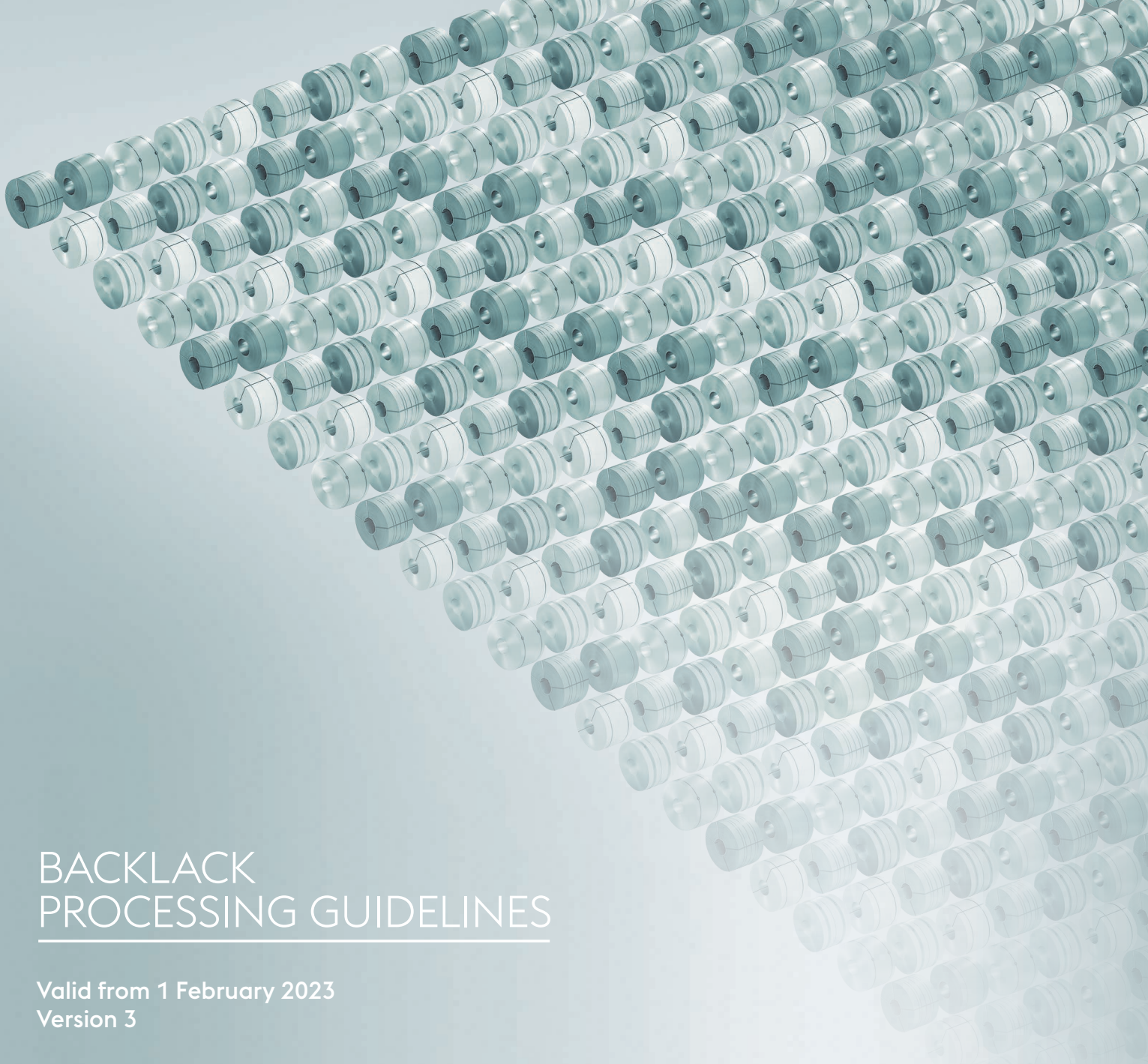

BACKLACK PROCESSING GUIDELINES

Valid from 1 February 2023
Version 3

voestalpine Steel Division
www.voestalpine.com/steel

voestalpine
ONE STEP AHEAD.

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GENERAL

These processing guidelines provide information on the treatment of electrical steel coated with backlack made by voestalpine and apply to Remisol EB 549 rapid and backlack-v®. These processing guidelines set forth the requirements for transport and storage process, regulations for the production of test specimens and parameters for approval-related testing. Please direct any questions to your responsible sales personnel or technical specialist at voestalpine.

