



# GRAIN ORIENTED ELECTRICAL STEEL

PRODUCT CATALOG | 2023

# CONTENT

<b>About NLMK Group</b>	<b>2</b>
<b>NLMK Group Electrical Steel</b>	<b>4</b>
<b>Applications</b>	<b>6</b>
<b>Production flow chart</b>	<b>8</b>
<b>Cold-rolled grain-oriented electrical steel</b>	<b>10</b>
Dimensional mix.	10
Magnetic properties of commercial grain-oriented steel grades	11
Table matching light gage cold-rolled grain-oriented electrical steel grades to standards	12
<b>Standard properties of electrical insulation coatings</b>	<b>13</b>
<b>Packing of finished products</b>	<b>14</b>
<b>Certification of the management system and NLMK Group products</b>	<b>16</b>

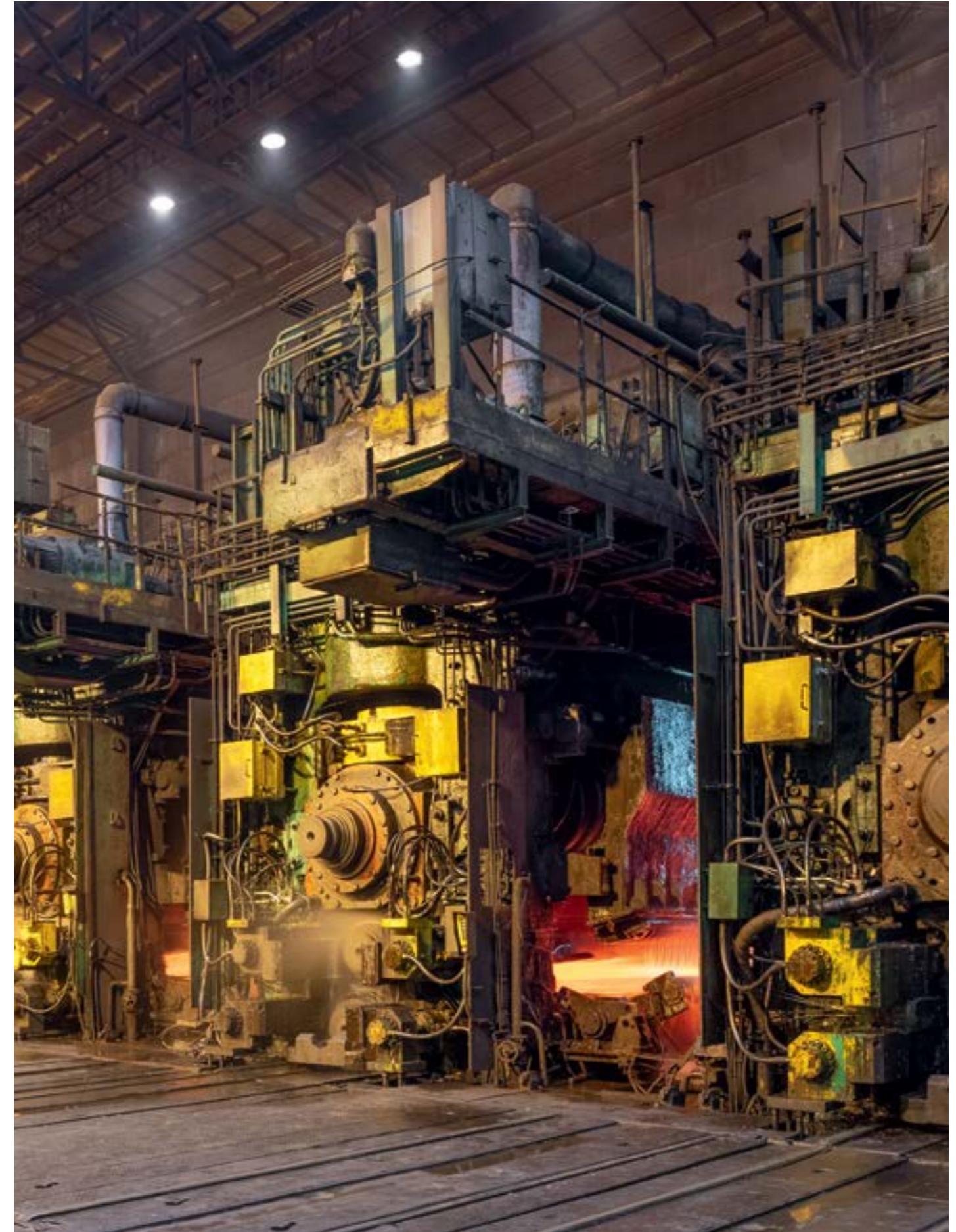




## ABOUT NLMK GROUP

● NLMK Group is a leading international manufacturer of high-quality steel products with a vertically integrated business model. NLMK's self-sufficiency in raw materials and energy and the high technological level of its equipment makes it one of the most efficient and profitable steelmaking companies in the world and number one in Russia. The company oversees all production stages, from mining to sales of downstream steel products to end consumers.

