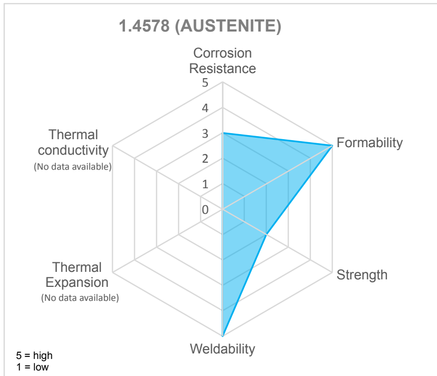
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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Formability
Strength
Weldability
Thermal Expansion
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Thermal conductivity
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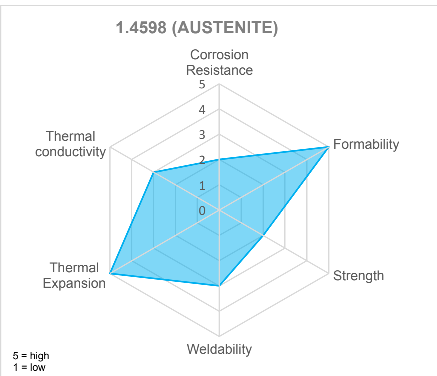
1 = low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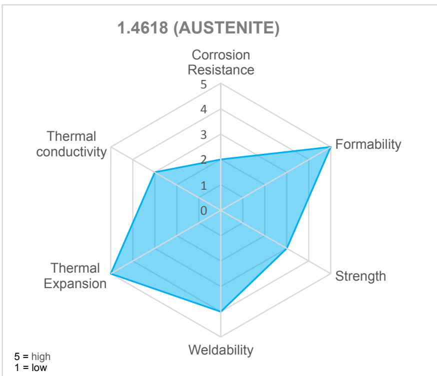
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
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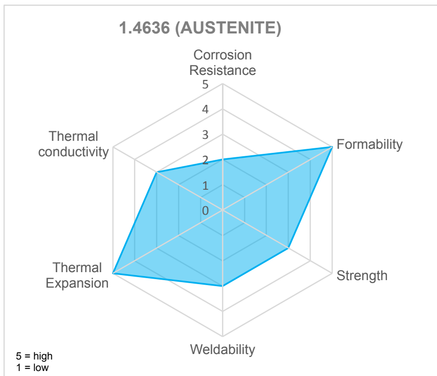
1 = low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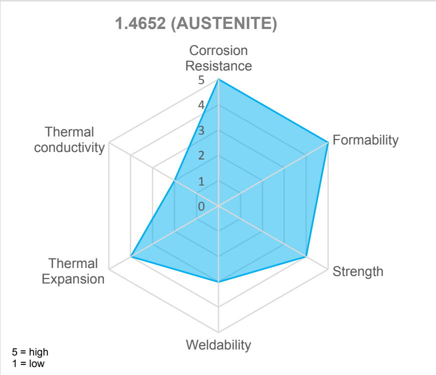
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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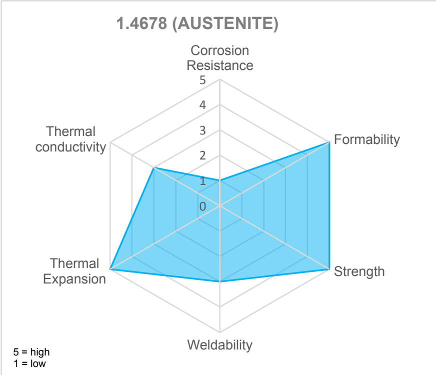
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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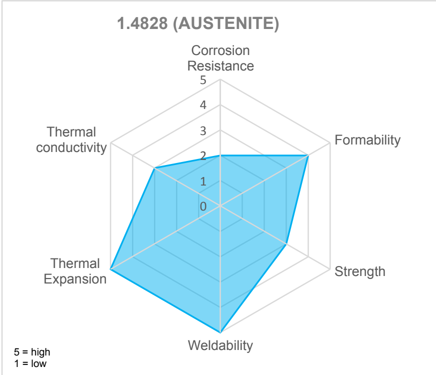
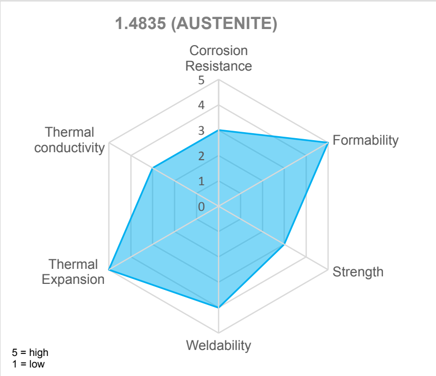
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low


1.4828 (AUSTENITE)
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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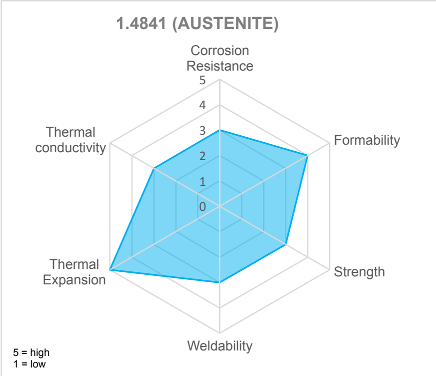
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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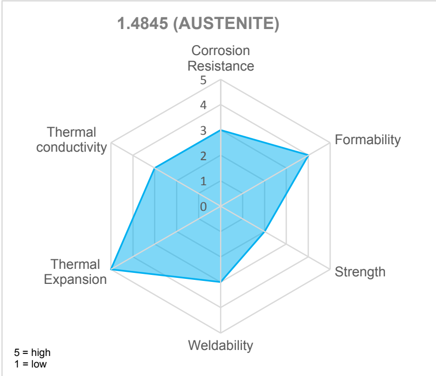
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low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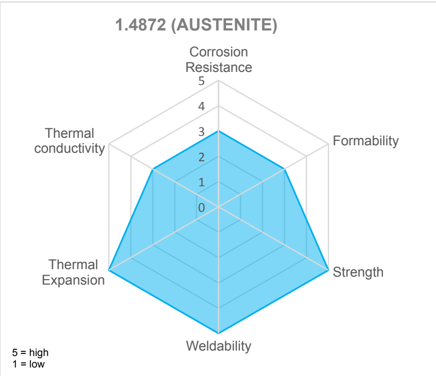
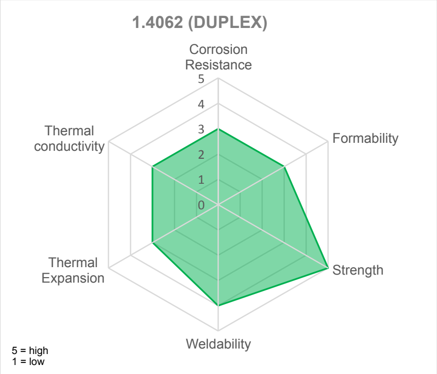
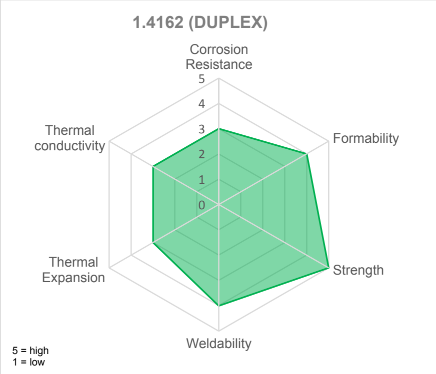
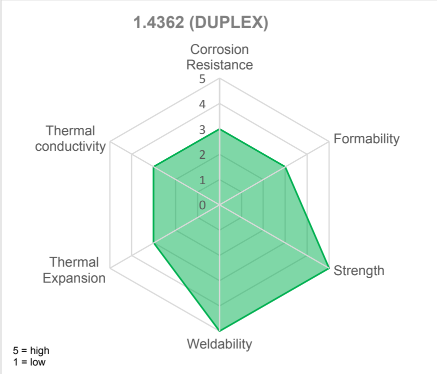
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low

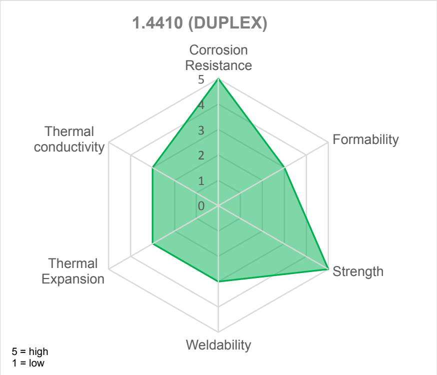

1.4872 (AUSTENITE)
Corrosion Resistance
Formability
Strength
Weldability
Thermal Expansion
Thermal conductivity
5 = high
1 = low

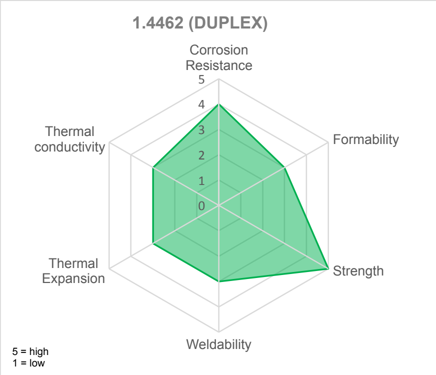
2.3 Austenitic-Ferritic Stainless Steels