TRANSPORT AND STORAGE

The following must be observed for the transport and storage of electrical steel coated with backlack:

- A limit temperature of +40 °C must not be exceeded.
  This limit temperature may be reached for a maximum of one month.
  The recommended storage temperature is +23 °C.
- The period of maximum storage is six months, beginning at the time the material is supplied by voestalpine. Should the customer fail to comply with the contractually agreed acceptance dates of deliveries, the aforementioned storage period shall be reduced accordingly by the duration of acceptance default.
- Dry storage must be ensured, and condensation must be avoided.

The above requirements must be ensured by the customer. Deviations from the above parameters can lead to negative changes in the product and/or processing properties.

GENERAL REQUIREMENTS FOR THE PRODUCTION OF STACKS AND TEST SPECIMENS

- Material straightening must be avoided.
- Stamping aids may not be used.
- The same orientation of cutting and stamping must be maintained when stacking. The height of any cutting or stamping burrs must not exceed 0.03 mm.
- When stacking the individual laminations to test specimens, laminations must be arranged such that the bottom side of the top-most lamination is bonded together with the top side of the second lamination and so farth.
- Local increases in pressure or temperature must be avoided during the adhesive-bonding process.
- Varnish squeeze-out is inspected visually. It is not permitted to deburr specimens for the purpose of assessing varnish squeeze-out.

Between being produced and tested, specimens are stored for at least 24 hours under these conditions: 23 °C ±2 °C and 50 ±10% r.h. (see DIN EN ISO 291).

GEOMETRY OF FLOATING ROLLER TEST SPECIMENS

The floating roller test specimen is made based on EN 1464. The test specimen must measure 25 mm by 200 mm and be at least 3 mm high (regardless of sheet thickness). The long side of the individual laminations is positioned transverse to rolling direction. Exactly one lamination is peeled from each test specimen, regardless of sheet thickness, using the floating roller device outlined in EN 1464. Duplicate specimens must be prepared.

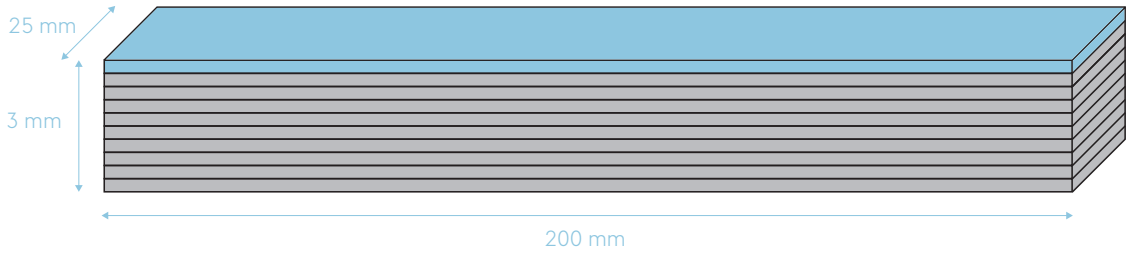

Figure 1: Geometry of test specimens for the testing of adhesion in the floating roller test

GEOMETRY OF TENSILE LAP-SHEAR TEST SPECIMENS

The geometry of test samples is selected pursuant to EN 1465. The tensile lap-shear test is performed in reinforced design for all strip thicknesses, whereas the actual component to be tested is reinforced with two layers of the same material. This serves to assess the actual quality of the bond and to prevent any plastic deformation or fracture of the joined component (see Figure 2). The overlap area is 12.5 mm by 25 mm (sample width). To avoid specimen deformation during the test, support sheets must butt against each other. Any gap is not permissible.

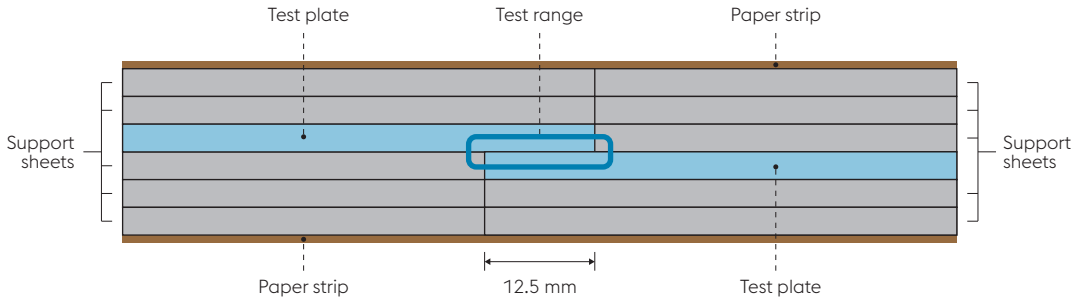

Figure 2: Geometry of test specimens (adapted from EN 1465). The long side of the laminations is in rolling direction.