NLMK's steelmaking capacity is over 18 m t. Almost 80% of NLMK steel is used to produce hot-rolled, cold-rolled, galvanized, pre-painted, electric (grain-oriented and non-grain-oriented) steel, as well as a wide range of plates and long products.



# NLMK GROUP ELECTRICAL STEEL

**N**LMK Group has been manufacturing non-grain-oriented (isotropic) and grain-oriented (anisotropic) electrical steels for 50 years producing GO steel since 1960, and NGO steel, since 1986. Non-grain-oriented electrical steel is produced at NLMK Lipetsk, while grain-oriented electrical steel is produced both at NLMK Lipetsk and VIZ-Steel (Yekaterinburg). Electrical steel production process is a Russian know-how. NLMK's share in the total production of NGO and GO steel in Russia is almost 100%.

**≈100%**  
IS THE SHARE OF NLMK ON  
RUSSIAN GRAIN-ORIENTED  
ELECTRICAL STEEL MARKET

**≈11%**  
IS THE SHARE OF NLMK ON  
GLOBAL GRAIN-ORIENTED  
ELECTRICAL STEEL MARKET



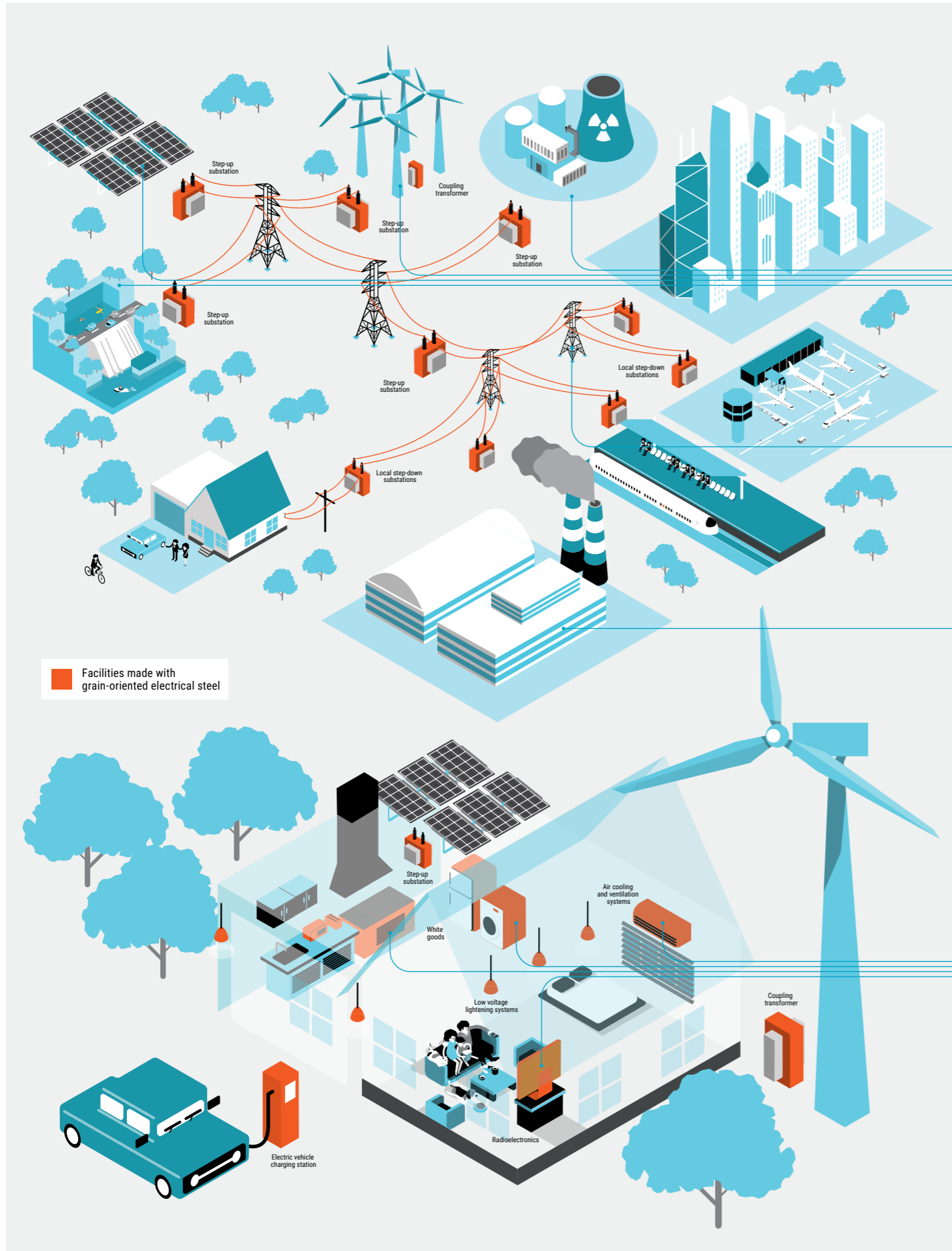
## Light gage cold-rolled grain-oriented electrical steel

