



# **NGO steel with low magnetic losses**



## One of the most efficient steelmakers in the world

**N**LMK'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 raw material mining to sales of downstream steel products to end users.

NLMK has a diversified product mix, ensuring our leading position at local markets and the efficiency of our sales. Leveraging our advantages – a flexible production chain, balanced product mix, efficient sales system, and widespread customer base – enables us to always be responsive and adjust to the changing market conditions.

**>18 m t**  
**NLMK'S STEELMAKING CAPACITY, WITH SUPPLIES TO OVER 70 COUNTRIES**

NLMK's products range from hot-rolled flats to unique electrical steel grades, with an emphasis on high-value-added products. Almost 80% of NLMK steel is used to produce hot-rolled, cold-rolled, galvanized, pre-painted, and electric steel (grain-oriented or non-grain-oriented), as well as a wide range of plates and long products. Flat products make up 83% of the production structure, with the rest accounted for by long products.

**NLMK's share on the Russian steel market**

NGO\*  
**≈100%**

GO\*  
**100%**

CRC  
**31%**

HDG  
**22%**

PP  
**22%**

\* ДОЛЯ ПО ОБЪЕМАМ ПРОИЗВОДСТВА

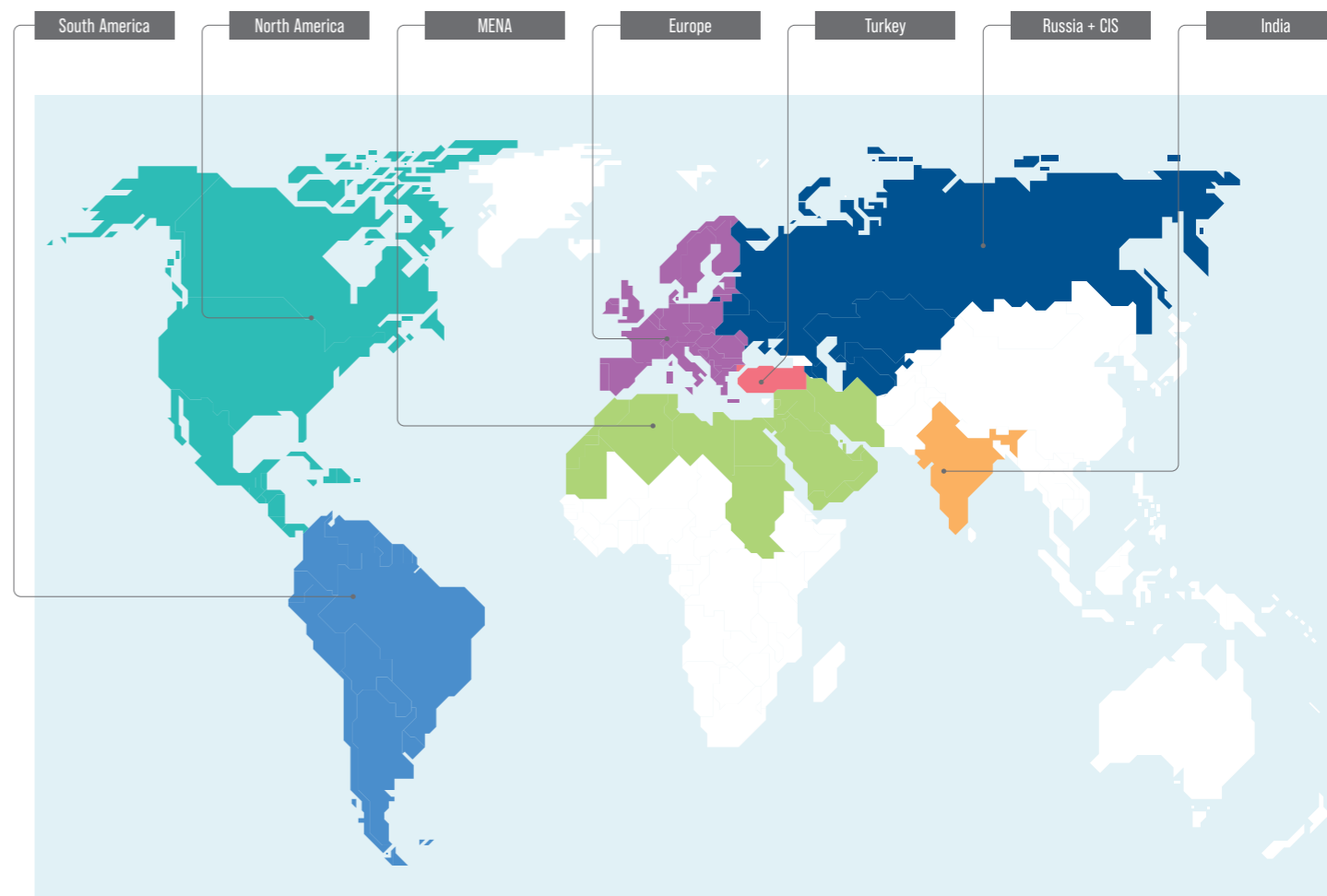
## Leaders on the electrical steel market