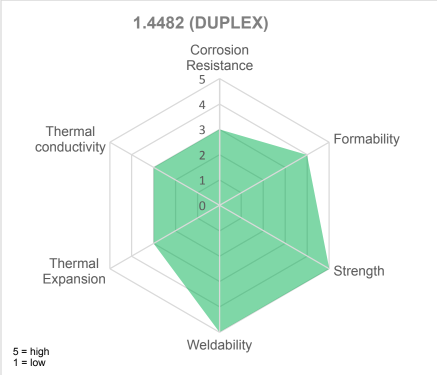


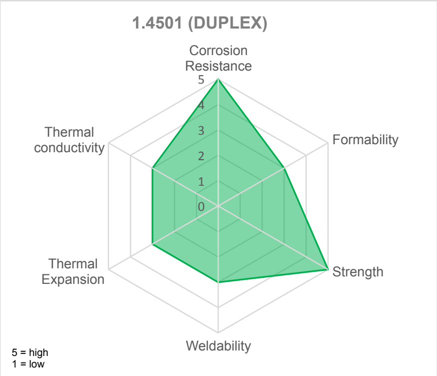


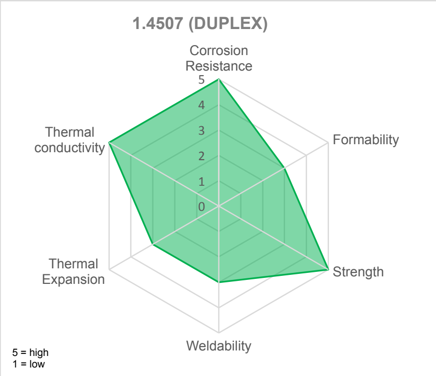


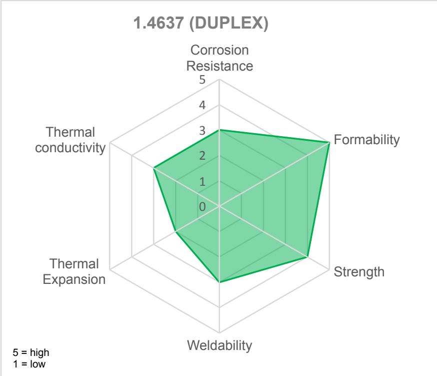


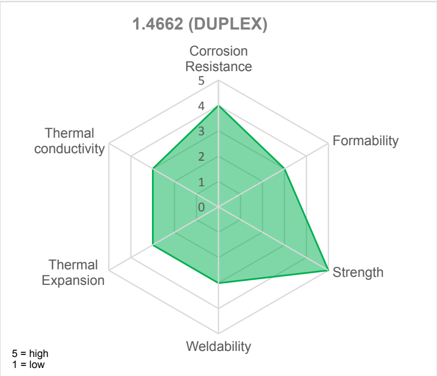


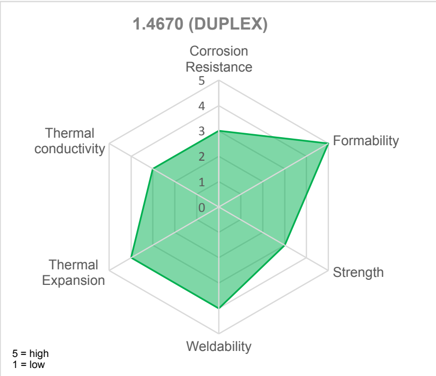


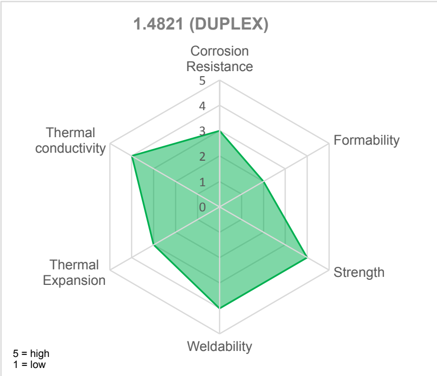




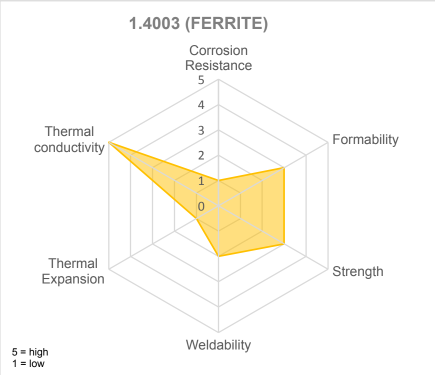


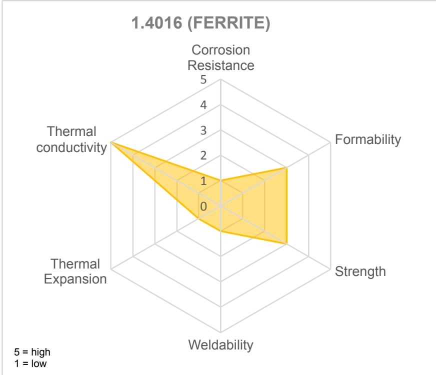


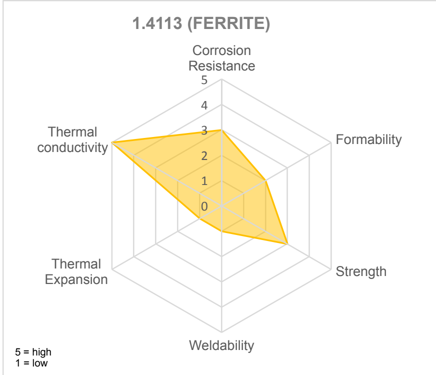


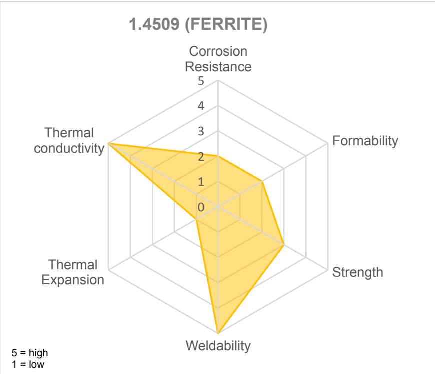


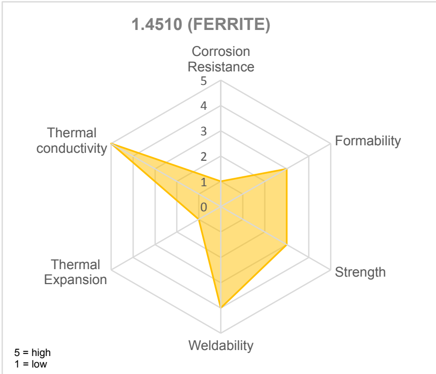
2.4 Ferritic Stainless Steels

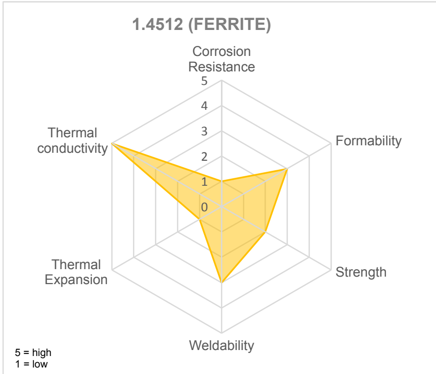


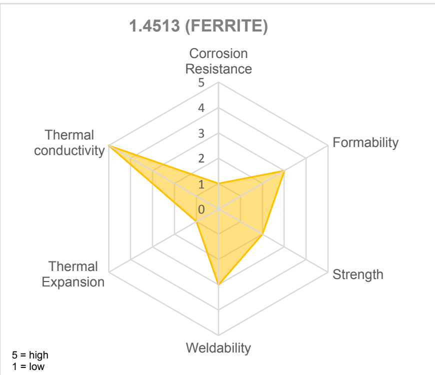


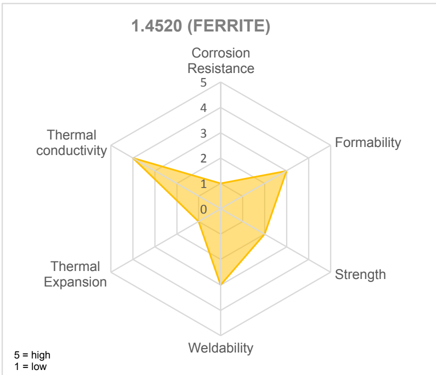


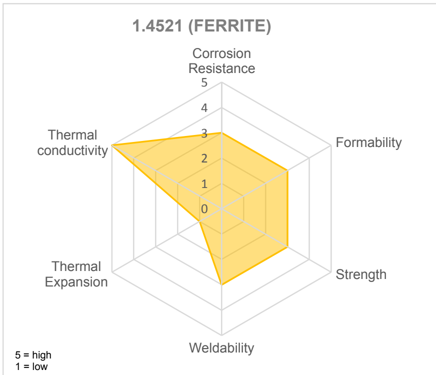


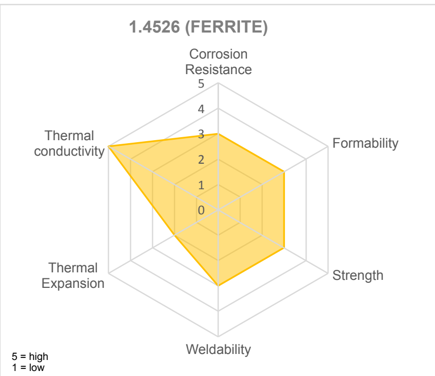


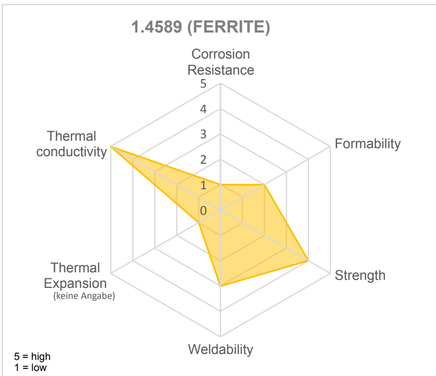


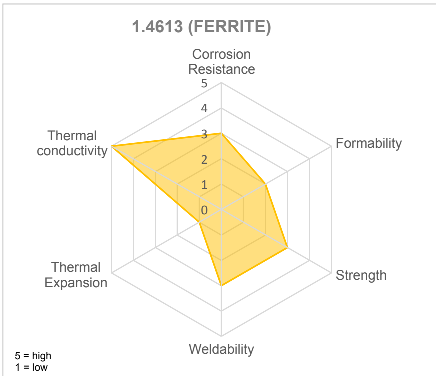


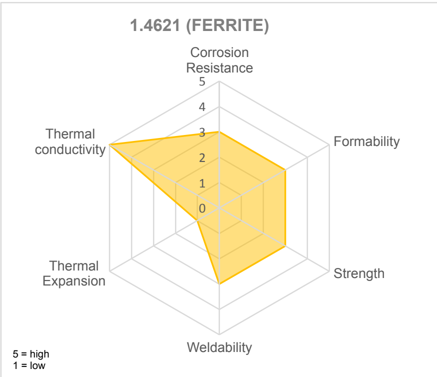


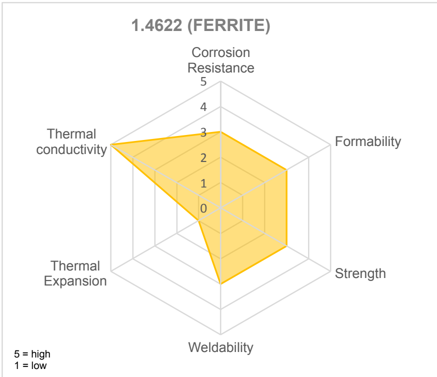


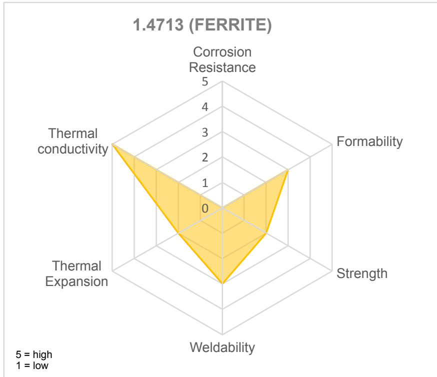


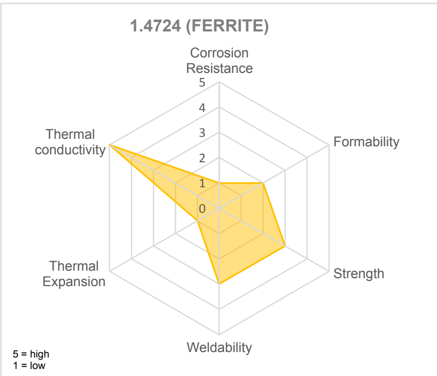


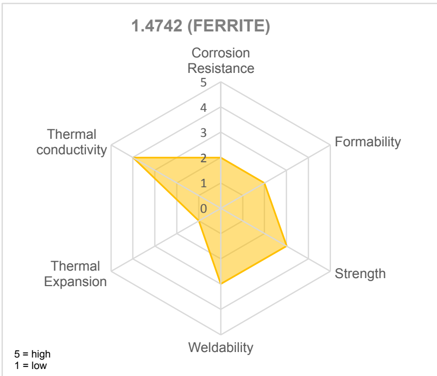