**N**LMK Group guarantees high quality of produced GO electrical steel due to strict control of production process, quality of materials used and final products. NLMK's grain-oriented steel has low specific magnetic losses, which makes it indispensable in terms of magnetic cores production. Grain-oriented steel is used to produce magnetically active units and devices for electrical energy generation and conversion.

Main requirements for grain-oriented steel are low specific magnetic losses and high magnetic induction. The use of high grade grain-oriented steel in electrical products reduces energy losses during transformation and ensures high accuracy of the measuring instruments.

Global requirements for the electrical products energy efficiency are annually tightened in order to reduce energy consumption and carbon emissions. Hence, the need arises to develop and manufacture high efficiency (energy efficient) transformers. This is impossible without high-quality grain-oriented steel, which is a key element in electrical equipment.





Electric power



Electric power transmission

## APPLICATIONS

Grain-oriented electrical steel (GOES) is widely used to produce power, distribution, measuring transformers, generators, high-voltage, low-voltage and electronic equipment, as well as in shunt reactors.



White goods and radioelectronics



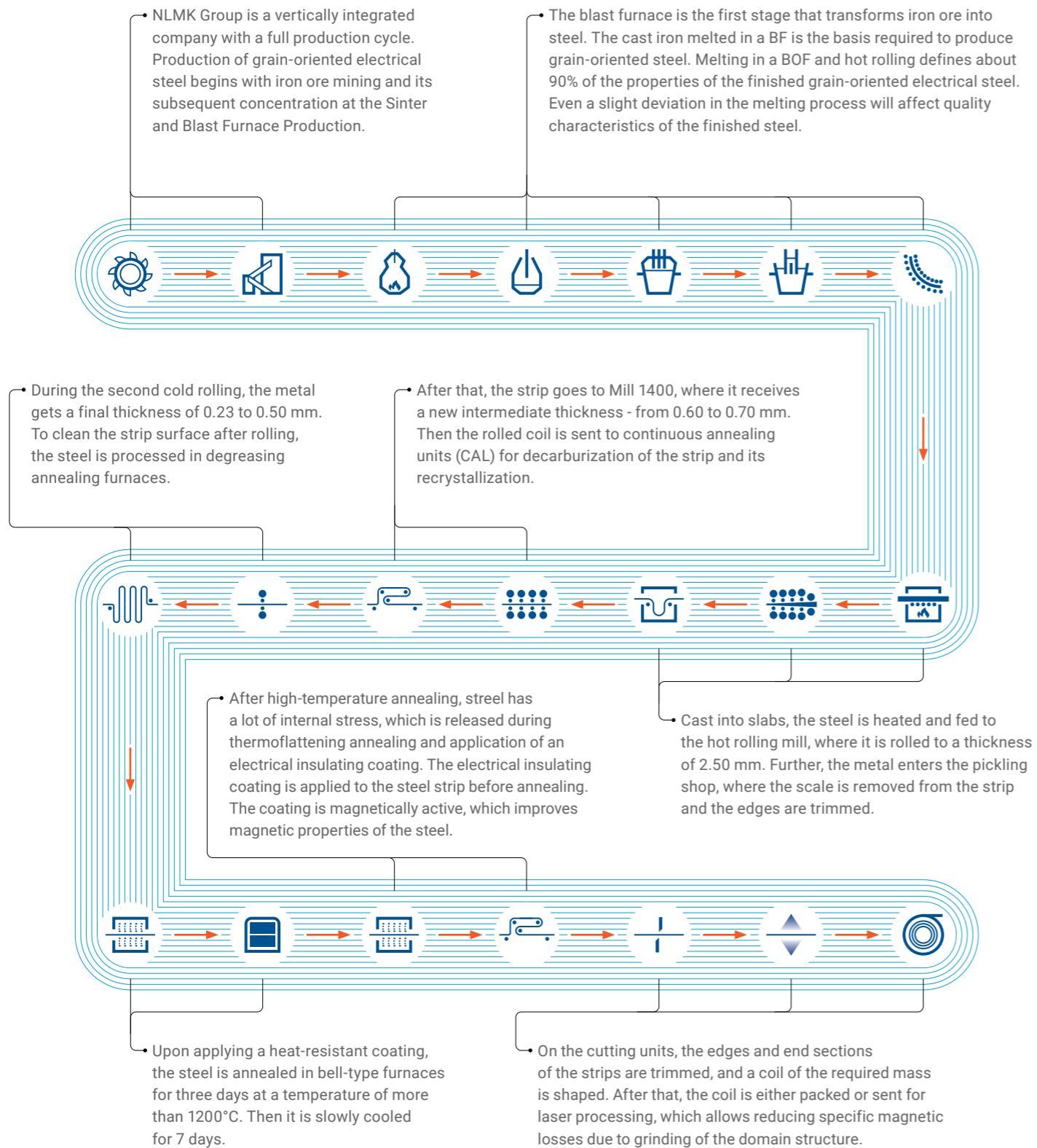
Industrial Equipment

**P**ower, distribution, measuring transformers are widely used in the power industry: thermal power plants (TPP), nuclear power plants (NPP); installed in power plants operating on renewable energy sources such as wind, hydro and solar energy. GOES is an essential component of shunt reactor units for nuclear power plants (NPP). NLMK's grain-oriented steel is used to ensure efficient operation of oil and gas, mining, and steelmaking equipment in the form of parts and components of power substations, power units start-up equipment, and relays.

Moreover, it is used in radio electric and measurement equipment, high-precision measurement devices that oversee operation of flow controllers and various measurement devices. NLMK's steel significantly improves energy efficiency of distribution transformers, which provide electricity to all urban infrastructure from household electrical appliances to residential and commercial complexes. Steel is also used to produce electromagnetic switching devices (relays) for scheduled switching on and off the city streets and highways lighting, and controlling of traffic regulation electrical equipment.