COMPLETION OF OUTGOING GOODS INSPECTION AT voestalpine

GENERAL

Unless otherwise agreed with the customer, voestalpine conducts initial testing to determine bondability and varnish squeeze-out. The floating roller test is based on EN 1464 for quick bonding. For conventional bonding, bondability is tested using a floating roller test based on EN 1464 or a tensile lap-shear test based on EN 1465 (reinforced).

The adhesion strength is subject to agreement between the customer and voestalpine on a project-specific basis. The following project specifics must be taken into account:

- Type of bonding (quick or conventional) and the respective test method
- Steel grade used
- Varnish and layer thickness used

Adhesion of the varnish in as-delivered condition is tested by means of cross-cutting (based on EN ISO 2409).

Component testing is not conducted by voestalpine.

BAKING OF TEST SPECIMENS: DESCRIPTION OF BONDING PROCESS AND BONDING PARAMETERS FOR QUICK BONDING

Single laminations are bonded using a heating press to form a test specimen for the floating roller test: manufactured by Vogt, component type A00251, including locking device, or heating presses with the same specifications. Before the test specimens are bonded, the locking device is tempered in the heating press. A PTFE film (thickness of 0.25 mm max.), which features adhesive on one side, is attached to the locking device to prevent test specimens from adhering to the locking device.

The procedures for bonding the single laminations is described below. The locking device must be preheated. The device must be brought to temperature again in the event that it is not possible to prevent cooling while the specimen is being handled. This must be done within 3 to 4 seconds to prevent the locking device from cooling down again:

- Removing the hot locking device from the heating press
- Remove the previous test specimen as required
- Insert single laminations to produce the new test specimen (at least 3 mm height)
- Close the locking device
- Insert the locking device into the heating press
- Start the time/temperature/pressure program of the heating press

Parameters for the bonding of single laminations into test specimens, quick bonding using Remisol EB 549 rapid:

	Remisol EB 549 rapid
Pressure / MPa	3
Time with closed heating press / min	2
Temperature / °C	240

The test specimen is removed from the locking device while still hot and is cooled in air to room temperature.

TESTING ADHESION STRENGTH: QUICK BONDING

Parameters for testing using a tensile test machine with peeling device based on EN 1464:

- Feed rate: 100 mm min^{-1}
- Temperature of test specimen: Room temperature

BAKING OF TEST SPECIMENS: DESCRIPTION OF BAKING DEVICE AND BONDING PARAMETERS FOR CONVENTIONAL BONDING

The baking device used by voestalpine is described in more detail in Figures 3 through 5 and in Table 1. It is used for the production of the test specimens for the floating roller test and the tensile lap-shear test.

Please observe the following rules when stacking single laminations in the baking device and during the baking process:

- Specimens up to a height of 65 mm max. can be inserted into the baking device.
- Individual test samples must be separated in the baking device by a double layer of pressure-resistant paper.
- The pressure load must be applied to the stack before the bonding process begins. No further pressure readjustment may take place during the bonding process itself.
- Once the single laminations have been stacked in the baking device (at room temperature), springs are inserted into the baking device, and the baking device is closed.
- When still cold, a defined pressure is applied to the stack in the device.
- The specimens are bonded in a preheated convection oven.
- After bonding is complete, the stacks are cooled in air or the closed baking device (up to temperatures below 80 °C).