Key to Figure 1 to Figure 3

Minimum yield strength $R_{p0.2}$ and minimum elongation at fracture A from EN 10088-2:2024-09 [5] (condition C, cold-rolled strip, solution-annealed)

Exceptions:

1.4305, 1.4466 (condition P, hot-rolled sheet, solution-annealed)

1.4006, 1.4021 and 1.4313 (condition P, hot-rolled sheet, quenched and tempered (+QT))

1.4034, 1.4057, 1.4418, 1.4567, 1.4578, 1.4594, 1.4596, 1.4598, 1.4670 (DIN EN 10088-3:2024-04 [6])

1.4622 (DIN EN 10028-7:2016-10 [7])

1.4713, 1.4724, 1.4742, 1.4821, 1.4828, 1.4835, 1.4841, 1.4845, 1.4872 (DIN EN 10095:2018-12 [8])

1.4913, 1.4923 (DIN EN 10269:2014-02 [9])

1.3964 (SEW 390:1991-11 [4])

1.4568, 1.4636 (manufacturer‘s specifications)

The effective sum PRE of the respective grade was calculated from the arithmetic mean of the limits for the alloying elements specified in DIN EN 10088-1:2024-04 [1].

PRE = %Cr + 3.3 x %Mo + (X) x %N (nitrogen factor (X) = 0 for grades with less than 3 % Mo, nitrogen factor (X) = 30 for grades with 3 % Mo or more, nitrogen factor (X) = 16 for duplex steels) |