# PRODUCTION FLOW CHART

During the entire production cycle of grain-oriented electrical steel, about 500 parameters are monitored to meet very narrow range. This is a guarantee of obtaining the highest quality material.



RH Degasser



Steel Hot Rolling, Mill 2000

Batch annealing furnaces



Electric insulation coating line



Laser treatment complex



# LIGHT GAGE COLD-ROLLED GRAIN ORIENTED ELECTRIC STEEL

## Dimensional mix

Grain-oriented steel products are shipped in coils, narrow strip and sheets

- **Strip thickness:** 0.15; 0.20; 0.23; 0.27; 0.28, 0.30; 0.35; 0.50 mm;
- **Rolled products with a thickness of 0.15 to 0.20 mm** are supplied in the form of a strip with a width of 16 to 80 mm inclusive.

- **Width of the rolled steel of 0.23–0.50 mm in thickness:** narrow strip – 20–499 mm; sheets – 914–960 mm; narrow strip – 650–1020 mm inclusive;

Coil ID – 500 mm, for 0.15mm narrow strip – 270 mm.  
Coil weight – up to 5t. Coil weight may be increased upon agreement with the customer.  
Weight of one piece in a narrow strip coil shall not be less than the weight calculated as 0.5 kg per 1 mm of narrow strip width.

## REQUIREMENTS TO THE TOLERANCES:

Nominal thickness, mm	0.15; 0.23; 0.27; 0.30	0.35; 0.50		
Max. steel thickness deviation, mm	±0.02	±0.03		
Max. weld thickness deviation, mm	≤0.02			
Transverse thickness variation*, mm	≤0.02			
Longitudinal thickness deviation per 1,500 mm of length, mm	≤0.02			
Burr, mm	≤0.02			
Nominal steel width, mm	/ ≤250	250</td> <td>≤500</td> <td>/ &gt; 500</td>	≤500	/ > 500
Maximum width deviations, mm	+0.8	+1.2		+0.5%
Non-flatness height to length ratio, %	≤1.5			
Wave height*, mm	≤3.0			
Camber per 1,500 mm of length*, max., mm	≤1.0			
No. of folds	≥5			
Residual stresses (gap along the cutting line)**, mm/	≤1.0			

\* For the rolled steel over 150 mm width

\*\* For the rolled steel over 500 mm width

Steel with the other product mix requirements can be produced by custom order subject to additional approval.

