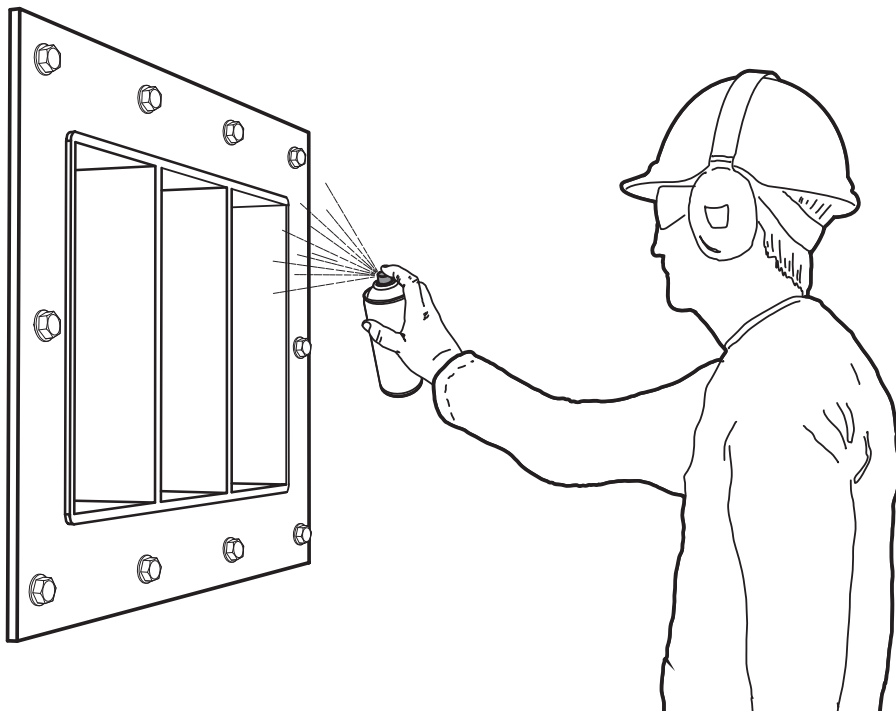


Description and application guidelines

Roxtec material and surface treatment guide



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Abstract

Roxtec cable and pipe sealing solutions are designed to be installed in a variety of conditions covering the roughest marine and offshore environments as well as advanced buildings and train sets. The intention of this document is to give the reader a general idea of the suitability of specific frame materials and surface treatments used for Roxtec frame parts for specific applications and requirements.

For product descriptions and auxiliary information, see www.roxtec.com

1 Metals used

The majority of the frames produced by Roxtec is in metal. To cover most customer demands, the primary materials are mild steel, acid-proof stainless steel and aluminum. For specific requirements in aggressive areas such as chemical plants, offshore or process industries, other materials or higher grades might be better in the design. This could be to match a specific hull material to simplify welding or a high-end stainless steel for salt and wastewater.

1.1 Welded frames

Welded frames are generally produced from profiles that are welded together to form single or multiple openings. This opening is defined to fit the sealing components used to achieve the tightness and fire properties of the complete system. To make sure the welding operation is reliable and of high quality, Roxtec follows standards EN ISO 5817-C and EN ISO 10042-C. Table 1 shows the chemical composition of the standard material. Equivalent materials of other standards can be found in Appendix A.



Table 1. Materials used in welded frames.

Mild steel	C %	Si %	Mn %	P %	S %	Cu %		
EN S355J2	≤ 0.22	≤ 0.55	≤ 1.6	≤ 0.03	≤ 0.03	≤ 0.55		
Acid-proof stainless steel	C %	Cr %	Ni %	Mo %	Mn %			
EN 1.4404	≤ 0.03	16.5–18.5	10–13	2–2.5	≤ 2			
Aluminum	Si %	Mn %	Cu %	Cr %	Fe %	Mg %	Zn %	Ti %
EN AW-6082 T6	0.7–1.3	0.4–1.0	≤ 0.1	≤ 0.25	≤ 0.5	0.6–1.2	≤ 0.2	≤ 0.1
EN AW- 5754 H12/22	≤ 0.4	≤ 0.5	≤ 0.1	≤ 0.3	≤ 0.4	2.6–3.6	≤ 0.2	≤ 0.15

1.2 Pipe sleeves

Pipe sleeves are mainly produced by extrusion to obtain the required tolerance as standard pipes often have a too wide tolerance. Larger pipe sleeves are rolled from flat bars or sheet metal and closed by welding. To make sure the welding operation is reliable and of high quality, Roxtec follows standards EN ISO 5817-C and EN ISO 10042-C. Table 2 shows the chemical composition for the standard material. Equivalent materials of other standards can be found in Appendix A.