Fig. 3: Values in brackets [XY] = Effective sum PRE of the respective grade

2.5 Diagrams

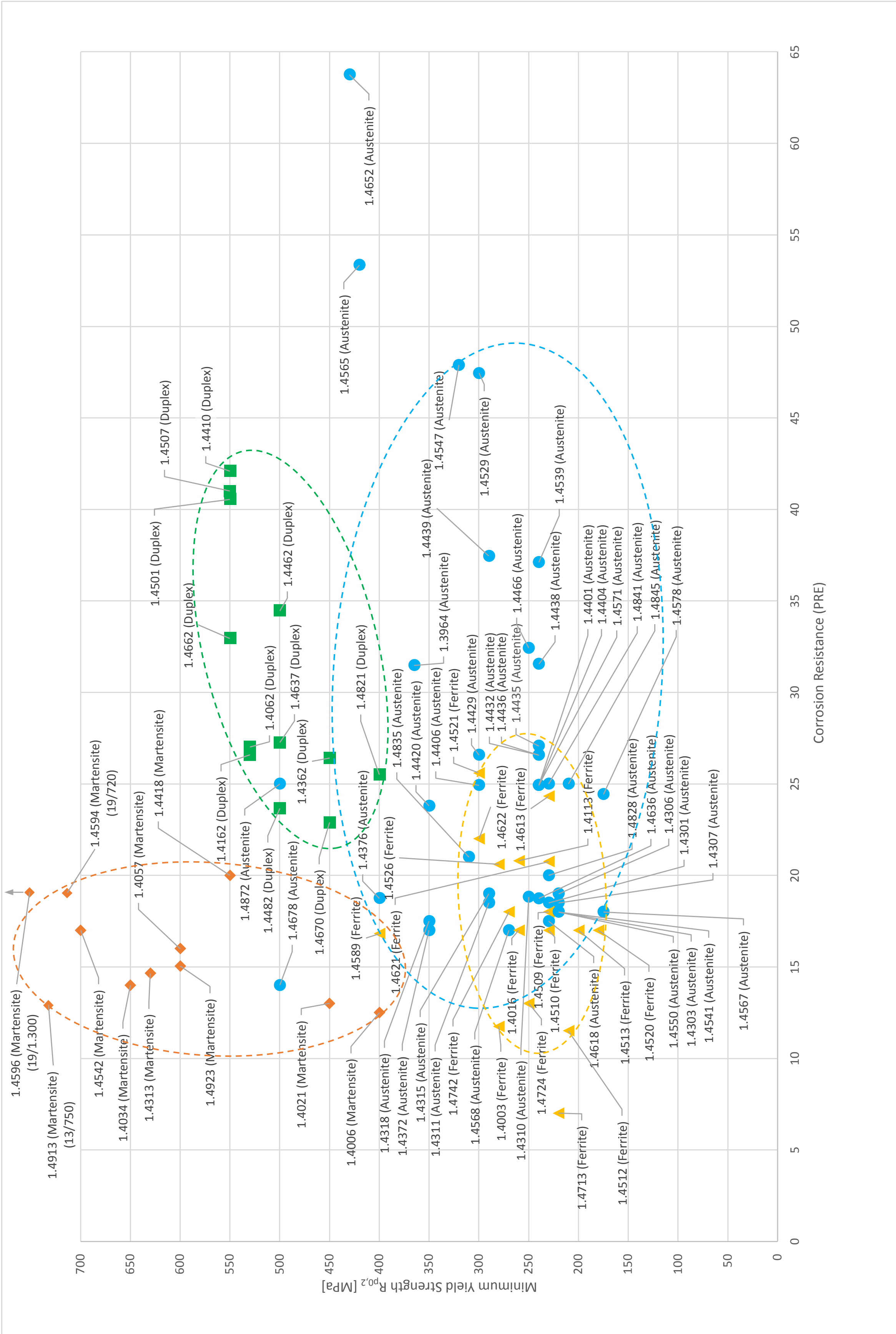


Figure 1: Strength vs. Corrosion Resistance

Formability vs. Corrosion Resistance

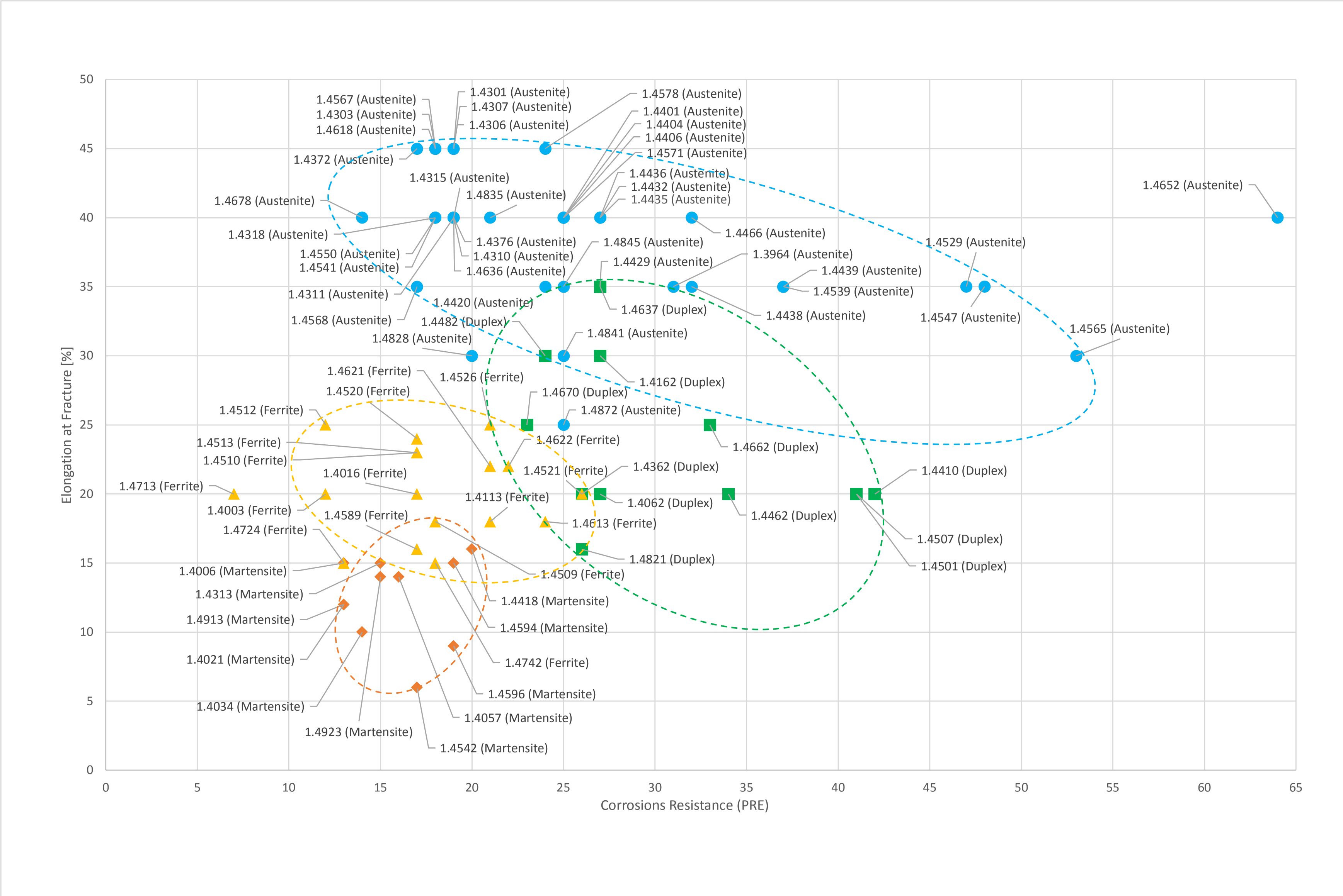


Figure 2: Formability vs. Corrosion Resistance

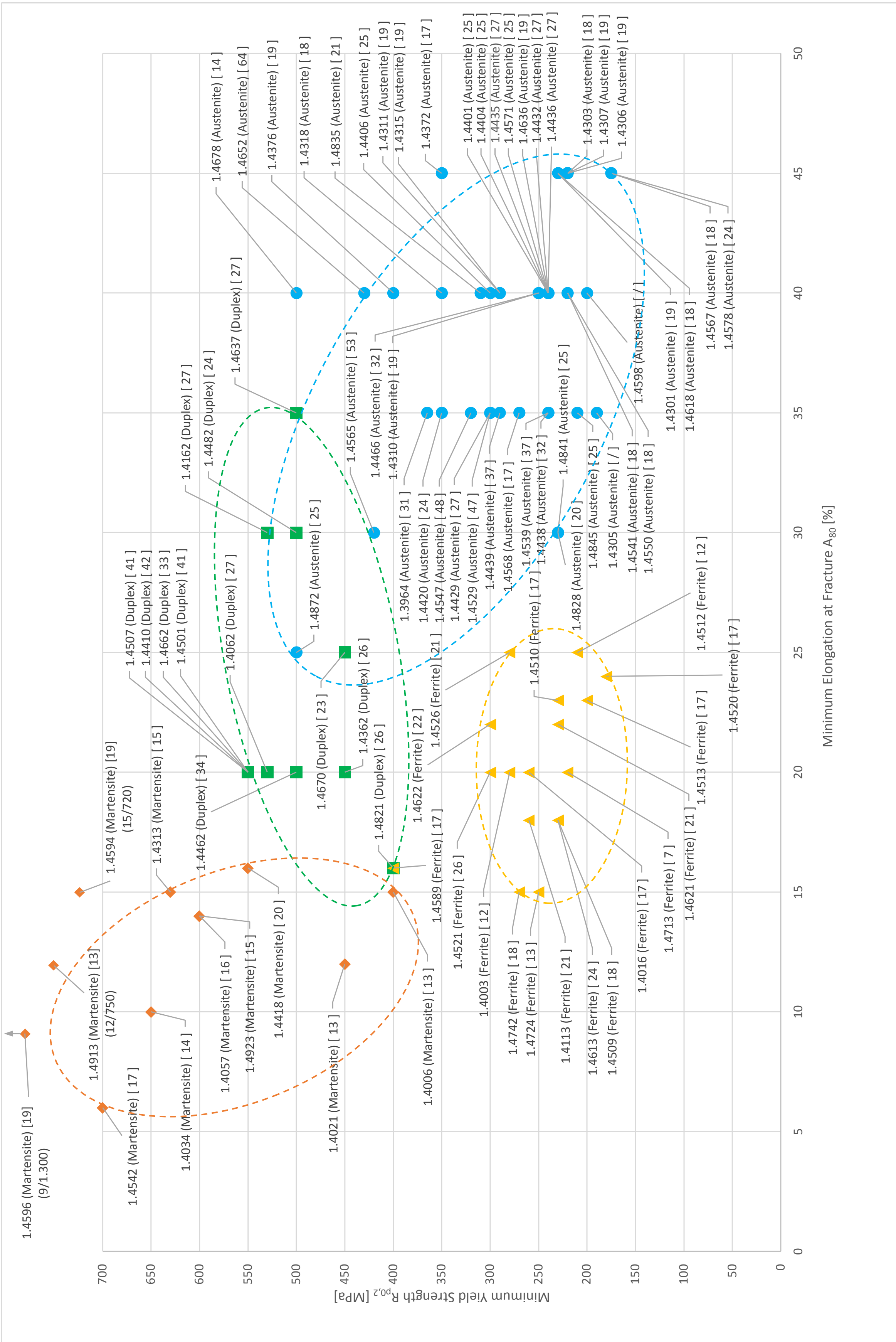


Figure 3: Strength vs. Formability

3 Material Selection and Durability according to Eurocode 3

In our everyday lives, we come across numerous stainless steel applications which, in the vast majority of cases and despite continuous use, still look excellent and show no signs of corrosion damage, some even after almost 100 years (Figure 4).

Unfortunately, there are also cases where corrosion occurs after only a short period of use. Usually, the reason for corrosion damages is that basics were not taken into account when selecting a material or something went wrong during manufacturing and processing.

The main advantage of stainless steels over simple structural steels is their good corrosion resistance, which makes additional corrosion protection measures redundant. However, it must be considered as a system property and not as a pure material property and is always an Interaction of design, medium and material (**Figure 5**). When selecting a material, the overall system with all its boundary conditions must therefore be considered.

Stainless steels can rust. There is no such thing as 'truly stainless'.
While surface corrosion does not play a role with stainless steels in the construction industry, various localised corrosion phenomena can impair the visual appearance or the load-bearing capacity.
Information on this can be found in [10] and [12].

The standard DIN EN 1993-1-4 (Eurocode 3) [1] contains a guideline for the selection of suitable stainless steels for load-bearing components in structural applications in its Annex A. It can be used to select a suitable stainless steel with regard to corrosion resistance. This ensures durability over many decades without additional corrosion protection measures or regular inspections. If the rules are not observed, on the other hand, components can fail prematurely within a few years (Figure 6). Design aspects are not considered in the guidelines in Annex A of the standard. Information on this can be found in section 4 of this information sheet.

DIN EN 1993-1-4 was reissued in April 2026. Comprehensive explanations of the changes can be found in [12].

Figure 4
Left: Chrysler Building, New York (first large-scale use of stainless steel in architecture; completed in 1930; no corrosion damage to date; cleaned twice to bring back the shine); **Right:** part of the Socony Mobil Building, New York (completed in 1956; had the world's largest stainless steel façade at the time of completion; no corrosion damage to date; cleaned once).