## MAGNETIC PROPERTIES OF COMMERCIAL GRAIN-ORIENTED STEEL GRADES

Nominal thickness, mm	Grade <sup>1</sup>	Specific Losses <sup>2</sup>		Magnetic polarization <sup>3</sup>	
		P <sub>1.5/50</sub> , W/kg, max	P <sub>1.7/50</sub> , W/kg, max	J <sub>500</sub> (B <sub>500</sub> ), T, min.	J <sub>2500</sub> (B <sub>2500</sub> ), T, min.
<b>Regular quality grain-oriented steel</b>					
0.23	NV23S-95	0.67	0.95	1.87	-
	NV23S-100	0.70	1.00	1.86	-
	NV23S-110	0.75	1.10	1.86	-
	NV23S-120	0.77	1.20	1.83	-
	NV23S-127	0.80	1.27	1.82	-
0.27	NV27S-100	0.70	1.00	1.87	-
	NV27S-105	0.73	1.05	1.87	-
	NV27S-110	0.75	1.10	1.86	-
	NV27S-120	0.80	1.20	1.84	-
	NV27S-130	0.85	1.30	1.83	-
	NV27S-140	0.89	1.40	1.82	-
0.30	NV27S-160 <sup>4</sup>	1.15	1.60	1.70	-
	NV30S-110	0.78	1.10	1.87	-
	NV30S-120	0.80	1.20	1.86	-
	NV30S-130	0.85	1.30	1.84	-
	NV30S-140	0.89	1.40	1.78	-
	NV30S-150 <sup>4</sup>	1.03	1.50	1.70	-
0.35	NV30S-175 <sup>4</sup>	1.19	1.75	1.68	-
	NV35S-120	0.90	1.20	1.86	-
	NV35S-130	0.95	1.30	1.83	-
	NV35S-145	1.00	1.45	1.81	-
	NV35S-160 <sup>4</sup>	1.10	1.60	1.68	-
0.50	NV35S-190 <sup>4</sup>	1.30	1.90	1.60	-
	NV50S-150 <sup>5</sup>	1.50	-	-	1.88
	NV50S-200 <sup>5</sup>	2.00	-	-	1.80
	NV50S-245 <sup>5</sup>	2.45	-	-	1.75
<b>Regular quality grain-oriented steel with optimum domain structure<sup>4</sup></b>					
0.23	NV23S-095L	-	0.95	1.84	-
	NV23S-100L	-	1.00	1.84	-
0.27	NV27S-100L	-	1.00	1.84	-
	NV27S-105L	-	1.05	1.84	-
0.30	NV30S-110L	-	1.10	1.84	-

### Appendix:

- ES with guaranteed magnetic properties different from those given in the table can be supplied upon agreement. Herewith, grade identification is made in line with the requirements stated in clause 3.2 of the present standard.
- Specific magnetic losses of P<sub>1.5/50</sub> provided for thickness of 0.23, 0.27, 0.30, 0.35 mm are for reference only;
- ES certification for specific magnetic losses and magnetic polarization is carried out according to the results of tests with the Epstein apparatus. If Single Sheet Test certification is needed, the level of specific magnetic losses and magnetic polarization is agreed with the Customer.
- Certification of the electrical steel with optimized domain structure (grade index – L) in terms of specific magnetic losses and magnetic polarization is made upon the results of the SST.
- ES certification is carried out according to specific losses P<sub>1.5</sub> / 50 (W / kg).