Table 2. Materials used in pipe sleeves.

Mild steel	C %	Si %	Mn %	P %	S %	Cu %
EN S355J2	≤ 0.22	≤ 0.55	≤ 1.6	≤ 0.03	≤ 0.03	≤ 0.55
EN E355	≤ 0.22	≤ 0.55	≤ 1.6	≤ 0.025	≤ 0.025	-

Acid-proof stainless steel	C %	Cr %	Ni %	Mo %	Mn %
EN 1.4404	≤ 0.03	16.5–18.5	10–13	2–2.5	≤ 2

Aluminum	Si %	Mn %	Cu %	Cr %	Fe %	Mg %	Zn %	Ti %
EN AW-6082 T6	0.7–1.3	0.4–1.0	≤ 0.1	≤ 0.25	≤ 0.5	0.6–1.2	≤ 0.2	≤ 0.1
EN AW-6060 T6	0.3–0.6	≤ 0.1	≤ 0.1	≤ 0.05	0.1–0.3	0.35–0.6	≤ 0.15	≤ 0.1
EN AW-5754 H12/22	≤ 0.4	≤ 0.5	≤ 0.1	≤ 0.3	≤ 0.4	2.6–3.6	≤ 0.2	≤ 0.15

1.3 Fittings and stayplates

Stayplates and fittings used for anchoring of sealing modules and frames are produced from coiled sheets and plates. The majority of fittings are of acid-proof stainless steel while the stayplates can be in galvanized or acid-proof stainless steel versions. Table 3 shows the chemical composition for the standard material. Equivalent materials of other standards can be found in Appendix A.



Table 3. Materials used in fittings and stayplates.

Mild steel	C %	Si %	Mn %	P %	S %	Cu %
EN S355J2	≤ 0.22	≤ 0.55	≤ 1.6	≤ 0.03	≤ 0.03	≤ 0.55
DX51D-Z275	≤ 0.18	≤ 0.5	≤ 1.2	≤ 0.12	≤ 0.045	≤ 0.3

Acid-proof stainless steel	C %	Cr %	Ni %	Mo %	Mn %
EN 1.4404	≤ 0.03	16.5–18.5	10–13	2–2.5	≤ 2

1.4 Cast and machined frames

Frames cast of aluminum are injection molded and the surface is treated with a powder coat or nickel-plating depending on requirements. Machined frames are manufactured from brass. Table 4 shows the chemical composition for the standard material. Equivalent materials of other standards can be found in Appendix A.

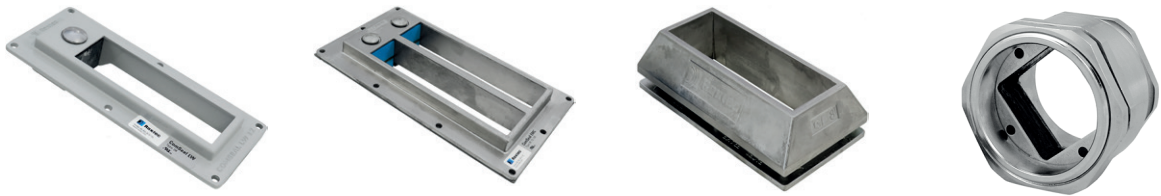


Table 4. Materials used in cast and machined frames.

Aluminum	Si %	Mn %	Cu %	Fe %	Zn %	Ti %
EN AC-44300	10.5–13.5	≤ 0.55	≤ 0.1	≤ 1.0	≤ 0.15	≤ 0.15

Brass	Cu %	Pb %	Fe %	Ni %	Sn %	Al %
CW614N	57–59	2.5–3.5	≤ 0.3	≤ 0.3	≤ 0.3	≤ 0.05

2 Surface treatments

A frame made of acid-proof stainless steel or aluminum does generally not need any additional coating. To facilitate technical needs such as electrical conductivity in the EMC assortment or higher corrosion resistance, there are several standard surface treatments in the product portfolio. The standard surface treatment of the products can be changed in type and color in our customization process to fit application specific demands and requirements.