Load-bearing components are components for which a static proof is required. Load-bearing components are subject to technical approvals. [2]
The procedure according to DIN EN 1993-1-4 Annex A [1] applies to load-bearing components in steel construction that are subject to the rules of Eurocode 3 'Design of steel structures' (EC3). However, it can also serve very well as a guide for the selection of suitable stainless steels with regard to corrosion for components that are not subject to EC3. Nevertheless it should be noted that for non-structural applications, other grades beyond those in Table 4 are also possible and common. [3], [13]

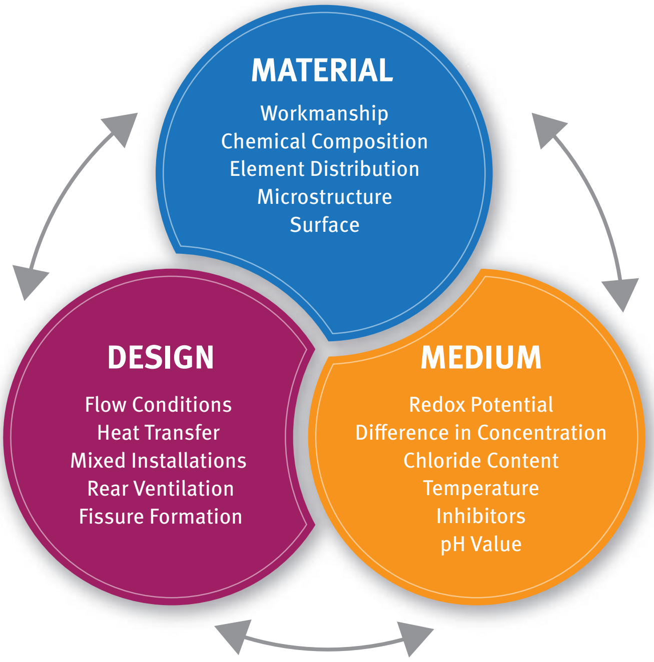
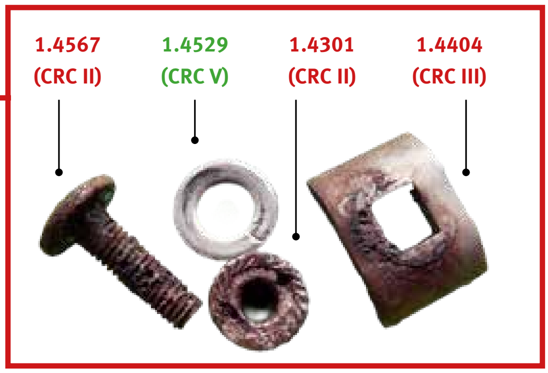


Figure 5:
Corrosion System

Figure 6:
Fasteners for lighting and cable support systems in a road tunnel with severe corrosion attack after eight years of use



CRC II: Pitting and Crevice Corrosion, substantial loss of cross-section

CRC III: Pitting and Crevice Corrosion

CRC V: Corrosion-free

No bimetallic corrosion!

3.1 Selection of a steel grade according to DIN EN 1993-1-4, Annex A

The explanatory notes on the guideline for material selection in accordance with Eurocode 3, Annex A given in this leaflet are primarily intended to help to understand the approach. Errors cannot be totally excluded. Therefore, the standard should always be used as a basis for specific applications.

The selection of a steel grade in accordance with DIN EN 1993-1-4 [1] is carried out in three steps, whereby some basic boundary conditions must be observed in advance (see info box „Basic boundary conditions and definitions“).

Attention: The procedure must not be used for constructions that are intended to be used in indoor swimming pool atmospheres. In this case, please refer to section 3.2.

Proceed as follows for all other load-bearing parts:

Step 1: Calculation of the corrosion resistance factor CRF

Step 2: Determination of the corrosion resistance class CRC

Step 3: Selection of a stainless steel grade whilst taking into account the determined CRC.

Basic boundary conditions and definitions:

The availability of grades or products, connection or joining methods as well as surface requirements[1] are not addressed.

- The application environment is close to the neutral pH value range (pH 4 to pH 10)[2,3].
- The components are not directly or only partially exposed to a chemical-technological or a chemical process.
- The components are not permanently or frequently immersed in seawater.
- The components are free of heat tinting, extraneous rust generating particles, etc.
- Applying the procedure for environments in regions outside Europe may be subject to additional uncertainties.
- An indoor area is an area that is located within closed doors or that is either ventilated or heated. All other areas are considered outdoor. Car parks, loading bays or other structures with large openings are also considered outdoor areas.
- This method should only be used for components that are exposed to the outside. CRF = 1 applies to indoor areas

Important notice: Indoor swimming pools are special cases of indoor areas (see section 3.2).

[1] The condition of surfaces can have a decisive influence on durability (see also [20]). If visual requirements are important for a component, a suitable surface finish may be specified in accordance with the product standard.
[2] Concrete, masonry and wood are not covered by DIN EN 1993-1-4, so this pH value restriction does not apply to these areas of application with higher pH values. However, stainless steels are perfectly suitable for applications above a pH value of 10. This has been proven by many years of experience and extensive tests. The abZ/aBG Z-30.3-6 takes this into account for reinforcements and anchorages [2]. Guidelines for the selection of stainless steels for fastenings in concrete or masonry can be found in DIN EN 1992-1-1 [21] and DIN EN 1996-1-1 [22] (in conjunction with the respective National Annex).
[3] See also info box „Influence of pH value on material selection in construction“

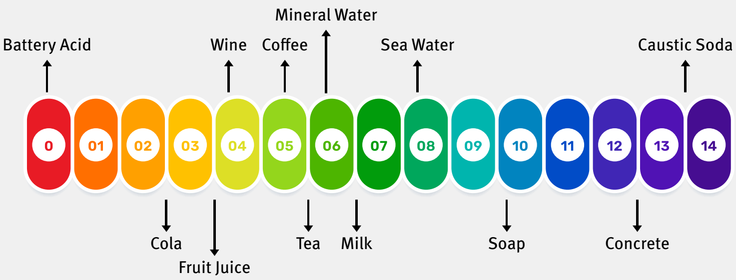
Influence of the pH value on material selection in the construction industry

A pH value range of 4 to 10 is assumed in EC 3 for the applicability of the material selection procedure with regard to the application environment. In practice, this restriction often leads to uncertainties and questions regarding the contact of stainless steels with alkaline building materials such as concrete and mortar or acidic building materials such as wood, which may lie outside the specified pH range.

- Under the typical boundary conditions in the construction industry, no higher requirements can be derived for stainless steels in direct contact with alkaline building materials, such as anchoring and fasteners, or in indirect contact, for example through run-off water from these building materials, than can be derived from the application of the procedure for material selection in accordance with EC 3.
- In case of contact with alkaline building materials such as concrete and mortar with pH values of 10 to 14, CRC II materials are generally sufficient if there are no other relevant exposures in accordance with EC 3.
- In case of components that penetrate the concrete or mortar, the requirements for material selection result directly from the procedure described in EC 3. These are also applicable accordingly for contact with building materials with pH values above 10. If there is a high risk of exposure to chlorides and at the same time a low risk of exposure to sulphur dioxide, at least a CRC III should be selected for this case.
- For components that are completely surrounded by concrete or mortar, the material requirement resulting from EC 3 can generally be reduced by one CRC, as the ambient conditions cannot have a direct effect on the stainless steel, although at least a CRC II material shall be selected. Only when completely encased in concrete in accordance with DIN EN 1992 [21] a reduction to corrosion resistance class CRC I can be made.
- In contact with building materials with pH values below 4 (e.g. hardwood), a material of at least CRC II should be selected for weather exposed outdoor areas, unless a higher corrosion resistance class is required for other reasons.
- Acidic surface films that form in the environment (e.g. due to harmful gases such as SO_2, NO_x or Cl_2 in the atmosphere) can also reach pH values of less than 3 on the surface of stainless steels. In the absence of chlorides, CRC III stainless steels are sufficiently resistant even under these conditions. If there is also a very high risk of exposure to chlorides, the corrosion protection requirements increase significantly. When using the EC 3 material selection procedure, CRC V materials must be used under conditions such as those found in road tunnels or indoor swimming pools, unless regular cleaning is carried out.
- In the absence of chlorides, austenitic stainless steels of CRC III and higher can therefore be used in the construction industry practically in the pH value range of 1 to 14. This does not apply to direct exposure to concentrated acids and bases in other sectors, such as parts and components in chemical processing plants.

pH value

The pH value, in a range from 0 to 14, is a measure of the hydrogen ion concentration and therefore of the acid concentration in aqueous solutions. The lower the pH value, the more acidic the solution; the higher the pH value, the more alkaline the solution.



3.1.1 Calculation of the CRF

When calculating the CRF, the atmosphere surrounding the component is assessed on the basis of three influence quantities, which are then summed up. The CRF thus represents the stress side.

$$CRF = F1 + F2 + F3$$

F1: accounting for risk of exposure to chlorides from salt water or deicing salts

F2: accounting for risk of exposure to sulphur dioxide

F3: accounting for cleaning regime or exposure to washing by rain

For the determination of the three summands F1, F2 and F3, Table 1, Table 2 and Table 3 are to be used.

Important: Not all parts of a structure need to be assigned to the same CRF. For example, some may be exposed to the weather while others are protected from the rain. Therefore, each case of exposure must be assessed separately.

Note: The National Annex may specify whether a less severe CRF may be selected if validated local experience or test data support a different choice.

Table 1: Determination of the risk of exposure to chlorides F1 of the corrosion resistance factor CRF according to [1]

F1 – Risk of exposure to chlorides from salt water or de-icing salts (road salt)		
1	Internally controlled environments	
0	Low risk of exposure	M > 10 km or S > 0,1 km
-3	Medium risk of exposure	1 km < M ≤ 10 km or 0,01 km < S ≤ 0,1 km
-7	High risk of exposure	0,25 km < M ≤ 1 km or S ≤ 0,01 km
-10	Very high risk of exposure	Road tunnels where de-icing salt is used or where vehicles might carry de-icing salts into the tunnel.
-10	Very high risk of exposure	North Sea coast of Germany and all Baltic coastal areas
-15	Very high risk of exposure	M ≤ 0,25 km 1) Atlantic coast line of Portugal, Spain and France. English Channel and North Sea Coastline of UK, France, Belgium, Netherlands and Southern Sweden. All other coastal areas of UK, Norway, Denmark and Ireland. Mediterranean Coast

Note: M is distance from the sea and S is distance from roads with de-icing salts

1) The distance M ≤ 0.25 km assumes the structure is not sheltered by ground topography. If the topography provides partial shelter to the structure, experience shows a grade from one lower class may be used. Examples of sheltering include structures built over inlets or estuaries with limited wave heights and permanent physical barriers such as trees, hills and other buildings within the 0.25 km zone.