### Table matching light gage cold-rolled grain-oriented electrical steel sheet grades to standards

Nominal thickness, mm	STO 05757665-008			GOST 32482			EN 10107			IS 3024			ASTM A876			
	Grade	P <sub>1,7/50</sub> , W/kg	B <sub>500</sub> , Tл	Grade	P <sub>1,7/50</sub> , W/kg	B <sub>500</sub> , T	Grade	P <sub>1,7/50</sub> , W/kg	B <sub>500</sub> , T	Grade	P <sub>1,7/50</sub> , W/kg	B <sub>500</sub> , T	Grade	P <sub>1,7/50</sub> , W/kg	P <sub>1,7/60</sub> , W/kg	
0,23	Regular quality															
	NV23S-100	1.10	1.86	-	-	-	-	-	-	-	-	-	-	-	-	
	NV23S-110	1.10	1.86	T110-23S	1.10	1.85	M110-23S	1.10	1.78	23CG110	1.10	1.78	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	23H070	1.17	1.54	
	NV23S-120	1.20	1.83	T120-23S	1.20	1.83	M120-23S	1.20	1.78	23CG120	1.20	1.78	-	-	-	
	NV23S-127	1.27	1.82	T127-23S	1.27	1.82	M127-23S	1.27	1.75	23CG127	1.27	1.75	-	-	-	
	Optimized domain structure (laser-treated)															
	-	-	-	-	-	-	-	-	-	-	-	-	-	23Q054	0.90	1.19
	NV23S-95L	0.95	1.84	T95-23D	0.95	1.87	-	-	-	-	-	-	-	-	-	
	NV23S-100L	1.00	1.84	T100-23D	1.00	1.86	-	-	-	-	-	-	-	-	-	
-	-	-	T105-23D	1.05	1.85	-	-	-	-	-	-	-	-	-		
0,27	Regular quality															
	NV27S-105	1.05	1.87	T105-27S	1.05	1.87	-	-	-	-	-	-	-	-	-	
	NV27S-110	1.10	1.86	T110-27S	1.10	1.86	-	-	-	-	-	-	-	-	-	
	NV27S-120	1.20	1.84	T120-27S	1.20	1.84	M120-27S	1.20	1.78	27CG120	1.20	1.78	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	27H074	1.24	1.63	
	NV27S-130	1.30	1.83	T130-27S	1.30	1.83	M130-27S	1.30	1.78	27CG130	1.30	1.78	-	-	-	
	NV27S-140	1.40	1.82	T140-27S	1.40	1.82	M140-27S	1.40	1.75	27CG140	1.40	1.75	-	-	-	
	Optimized domain structure (laser-treated)															
	-	-	-	T95-27D	0.95	1.87	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	27Q057	0.96	1.26	
NV27S-100L	1.00	1.84	T100-27D	1.00	1.86	-	-	-	-	-	-	-	-	-		
NV27S-105L	1.05	1.84	T105-27D	1.05	1.85	-	-	-	-	-	-	-	-	-		
0,30	Regular quality															
	NV30S-110	1.10	1.87	T111-30S	1.11	1.87	-	-	-	-	-	-	-	-	-	
	NV30S-120	1.20	1.86	T120-30S	1.20	1.86	M120-30S	1.20	1.78	-	-	-	-	-	-	
	NV30S-130	1.30	1.84	T130-30S	1.30	1.84	M130-30S	1.30	1.78	30CG130	1.30	1.78	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	30H083	1.39	1.83	
	NV30S-140	1.40	1.78	T140-30S	1.40	1.82	M140-30S	1.40	1.78	30CG140	1.40	1.78	-	-	-	
	-	-	-	-	-	-	M150-30S	1.50	1.75	30CG150	1.50	1.75	-	-	-	
	Optimized domain structure (laser-treated)															
	-	-	-	T100-30D	1.00	1.87	-	-	-	-	-	-	-	-	-	
-	-	-	T105-30D	1.05	1.86	-	-	-	-	-	-	-	-	-		
NV30S-110L	1.10	1.84	T110-30D	1.10	1.85	-	-	-	-	-	-	-	-	-		
0,35	Regular quality															
	NV35S-120	1.20	1.86	T120-35S	1.20	1.86	-	-	-	-	-	-	-	-	-	
	NV35S-130	1.30	1.83	T130-35S	1.30	1.83	M135-35S	1.35	1.78	-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	NV35S-145	1.45	1.81	T145-35S	1.45	1.81	M145-35S	1.45	1.78	35CG145	1.45	1.78	-	-	-	
	-	-	-	-	-	-	M155-35S	1.55	1.78	35CG155	1.55	1.78	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	-	35H094	1.57	2.07	
	-	-	-	-	-	-	M165-35S	1.65	1.75	35CG165	1.65	1.75	-	-	-	

# STANDARD PROPERTIES OF ELECTRICAL INSULATION COATINGS

Based upon customer demand flat products may be produced with special magnetic property requirements. Flat products are supplied in coils, narrow strips or sheets with electric insulation coating of the following types:

- **CC (Coating Conventional)** a primer based on magnesium and silicon oxides, on top of which a layer of phosphates is applied (analogue of the C2 + C5 coating according to ASTM A976M);
- **CM (Coating Magnetoactive)** a primer based on magnesium and silicon oxides coated with phosphate and silicon oxides (equivalent of S2 coating, as well as C2+C5 according to ASTM A976M);

Upon request of a Customer grain-oriented rolled steel with a thickness of 0.50 mm can be supplied with a semi-organic heat-resistant coating that improves formability "CS" (Coating Soft) (equivalent to C4 according to ASTM A976).