2.1 Shop primer

To protect mild steel products during transportation to site, a minimum 20µm thick shop primer is applied. This coating reduces surface corrosion during transportation and handling before the welding operation. The shop primer can be welded and does not need to be sandblasted before the welding

operation. After welding it to the structure, it is recommended to coat the frames and sleeves with a paint system in accordance with the environmental conditions and application requirements.

2.2 Hot dipped galvanization

This galvanizing process is done by lowering the metal into a zinc bath. The general thickness of this operation is 85µm in accordance with EN ISO 1461. This is a cost-efficient corrosion protection suitable in most in- and outdoor application areas. If damaged, it can heal itself and it is easy to repair if big portions of the coating are scratched off. Frames with this surface protection are intended to be bolted or cast to the structure.

2.3 Electro-galvanization

The electro-galvanization process also applies a zinc layer but the coating is applied in a thinner way. It is applied by adding a current through the metal piece, attracting the zinc ions to the surface of metal. This creates a much smoother surface than hot dip galvanization. The minimum thickness is 8 µm according to ISO 2081. It works well in weather-protected areas and indoor applications.

2.4 Powder coating

The powder coating gives a great finish and increases the corrosion protection of the metal. Powder coating is applied by placing the metal in a chamber with paint powder. Thereafter the metal is charged electrically to attract an even layer of powder before being put in a hot oven. The melted polyester powder coating thickness is defined by the corrosion requirement.

2.5 Anodizing

Anodized frames are exposed to electrolytic passivation to increase the oxide layer that forms naturally on aluminum. This layer increases the corrosion protection and resistance to wear. The thickness is generally minimum 20µm according to ISO 7599.

2.6 Chemical nickel-plating

By chemically applying a layer of nickel on frames, the resistance against mechanical wear and corrosion is improved. This surface treatment also makes sure the electrical conductivity is sufficient over time to support the efficiency of the EMC products. The chemical nickel-plating is done in accordance with ISO 4527 with a minimum thickness of 10µm.

3 General corrosion classes

When combining different metal and surface treatments, the finished product reaches different corrosion classes. Roxtec frames are tested in accordance with the international standard EN ISO 12944-2 to simplify the choice of system in specific application areas. The environmental conditions can vary over a system's lifecycle so the corrosion classes should only be used as indicative. If in doubt, a higher classed material should be considered. When selecting the proper material it is also important to identify the expected maintenance interval. In accordance with EN ISO 12944-2, the durability determines when the first maintenance is expected to be needed. Periodical visual inspection is recommended on a regular basis if the system is used in corrosive environments.

3.1 Corrosion classes and durability

The materials used in standard Roxtec frames are tested at third party laboratories to determine a corrosion class for atmospheric corrosion in accordance with ISO 12944. This is to be used as a reference

and depends on actual exposure to chemicals and pollution. Special types of aggressive media require higher grades of steel such as Duplex. Table 5 shows the general corrosion classes of the materials used in the frames produced by Roxtec.

Table 5. Corrosion classes for Roxtec frames.

Material	C1 Very low	C2 Low	C3 Medium	C4 High	C5 Very high	CX Extreme	Expected time to first major maintenance*
Steel – Shop primed ¹	X						< 5 years
Steel – Hot dipped galv ²				X			5–15 years
Steel – Electro–galvanized ³			X				5–15 years
Steel – Acid–proof stainless*					X		> 15 years
Steel – Stainless				X			5–15 years
Steel – Powder coated ⁴			X				5–15 years
Aluminum – Marine grade					X		> 15 years
Aluminum – Nickel–plated ⁵			X				5–15 years
Aluminum – Powder coated ⁶			X				5–15 years
Polyamide ⁷				X			5–15 years
ABS				X			> 15 years
AluZink				X			5–15 years
Brass			X				5–15 years

*Acids destroying the passive film accelerate the corrosion and shorten the life expectancy. Uniform corrosion is considered.