Table 2: Determination of the risk of exposure to sulphur dioxide F2 of the corrosion resistance factor CRF according to [1]

F2 – Risk of exposure to sulphur dioxide		
0	Low risk of exposure	< 10 µg/m³ average gas concentration
-5	Medium risk of exposure	10 µg/m³ to 90 µg/m³ average gas concentration
-10	High risk of exposure	90 µg/m³ to 250 µg/m³ average gas concentration

Note: For European coastal environments the sulphur dioxide concentration is usually low. For inland environments the sulphur dioxide concentration is either low or medium. The high classification is unusual and associated with particularly heavy industrial locations or specific environments such as road tunnels. Sulphur dioxide concentration can be evaluated according to the method in EN ISO 9225. Ferritic stainless steels demonstrate increased sensitivity to sulphur dioxide

Table 3: Determination of the influence of cleaning or rain F3 of the corrosion resistance factor CRF according to [1]

F3 – Cleaning regime or exposure to washing by rain	
0	Fully exposed to washing by rain
-2	Specified cleaning regime
-7	No washing by rain or no specified cleaning

Note: Wenn F1 + F2 ≥ 0, then F3 = 0
Note: If the component is to be regularly inspected for any signs of corrosion and cleaned, this should be made clear to the user in written form. The inspection, cleaning method and frequency should be specified. The more frequently cleaning is carried out, the greater the benefit. The frequency should not be less than every 3 months. Where cleaning is specified, it should apply to all parts of the structure, and not just those easily accessible and visible.

Table 4: Determination of the corrosion resistance class CRC and assignment of the corresponding steel grades according to [1]

CRF	CRC	Steel Grade [1]	Structure
CRF = 1	I - low	1.4003	Ferritic[2]
		1.4016	Ferritic[2]
		1.4512	Ferritic[2]
0 ≥ CRF > -7	II - moderate	1.4301	Austenitic
		1.4307	Austenitic
		1.4311	Austenitic
		1.4541	Austenitic
		1.4318	Austenitic
		1.4306	Austenitic
		1.4567	Austenitic
		1.4482	Austenitic-Ferritic
		1.4621	Ferritic[2]
		1.4622	Ferritic[2]
		1.4509	Ferritic[2]
		1.4521	Ferritic[2]
-7 ≥ CRF > -15	III - medium	1.4401	Austenitic
		1.4404	Austenitic
		1.4435	Austenitic
		1.4571	Austenitic
		1.4429	Austenitic
		1.4432	Austenitic
		1.4162	Austenitic-Ferritic
		1.4362	Austenitic-Ferritic
		1.4062	Austenitic-Ferritic
		1.4578	Austenitic
		1.4420	Austenitic
-15 ≥ CRF ≥ -20	IV - high	1.4439	Austenitic
		1.4462	Austenitic-Ferritic
		1.4539	Austenitic
		1.4662	Austenitic-Ferritic
CRF < -20	V - very high	1.4565	Austenitic
		1.4529	Austenitic
		1.4547	Austenitic
		1.4410	Austenitic-Ferritic
		1.4501	Austenitic-Ferritic
		1.4507	Austenitic-Ferritic

3.1.2 Determining the CRC and selecting the steel grade

There is a total of five corrosion resistance classes, ranging from I (low corrosion resistance) to V (very high corrosion resistance). Using the calculated CRF, the minimum required corrosion resistance class can be determined from table 4, and a steel grade can then be selected that is assigned to the required CRC or a higher one. However, selecting a higher CRC is usually not cost-effective.

The CRC stands for alloy-dependent corrosion resistance.

In the following the correct CRC is determined using the example of fasteners for lighting and cable support systems in road tunnels (see Figure 6).

Road tunnels with chloride import
(Table 1):
F1 = -10

High risk of exposure to sulphur dioxide
(Table 2 incl. note)
F2 = -10

No wash-off by rain and no specific cleaning concept (Table 3):
F3 = -7

For the CRF this results in a value of:
CRF = -10 - 10 - 7 = -27

This means that a steel grade from CRC V must be selected (Table 4).

Notes:
[1] A grade from a higher class may be used in place of the class indicated by the CRF.
[2] The fracture toughness of ferritic stainless steels should be checked for external applications, see 5.1.3 in [1].

3.2 Indoor swimming pool atmosphere

Stainless steels are often used in the construction and furnishing of indoor swimming pools and in the renovation of swimming pools. A distinction is made between pool areas that are predominantly exposed to wet corrosion and components that are predominantly exposed to atmospheric corrosion. In the latter case, a distinction is also made between non-load-bearing and load-bearing components. [23]

Load-bearing components in indoor swimming pool atmospheres that are not or only rarely rinsed or cleaned are exposed to conditions under which pitting corrosion, crevice corrosion and, in particular, stress corrosion cracking can occur.

Even surfaces that are a far from the pool can be damaged by chloride-containing compounds in the ambient air. Repeated drying of splash water from the pool area or the deposition of fine mist droplets can lead to a highly concentrated and highly corrosive chloride-containing layer on the component surfaces, which exceeds the resistance of many steel grades. This is particularly critical for components whose failure could lead to personal injury. These include, for example, holders for drop lights and loudspeakers, fastening elements for suspended ceilings (Figure 7) as well as rods and wire ropes for fastening air shafts, water slides or other structural elements. [24]

Therefore, only the corrosion resistance classes listed in Table 5 are permitted for use in indoor swimming pool atmospheres for load bearing components as well as fasteners, connectors and threaded parts.

Figure 7: Serious accident in the indoor swimming pool in Uster (Switzerland) in 1985, in which numerous people died due to the collapse of the suspended ceiling. The cause was stress corrosion cracking on the Cr-Ni steel (CRC II) suspension brackets. The surfaces of the broken brackets show varying degrees of advanced corrosion. The bracket on the right shows severe necking with a typical sliding fracture surface and has probably borne the longest. A slight necking is still visible on the middle bracket.

Table 5:
Steel grades for indoor swimming pool atmospheres according to [1]

Load-bearing parts in swimming pool atmosphere	Corrosion resistance class (CRC)
Load bearing members which are regularly cleaned	CRC III or CRC IV
Load bearing members which are not regularly cleaned	CRC V (excluding 1.4410, 1.4501 and 1.4507)
All fixings, fasteners and threaded parts	CRC V (excluding 1.4410, 1.4501 and 1.4507)

Note: If the component is to be regularly inspected for any signs of corrosion and cleaned, this should be made clear to the user in written form. The inspection, cleaning method and frequency should be specified. The more frequently cleaning is carried out, the greater the benefit. The frequency should not be less than every week. Where cleaning is specified, it should apply to all parts of the structure, and not just those easily accessible and visible.

3.3 Mechanical fasteners

Stainless steel bolts and nuts as well as general rules for the selection of stainless steels for fasteners are regulated in the standards DIN EN ISO 3506-1 [18], DIN EN ISO 3506-2 [19] and DIN EN ISO 3506-6 [25]. However, the screw materials in these standards are not designated with material numbers, as known from DIN EN 10088-1, for example, but with letter-digit combinations to which specified limit values for the chemical composition are assigned.

The letter stands for the group of stainless steels and the number indicates the range of chemical composition within the group. Table 6 contains an overview of the grades according to DIN EN ISO 3506-1 [18].

Table 6:

Grades of stainless steels for mechanical fasteners according to [18]

Grades of stainless steels		Chemical Composition[1] (melt analysis, mass fraction in %)[2]										Other elements and remarks
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	N	
Austenitic	A1	0,12	1,00	6,5	0,020	0,15 to 0,35	16 to 19,0	0,70	5,0 to 10,0	1,75 to 2,25	-	[3), 4), 5)]
	A2	0,10	1,00	2,00	0,050	0,030	15,0 to 20	-[6]	8,0 to 19,0	4,0	-	[7), 8)]
	A3	0,08	1,00	2,00	0,045	0,030	17,0 to 19,0	-[6]	9,0 to 12,0	1,00	-	5C ≤ Ti ≤ 0,80 and/or 10C ≤ Nb ≤ 1,00
	A4	0,08	1,00	2,00	0,045	0,030	16,0 to 18,5	2,00 to 3,00	10,0 to 15,0	4,0	-	[8), 9)]
	A5	0,08	1,00	2,00	0,045	0,030	16,0 to 18,5	2,00 to 3,00	10,5 to 14,0	1,00	-	5C ≤ Ti ≤ 0,80 and/or 10C ≤ Nb ≤ 1,00 [9]
	A8	0,030	1,00	2,00	0,040	0,030	19,0 to 22,0	6,00 to 7,0	17,5to 26,0	1,50	-	-
Martensitic	C1	0,09 - 0,15	1,00	1,00	0,050	0,030	11,5 to 14,0	-	1,00	-	-	[9]
	C3	0,17 - 0,25	1,00	1,00	0,040	0,030	16,0 to 18,0	-	1,50 - 2,50	-	-	-
	C4	0,08 - 0,15	1,00	1,50	0,060	0,15 to 0,35	12,0 to 14,0	0,60	1,00	-	-	[3), 9)]
Ferritic	F1	0,08	1,00	1,00	0,040	0,030	15,00 to 180	-[6]	1,00	-	-	[10]
Duplex	D2	0,040	1,00	6,0	0,040	0,030	19,00 to 24,00	0,10 to 1,00	1,50 to 5,5	3,00	0,05 to 0,20	Cr + 3,3Mo + 16N ≤ 24,0 [11]
	D4	0,040	1,00	6,0	0,040	0,030	21,00 to 25,00	0,10 to 2,00	1,00 to 5,5	3,00	0,05 to 0,30	Cr + 3,3Mo + 16N › 24,0 [11]
	D6	0,030	1,00	2,00	0,040	0,015	21,0 to 23,0	2,50 to 3,5	4,5 to 6,5	-	0,08 to 0,35	-
	D8	0,030	1,00	2,00	0,035	0,015	24,0 to 26,0	3,00 to 4,5	6,0 to 8,0	2,50	0,20 to 0,35	W ≤ 1,00