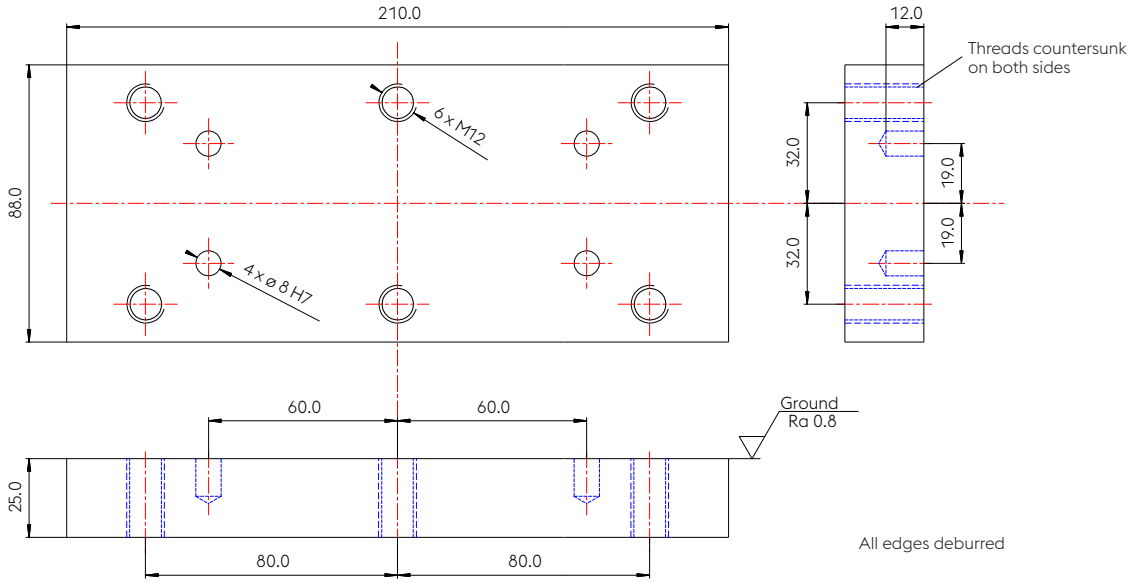

Figure 3: Base plate of baking device for the production of test samples

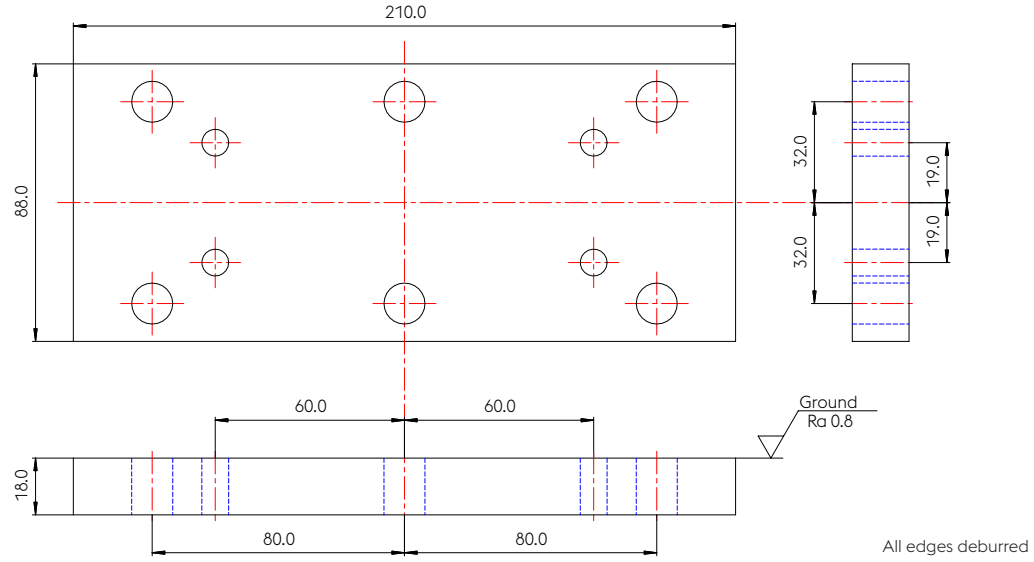

Figure 4: Head plate of baking device for the production of the test samples

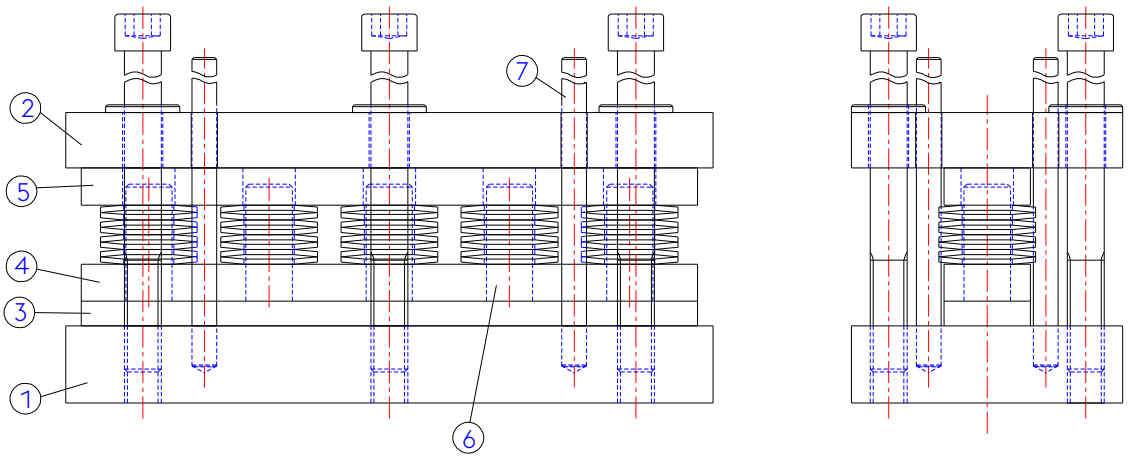

Figure 5: Assembled baking device

Table 1: Baking device component list

Component	Name	Units	Material
1	Base plate 210 x 88 x 25	1	1.4122
2	Head plate 210 x 88 x 18	1	1.4122
3	Intermediate layer 200 x 28 x 8	1	1.4122
4	Spring mount base plate 200 x 28 x 12	1	1.4122
5	Spring mount cover plate 200 x 28 x 12	1	1.4122
6	Pin Ø 16 x 37 DIN EN ISO 8734	5	
7	Round steel Ø 8 h 9 x 140	4	1.4122
	Cup springs 31.5 x 16.3 x 1.75 A DIN 2093 FDST		

The parameters for bonding the individual laminations into test specimens for conventional bonding

	Remisol EB 549 rapid	backlack-v®
Pressure applied at room temperature / MPa	3	1
Baking time / min	120	240
Furnace chamber temperature / °C	200	130

TESTING ADHESION STRENGTH: CONVENTIONAL BONDING

Parameters for testing using a tensile test machine based on EN 1465 (tensile lap-shear test):

» Feed rate: 10 mm min^{-1}
» Temperature of test specimen: Room temperature

Parameters for testing using a tensile test machine with peeling device based on EN 1464 (floating roller test):

» Feed rate: 100 mm min^{-1}
» Temperature of test specimen: Room temperature

INSPECTION OF INCOMING GOODS AT THE CUSTOMER

Upon receipt, the customer shall undertake to carry out a proper inspection of the incoming goods. The incoming inspection must be carried out in accordance with the general conditions of the voestalpine outgoing goods inspection, must include the determination of bondability based on the agreed testing method and visual inspection of any varnish squeeze out on the bonded test specimen. If the strip width is too small, incoming inspection at the customer must be conducted with longitudinal test specimens.

Complaints cannot be accepted for the respective material in the event of failure to carry out the incoming goods inspection on the customer's premises (including the aforementioned tests in their entirety) within a maximum of one month following delivery. In case of doubt, the parameters listed in this document shall be applicable to the testing of the respective backlack.

PROCESS WINDOW FOR CUSTOMER STACK PRODUCTION