### TECHNICAL SPECIFICATION ACCORDING TO STO 05757665-008

Coating type	Base	Colour	Thickness, μm	Resistance factor, Омxcm <sup>2</sup>	Thermal resistance
CC	Phosphates	Grey	≤5.0	≥20	(840±10) °C, 3 h, in neutral atmosphere
CM	Silicates, phosphates, chromates	Gray or gray-brown	≤5.0	≥20	(840±10) °C, 3 h, in neutral atmosphere



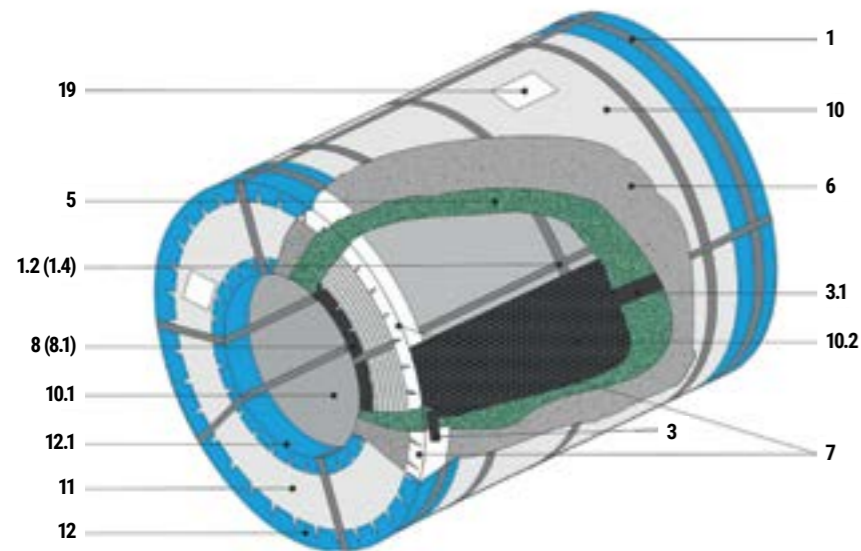


## PACKAGING

The packaging of NLMK rolled products ensures their protection from damage during handling, transportation, as well as from the impact of external weather conditions. Rolled products can be packaged vertically or horizontally. Rolled steel can be delivered in containers.

Main packaging patterns are shown on the schematics below. Other packaging elements may be used upon agreement with the customer. To protect the steel against corrosion, it is recommended to store rolled products in intact original packaging in covered waterproof warehouses.