Note:

1) According to material standards, values are maximum unless otherwise indicated and the number of digits shown is in accordance with usual rules, see e.g. EN 10088 (all parts)
2) In case of dispute, product analysis applies.
3) Selenium can be used to replace sulphur, however restrictions may apply to its use.
4) If the nickel content is below 8,0 %, the minimum manganese content shall be 5,0 %.
5) There is no minimum limit for the copper content provided that the nickel content is greater than 8,0 %.
6) Molybdenum may be present at the discretion of the manufacturer. However, if for some applications limiting of the molybdenum content is essential, this shall be stated at the time of ordering by the purchaser.
7) If the chromium content is below 17,0 %, the minimum nickel content should be 12,0 %.
8) For austenitic stainless steels having a maximum carbon content of 0,030 %, nitrogen may be present but shall not exceed 0,22 %.
9) At the discretion of the manufacturer the carbon content may be higher as necessary in order to obtain the specified mechanical properties for larger diameters, but shall not exceed 0,12 % for austenitic steels.
10) Titanium and/or niobium may be included to improve corrosion resistance.
11) This formula is used solely for the purpose of classifying duplex steels in accordance with this document (it is not intended to be used as a selection criterion for corrosion resistance.

3.3.1 Corrosion resistance classes for fasteners

In Table 7, bolt grades are assigned to the corrosion resistance classes (CRC). An assignment of stainless steels approved in DIN EN 1993-1-4 [1] to the grades from DIN EN ISO 3506-1 [18] and the corrosion resistance classes can also be found in Table 2 of Annex 2 of abZ/aBG Z-30.3-6 [2]. For use in environments with low corrosive exposure (CRC I), a stainless ferritic steel is also approved for fasteners [2].

According to DIN EN 1993-1-4 [1], stainless steel bolts and nuts should comply with the standards EN ISO 3506-1 and EN ISO 3506-2. This means that only the bolt materials listed in Table 7 are approved for load bearing components in accordance with Eurocode 3. The corrosion resistance of bolts should be equal to or better than that of the base material.
Washers should be made of stainless steel and manufactured in accordance with the standards EN ISO 7089 [26] or EN ISO 7090 [27].

For components that are not subject to the rules of EC3, grades from Table 4, assigned to the respective corrosion resistance class, can also be used for bolts, nuts and washers (see also info box „Load bearing components“ on p. 19).

3.3.2 Combinations of stainless steels for fasteners

When using bolts with nuts and washers, the same type of stainless steel should be paired to ensure corrosion resistance (e.g. A2 nut with A2 bolt).
Other combinations such as A4 nut with D4 bolt are always possible. Combinations of A2 with A4 are also possible, provided that

- the component with the lower corrosion resistance corresponds to the CRC required under the conditions of use and is therefore sufficiently corrosion-resistant and
- the risk of the screw seizing should be considered.

In cases of doubt, a materials expert should be consulted.

When combining stainless steels with unalloyed or low-alloy steels in bolted joints, the use of insulating parts should be considered to avoid bimetallic corrosion (see also section 4.3 and [18]).

Table 7: Classification of bolt materials into corrosion resistance classes in accordance to [1]

Corrosion Resistance Class (CRC)	Austenitic	Austenitic-Ferritic (Duplex)
I	-	-
II	A2, A3	D2
III	A4, A5	D4
IV	A8	D6
V	A8 1)	D8 1)

Note:
1) The specific case of stress corrosion cracking of stainless steel structural components in swimming pools is addressed in EN 13451-1: the only grades which are recommended unreservedly for this application and available as fasteners fall into the A8 grade. [25]

4 Factors influencing corrosion resistance

Some factors that can have an influence on corrosion resistance are listed below. The list makes no claims to completeness. abZ/aBG Z-30.3-6 [2], DIN EN 1993-1-4 [1] and [12] also provide information and details.

4.1 Welded or Thermally Cut Parts

Post-treatment of weld seams and cut edges to remove heat tinting is required. All annealing colours, including straw yellow and lighter, should be removed.
Areas in which heat tinting cannot be removed should be positioned in such a way that they are completely sealed by the weld seam.
Further information on this is given in abZ/aBG Z-30.3-6 [2], [28] and [29].

4.2 Extraneous Rust

Particles that cause extraneous rust shall not get in contact with surfaces of stainless steels. When machining stainless steels or removing surface discolouration, tools that have previously been used to work on unalloyed or low-alloy steel, or wire brushes made from such steels, shall therefore not be used. If this is not possible, the surface must subsequently be reworked to remove the particles that cause extraneous rust (e.g. by grinding or pickling).

4.3 Bimetallic Corrosion

If different metals come into contact in a structure, bimetallic corrosion (also known as contact corrosion or galvanic corrosion) can occur. However, it only occurs if a moist film (electrolyte) is present at the contact point and only if this is frequently and persistently moist.
In an aqueous environment (including soil), bimetallic corrosion is more significant than in the atmosphere, where it can only be effective if moisture is present.
If air pollution, hygroscopic salts, constantly damp deposits, self-absorbing seals or constantly damp gaps are present, damage is possible even under conditions of otherwise harmless atmospheric stress.
When stainless steel comes into contact with less noble metals such as unalloyed or low-alloy structural steel, galvanised steel or aluminium, there is only a risk of bimetallic corrosion for the less noble metals; it practically does not occur on stainless steels themselves. Even the combination of alloys with different CRCs cannot lead to bimetallic corrosion as long as it is ensured that the lower CRC satisfies the required corrosion resistance under the conditions of use.
ISER data sheet 829 [30] summarises a lot of basic information on the subject of bimetallic corrosion. It also contains information on preventive measures. [1], [12] and [2] also provide information and explanations.

4.4 Liquid metal-induced stress corrosion cracking

When stainless steels come into contact with liquid zinc or copper, the liquid metals can intrude into the steel along the grain boundaries, leading to the risk of immediate embrittlement and component failure. This form of damage is known as liquid metal-induced stress corrosion cracking or solder embrittlement. For this reason, hot-dip galvanising of stainless steels is generally not permitted. [1]
Constructions must be designed in such a way that no liquid zinc can drip from galvanised components onto the surfaces of stainless steels in the event of fire, unless the embrittlement of the stainless steel does not impair the stability of the structure in the specific case. Abrasion of zinc and copper on steel surfaces can also lead to solder embrittlement if, for example, the contaminated component is heated to a high temperature during further processing (e.g. heat treatment, welding).

4.5 Washing by rain

If „Fully exposed to washing by rain“ (see also Table 3) is selected as the cleaning concept, it must be ensured that all parts of a structure can be reached by rain. Otherwise, due to the lack of a specific cleaning concept, there is a risk that corrosion-causing substances will be deposited and accumulate on the component surface due to the entry of aerosols and evaporation and subsequently cause corrosion.
Therefore, if it cannot be ensured that each individual part is completely washed off by rain, a specific cleaning concept must be drawn up (see Table 3 incl. notes).

4.6 Welding of high-carbon grades

Steels with a carbon content of more than 0.030 % by mass (e.g. 304/1.4301, 316/1.4401) can be sensitised during joining by welding and thus tend to intergranular corrosion (IC) if they are not stabilised by titanium (Ti) or niobium (Nb). Thick-walled parts should therefore not be manufactured from these grades if welding is the intended joining technology. The maximum thicknesses according to Annex 6, Table 8 of abZ/aBG Z-30.3-6 [2] should be noted.

4.7 Sulphur-alloyed grades – „Machining grades“

Some grades of stainless steels (e.g. 303/1.4305 and 1.4598) are alloyed with sulphur, which results in improved machinability compared to standard grades. Chips break off more easily at the sulphide precipitations that form, making it easier to manufacture mass-produced parts or parts that require a high level of machining. However, the use of machining grades must be carefully checked with regard to the area of application, temperature, corrosive media, any chloride loads, etc. Due to cases of damage and from a normative point of view, there are some restrictions on the use of these grades.
Above all, they exhibit reduced corrosion resistance compared to similar grades, although this cannot be recognised on the basis of the pitting resistance equivalent (PRE) number. The sulphide precipitations promote the start of pitting corrosion.
Furthermore, sulphur-alloyed grades are not suitable for pressure vessels or contact with foodstuff, may not fulfil European Directive 94/27 with regard to skin compatibility for humans and are also not approved for load-bearing applications in the construction sector in accordance with abZ/aBG Z-30.3-6 [2].