- 1) Minimum 20µm of shop primer used for transportation protection.
- 2) Minimum thickness of 70µm of zinc coating according to EN ISO 1461.
- 3) Minimum 8 µm according to ISO2081 (Fe/Zn c1).
- 4) Minimum 40µm. Specified by demand.
- 5) Minimum 10µm according to EN 4527.
- 6) Minimum 50–70µm. Specified by demand.
- 7) Glass–fiber 20–30% reinforced PA 6.6.

The products used for underground systems are designed for a long life underground and are tested for immersion in saltwater and soil. If micro-bacteria or strong chemicals are expected in the groundwater or soil, the material of the fittings must be considered to be of a higher grade than the standard material.

Table 6. Immersed corrosion tests of Roxtec frames.

Material	Im 2	Im 3	Expected time to first major maintenance
Steel – Acid–proof*	X	X	> 15 years
ABS	X	X	> 15 years

*Acids destroying the passive film accelerate the corrosion and shorten the life expectancy. Uniform corrosion is considered.

3.2 Preventive corrosion protection

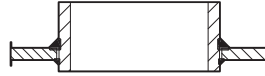
The expected lifetime of an installed Roxtec frame can often be prolonged by taking some simple design precautions.

3.2.1 Welding

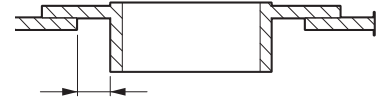
A welded frame that is exposed to humidity and water from both sides benefits from a two-sided weld seam protecting against crevice corrosion, see pictures 1 & 2. The aperture for a flanged frame should not be too tight to the frame walls either as the final coating is easier to apply when a distance of minimum 15mm is respected, see picture 3.



Picture 1. Double-sided weld pass.



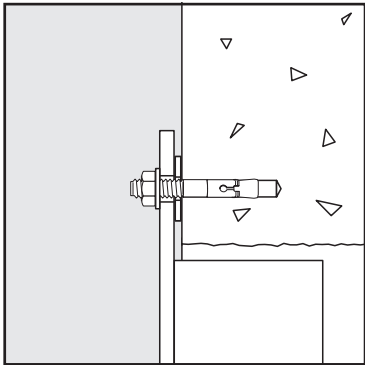
Picture 2. Double-sided weld pass.



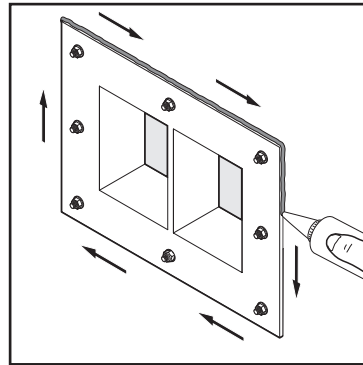
Picture 3. 15mm clearance.

3.2.2 Bolting

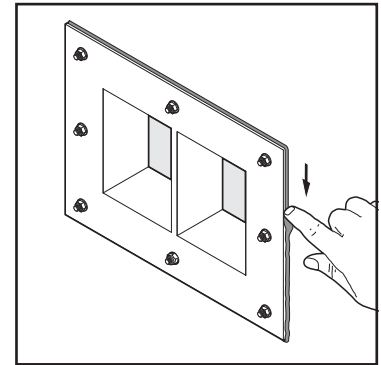
A bolted frame using a gasket or sealant can benefit from a protective string of sealant at the perimeter of the frame. This prevents standing water and crevice corrosion but also frost wedging during wintertime, pictures 4-6.



Picture 4. Gap between structure and frame.



Picture 5. Sealant applied.



Picture 6. Sealant smoothed out.