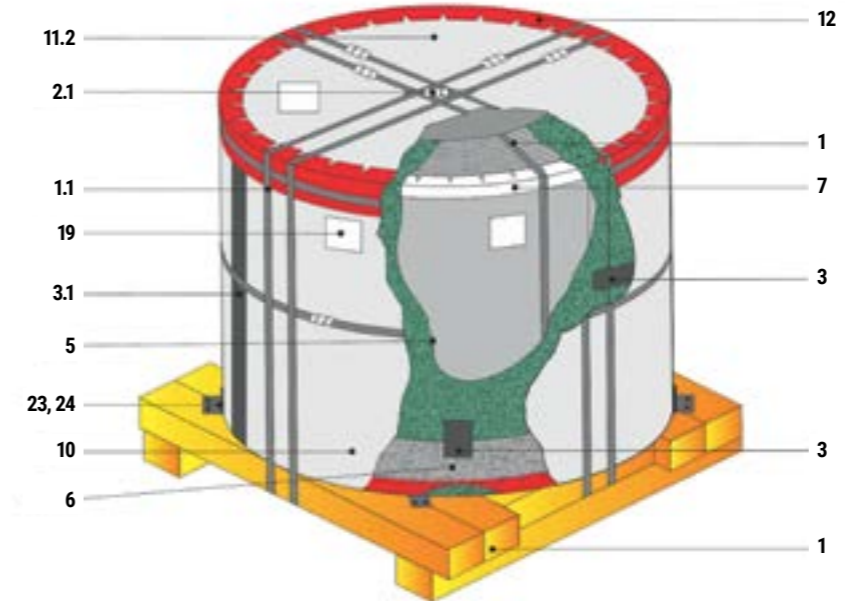
### Horizontal packaging



#### PACKAGING ELEMENTS

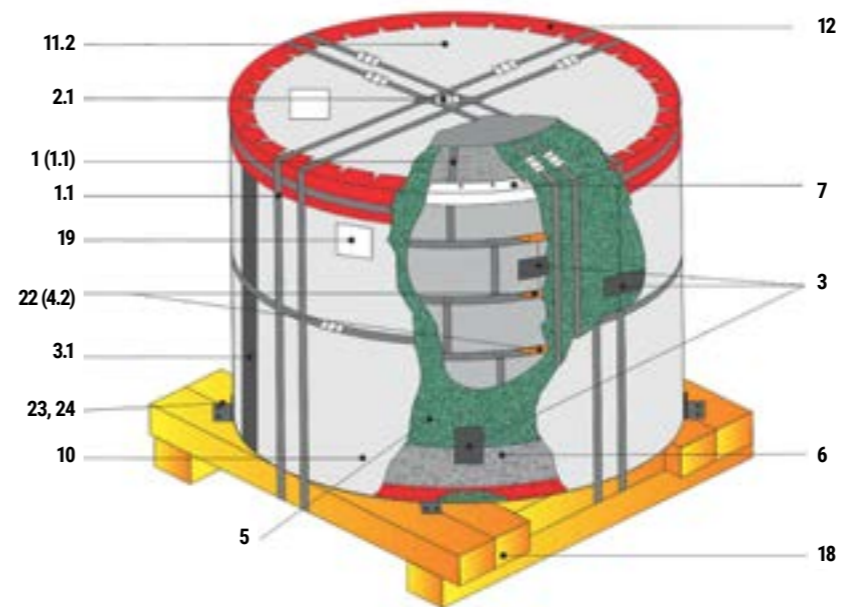
Item No.	
1	Polyester packaging strap 1.3x25 mm
1.2	Polyester packaging strap 1.0x19 mm
1.3	Steel packaging strap 1.0x30-32 mm
1.4	Steel packaging strap 1.0x32 mm
3	Adhesive tape, 50 mm
3.1	Adhesive tape, 100 mm
5	Anti-corrosion packaging paper
6	Polyethylene film
7	Protective cardboard angle 60x60 mm
10	Outer steel packaging sheet
10.1	Inner packaging sheet
10.2	Additional plastic packaging sheet
11	End steel cover
12	Outer corrugated angle
12.1	Inner corrugated angle
19	Shipment label

### Vertical packaging



#### PACKAGING ELEMENTS

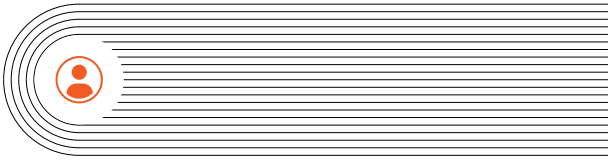
Item No.	
1	Polyester packaging strap 1.3x25 mm
1.1	Steel packaging strap 0.8x32 mm
2.1	Purchased strapping seal
3	Adhesive tape, 50 mm
3.1	Adhesive tape, 100 mm
4.2	Steel liner between bundles
5	Anti-corrosion packaging paper
6	Polyethylene film
7	Protective cardboard angle 60x60 mm
10	Outer packaging sheet (steel)
11.2	Blind end cover
12	Outer corrugated angle
18	Pallet for vertical shipment
19	Shipment label
22	Wooden pad (planed)
23	Steel angle 75x75 mm
24	Nails



# CERTIFICATION OF NLMK GROUP'S MANAGEMENT SYSTEM AND PRODUCTS

Certification authority	Regulatory document	Product
TÜV AUSTRIA CERT GMBH	EN ISO 9001:2015	Quality Management System
TÜV AUSTRIA CERT GMBH	EN ISO 14001:2015	Environment Quality Management System
TÜV AUSTRIA CERT GMBH	EN ISO 45001:2018	Labour Protection & Industrial Safety Management System
TÜV AUSTRIA CERT GMBH	EN ISO 50001:2018	Energy Management System





# CONTACT DETAILS

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