Depending on the baking varnish used, different process windows must be observed for the processing of individual laminations into stacks. These windows can be found in the data sheets of the varnish manufacturer. The parameters listed below correspond to those in the data sheets of the varnish manufacturer.

Table 2: Process window for electrical steel strip, coated with Remisol EB 549 rapid, quick bonding

Parameters	**Value**
Coating film thickness per side / µm	4
Pressure / MPa	3

Temperature / °C	Time / min
220	5
240	2
260	1

Table 3: Process window for electrical steel strip, coated with Remisol EB 549 rapid, conventional bonding

Parameters	**Value**
Coating film thickness per side / µm	4
Pressure applied at room temperature / MPa	3
Temperature / °C	20 – 200 (ramp)
Time / min	120

Table 4: Process window for electrical steel, coated with backlack-v®, conventional bonding

Parameters	**Value**
Coating film thickness per side / µm	3 – 5
Pressure applied at room temperature / MPa	0.5 – 1
Heating rate in stack during heating phase / K min^{-1}	0.5 – 1
Final stack temperature / °C	130 – 150
Holding time at 130 °C (final stack temperature) / min	≥ 120
Holding time at 150 °C (final stack temperature) / min	≥ 60

LEGAL INFORMATION

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To the extent that individual technical properties and specifications are not specifically defined by the customer, e.g. by means of meaningful measurements and limit values, such properties and specifications shall merely serve as technical guidelines and non-binding target values unless agreed on an individual basis.

voestalpine shall not grant any warranty nor be held liable for properties and/or specifications other than those explicitly agreed. This also applies to the suitability and applicability of pre-materials for certain applications as well as to the further processing of materials. All application risks and suitability risks are borne by the customer. Based on differences in production technologies, voestalpine offers no warranty nor will voestalpine be held liable with respect to the processability of electrical steel coated with Backlack and backlack-v® in large-scale processes for the production of lamination stacks by the customer.

The Technical Terms of Delivery applicable to electrical steel are available at:
www.voestalpine.com/stahl/Downloadcenter
The General Terms of Sale for Goods and Services of the voestalpine Steel Division shall apply and can be accessed at:
www.voestalpine.com/stahl/Die-Steel-Division/Allgemeine-Verkaufsbedingungen

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