3.2.3 Fasteners

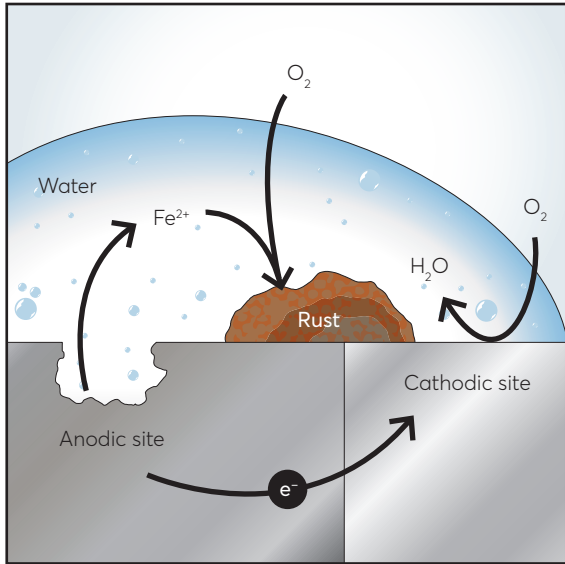
Fasteners should be selected in accordance with the material used in the frame to avoid galvanic corrosion. This means stainless steel fasteners for stainless steel and aluminum frames, and galvanized fasteners for mild steel frames.



3.2.4 Mix of materials

Generally, it is recommended to avoid mixing different types of materials in the same transit. In environments with presence of electrolytes, this can be harmful as galvanic corrosion can occur, making the less noble material corrode. This can be prevented by avoiding standing water or by applying a coating that electrically insulates the materials from each other. Gaskets between flanges and structure also break the electrical contact. If electrical contact is unavoidable, the size of the less noble material should be considerably bigger to reduce corrosion.

For primed and galvanized mild steel frames, it is recommended to use galvanized fasteners and stayplates. Frames in aluminum and stainless steel are recommended to be installed with stainless steel fasteners and stayplates.



Appendix A – Cross-reference table

The table shows comparable grades of different international recognized steel standards. The actual chemistry can differ between standards but the performance of the Roxtec system is not affected.

Welded frames	EN	ASTM	UNS	DIN	KS	GB/T
Mild steel	S355J2	A572-50	K02303	ST52-3N	SM420C	Q355D
Acid-proof stainless steel	1.4404	316L	S31603	1.4404	STS316L	022Cr17Ni12Mo2不锈钢, 316L精钢
Aluminum	AW-6082 T6	6082	A96082	3.2315	6082	6082
	AW-5754 T6	5754	A95754	3.3535	5754	5754

Stayplates	EN	ASTM	UNS	DIN	KS	GB/T
Mild steel	DX51D+ Z275	-	-	DX51D+ Z275	-	-
Acid-proof stainless steel	1.4404	316L	S31603	1.4404	STS316L	022Cr17Ni12Mo2不锈钢, 316L精钢

Pipe sleeves	EN	ASTM	UNS	DIN	KS	GB/T
Mild steel	S355J2	A572-50	K02303	ST52-3N	SM420C	Q355D
	E355					
Acid-proof stainless steel	1.4404	316L	S31603	1.4404	STS316L	022Cr17Ni12Mo2不锈钢, 316L精钢
Aluminum	AW-6082 T6	6082	A96082	3.2315	6082	6082
	AW-6060 T6	6060	A96060	3.3206	6060	6060
	AW-5754 H12/22	5754	A95754	3.3535	5754	5754
Brass	CW614N	C37710	C37710	2.0401		CW614N

Cast frames and pipe sleeves	EN	ASTM	UNS	DIN	KS	GB/T
Acid-proof stainless steel	1.4404	316L	S31600	1.4436	STS316L	-
Aluminum	AC-44300	A413.0	A14130	3.2582	-	-

Note: The temper of the standard material must be respected when comparing materials.

References

- EN ISO 5817 – Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections
- EN ISO 10042 – Welding – Arc-welded joints in aluminium and its alloys – Quality levels for imperfections
- ISO 1461 – Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
- ISO 2081 – Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel
- ISO 4527 – Metallic coatings – Autocatalytic (electroless) nickel-phosphorus alloy coatings – Specification and test methods
- EN ISO 12944 – Paints and varnishes – Corrosion protection of steel structures by protective paint systems
- ISO 7599 – Anodizing of aluminium and its alloys – Method for specifying decorative and protective anodic oxidation coatings on aluminium
- ISO 4527 – Metallic coatings – Autocatalytic (electroless) nickel-phosphorus alloy coatings – Specification and test methods

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(b) Installation shall be carried out in accordance with Roxtec installation instructions in effect from time to time.

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