4.8 Further general information

Surfaces (see also [20], [28], [31], [32]):

- Surfaces with a roughness average of less than 0.5 µm have a significantly higher corrosion resistance than rougher surfaces.
- Stainless steel is to be stored and processed separately from other steels
- Do not use the same tools for stainless steel and other steels
- Clean processing machines beforehand
  Do not use steel wool or brushes, only those made of stainless steel
- Avoid contact between rusting steel and stainless steel
- Do not use foils containing chloride (e.g. PVC)

Cleaning/Care (see also [33]):

- Regular removal of deposits
- Remove protective films timely
- Carry out basic cleaning after completion of a work
- Do not use cleaners containing chlorides
- Remove paint splashes with solvents

Gaps and Welding Defects (see also [20]):

- Avoid corrosion due to gaps and welding defects (Figure 8:).
- Gaps between stainless steels and non-conductors are particularly susceptible to corrosion
- Gaps under deposits of airborne substances are also particularly susceptible to corrosion

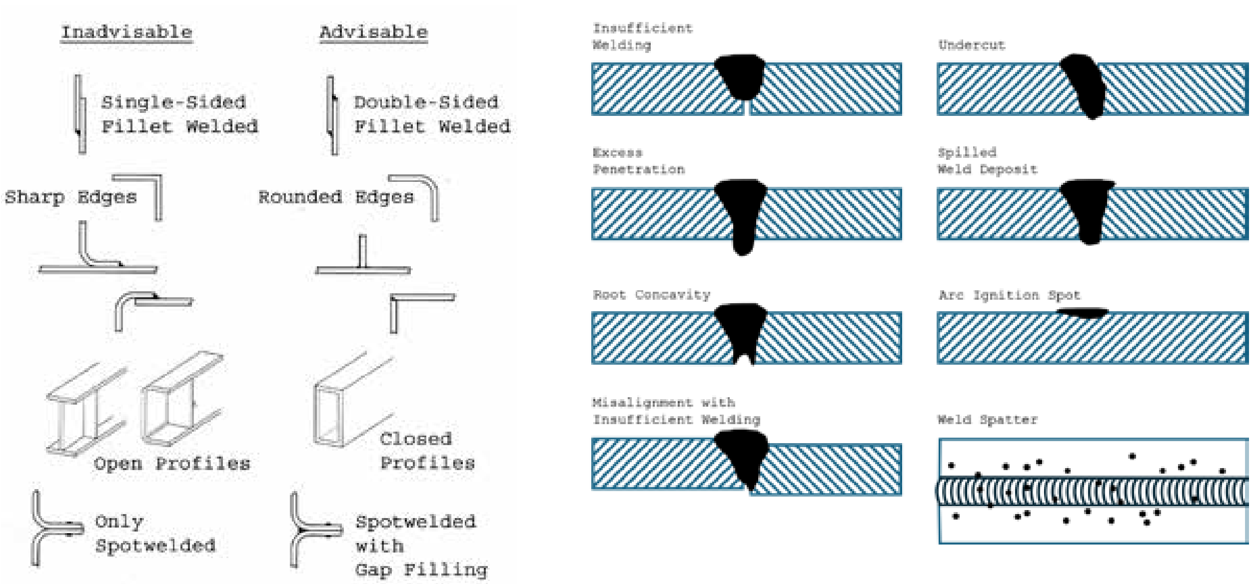


Figure 8: Constructions with a gap to avoid and recommended alternatives (left) and examples of welding defects to avoid (right)

5 Literature

All ISER brochures are available for free download at **www.edelstahl-rostfrei.de/publikationen**

[1] DIN EN 1993-1-4:2026-04 - Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 1-4: Tragwerke aus nichtrostenden Stählen, Berlin: DIN Media, 2026.

[2] Sonderdruck 862 - Allgemeine bauaufsichtliche Zulassung Z-30.3-6 vom 20. April 2022 „Erzeugnisse, Bauteile und Verbindungselemente aus nichtrostenden Stählen“, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2022.

[3] DIN EN 10088-1:2024-04 - Nichtrostende Stähle - Teil 1: Verzeichnis der nichtrostenden Stähle; Berlin: DIN Media, 2024.

[4] SEW 390:1991-11 – Nichtmagnetisierbare Stähle – Technische Lieferbedingungen, Stahl-Eisen-Werkstoffblätter (SEW) des Vereins Deutscher Eisenhüttenleute, Düsseldorf, 1991.

[5] DIN EN 10088-2:2014-12 - Nichtrostende Stähle - Teil 2: Technische Lieferbedingungen für Blech und Band aus korrosionsbeständigen Stählen für allgemeine Verwendung, Berlin: DIN Media, 2014.

[6] DIN EN 10088-3:2024-04 - Nichtrostende Stähle - Teil 3: Technische Lieferbedingungen für Halbzeug, Stäbe, Walzdraht, gezogenen Draht, Profile und Blankstahlerzeugnisse aus korrosionsbeständigen Stählen für allgemeine Verwendung, Berlin: DIN Media, 2024.

[7] EN 10028-7:2016 - Flat Products Made of Steels for Pressure Purposes - Part 7: Stainless Steels, Berlin: DIN Media, 2016

[8] DIN EN 10095:2018-12 - Hitzebeständige Stähle und Nickellegierungen, Berlin: DIN Media, 2018.

[9] DIN EN 10296-2:2006-02 - Geschweißte kreisförmige Stahlrohre für den Maschinenbau und allgemeine technische Anwendungen - Technische Lieferbedingungen - Teil 2: Nichtrostende Stähle, Berlin: DIN Media, 2006.

[10] Merkblatt 821 - Edelstal Rostfrei - Eigenschaften, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2014.

[11] Merkblatt 830 - Edelstahl Rostfrei in chloridhaltigen Wässern, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2012.

[12] N. Stranghöner, N. Baddoo, F. Meza, D. Ulbrich, C. Abraham und D. Jungbluth, Neue Entwicklungen in PrEN 1993-1-4:2022, Stahlbau-Kalender 2023, 2023.

[13] Merkblatt 875 - Edelstahl Rostfrei im Bauwesen: Technischer Leitfaden, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2015.

[14] Merkblatt 987 - Nichtrostende und hitzebeständige Stähle bei hohen Temperaturen, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2020.

[15] DIN EN 10088-4:2010-01 - Nichtrostende Stähle - Teil 4: Technische Lieferbedingungen für Blech und Band aus korrosionsbeständigen Stählen für das Bauwesen, Berlin: DIN Media, 2010.

[16] DIN EN 10088-5:2009-07 - Nichtrostende Stähle - Teil 5: Technische Lieferbedingungen für Stäbe, Walzdraht, gezogenen Draht, Profile und Blankstahlerzeugnisse aus korrosionsbeständigen Stählen für das Bauwesen, Berlin: DIN Media, 2009.

[17] DIN EN 10297-2:2006-02 - Nahtlose kreisförmige Stahlrohre für den Maschinenbau und allgemeine technische Anwendungen - Technische Lieferbedingungen - Teil 2: Rohre aus nichtrostenden Stählen, Berlin: DIN Media, 2006.

[18] DIN EN ISO 3506-1:2020-08 - Mechanische Verbindungselemente - Mechanische Eigenschaften von Verbindungselementen aus korrosionsbeständigen nichtrostenden Stählen - Teil 1: Schrauben mit festgelegten Stahlsorten und Festigkeitsklassen (ISO 3506-1:2020), Berlin: DIN Media, 2020.

[19] DIN EN ISO 3506-2:2020-08 - Mechanische Verbindungselemente - Mechanische Eigenschaften von Verbindungselementen aus korrosionsbeständigen nichtrostenden Stählen - Teil 2: Muttern mit festgelegten Stahlsorten und Festigkeitsklassen (ISO 3506-2:2020), Berlin: DIN Media, 2020.

[20] Merkblatt 828 - Korrosionsbeständigkeit nichtrostender Stähle an der Atmosphäre, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2016.

[21] DIN EN 1992-1-1:2025-09 - Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1-1: Allgemeine Regeln und Regeln für Hochbauten, Brücken und Ingenieurbauwerke, Berlin: DIN Media, 2025.

[22] DIN EN 1996-1-1:2013-02 - Eurocode 6: Bemessung und Konstruktion von Mauerwerksbauten - Teil 1-1: Allgemeine Regeln für bewehrtes und unbewehrtes Mauerwerk, Berlin: DIN Media, 2013.

[23] Merkblatt 831 - Edelstahl Rostfrei in Schwimmbädern, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2016.

[24] A. Burkert, D. Dygutsch, J. Fischer und H.-P. Wilbert, „Einsatz und Pflege von Edelstahl Rostfrei in Schwimmbädern,“ AB Archiv des Badwesens, p. 610 ff., 10 2014.

[25] DIN EN ISO 3506-6:2022-09 - Mechanische Verbindungselemente – Mechanische Eigenschaften von Verbindungselementen aus korrosionsbeständigen nichtrostenden Stählen – Teil 6: Allg. Regeln f. d. Auswahl von nichtrostenden Stählen u. Nickellegierungen für Verbindungselemente, Berlin: DIN Media, 2022.

[26] EN ISO 7089:2000 - Plain washers - Normal series, Product grade A, Berlin: DIN Media, 2000

[27] EN ISO 7090:2000 - Plain washers, chamfered - Normal series, Product grade A, Berlin: DIN Media, 2000

[28] Merkblatt 823 - Schweißen von Edelstahl Rostfrei, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2019.

[29] Merkblatt 986 - Visuelle Beurteilung von Schweißnähten bei nichtrostendem Stahl - ein bebilderter Leitfaden, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2020.

[30] Merkblatt 829 - Edelstahl Rostfrei in Kontakt mit anderen Werkstoffen, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2026.

[31] Merkblatt 822 - Die Verarbeitung von Edelstahl Rostfrei, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2012.

[32] Merkblatt 968 - Mechanische Oberflächenbehandlung nichtrostender Stähle in dekorativen Anwendungen, Brüssel: Euro Inox, 2006.

[33] Merkblatt 824 - Die Reinigung von Edelstahl Rostfrei, Düsseldorf: Informationsstelle Edelstahl Rostfrei, 2024.

Notes

Informationsstelle Edelstahl Rostfrei
Sohnstraße 65
40237 Düsseldorf
www.edelstahl-rostfrei.de