**N**LMK's high-tech electrical steels have become the company's signature product. NLMK Group produces non-grain-oriented (or isotropic) steel at its Lipetsk site. The company's many years of experience in the production of electrical steels and its large-scale programme to modernize equipment and processes ensure the consistently high quality of its products and leading positions on the internal and global markets. NLMK's share on the Russian NGO steel market is 100%. In Europe, its share is 10% and in Turkey, it's over 50%.

**≈300,000 t**

**OF NGO STEEL IS PRODUCED BY NLMK EVERY YEAR. THE COMPANY PLANS TO BOOST ITS PRODUCTION TO 400,000 T, KEEPING IN MIND THE GROWING DEMANDS OF THE PREMIUM MARKET SEGMENT**

### Key NLMK markets

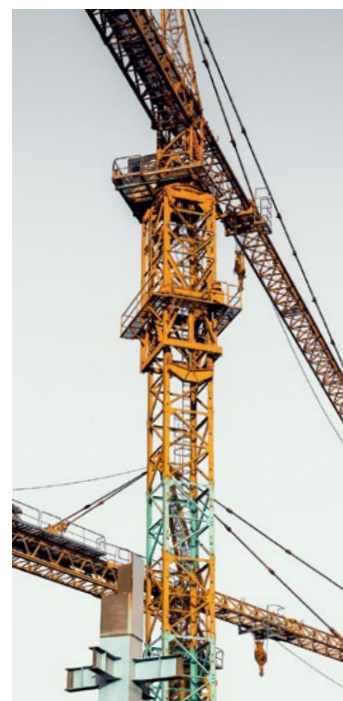


# Broad range of applications in energy and electrical engineering

- POWER GENERATORS FOR HYDRAULIC, GAS, AND STEAM TURBINES
- LARGE ELECTRIC MACHINES
- MOTORS, GENERATORS AND HIGH-FREQUENCY CONVERTERS



- ASYNCHRONOUS MOTORS (POWER UP TO 400 KW)
- WHITE GOODS
- MOTORS FOR PUMPS, AIR CONDITIONING, FRIGDES AND VENTILATORS



- SELF-CONTROLLED ELECTRIC MOTORS
- MOTORS FOR CRANES AND ELECTRIC LOCOMOTIVE LIFTS
- ELECTROTHERMAL AND WELDING EQUIPMENT, HIGH-VOLTAGE GEAR



- LOW-VOLTAGE GEAR
- TRANSFORMERS FOR COMMUNICATIONS
- ELECTRONICS, THROTTLES
- RELAY, DC MAGNETIC POLES, BALLASTS



## Stricter requirements for equipment energy efficiency and efforts to reduce CO<sub>2</sub> emissions drive demand for HG grades

**G**lobal efforts to reduce CO<sub>2</sub> emissions result in stricter requirements for the energy efficiency parameters of electric motors. The transition to premium IE3 and IE4 engines is well underway, leading to an increase in the consumption of high-grade NGO steel with low magnetic losses:  $\leq 3.5$  W/kg at a frequency of 50 Hz. NLMK estimates that by 2022 consumption of high grades will total 2.8 m t.

NLMK Group produces such high-alloy grades with low magnetic losses: from  $P_{1,5/50} \leq 3.30$  W/kg to 2.35 W/kg for 0.35 mm gauges, from  $P_{1,5/50} \leq 4.00$  to 2.50 W/kg for 0.50 mm gauges, and from  $P_{1,5/50} \leq 4.00$  W/kg to 3.10 W/kg for 0.65 mm gauges. With these grades, equipment manufacturers can increase the impact of no-load running due to extra low magnetic losses in the steel. Such steels are most effective in large electric equipment and electric machines with a high core remagnetization frequency.

**2.8 m t**  
WILL BE THE CONSUMPTION OF HIGH GRADES BY 2022 ACCORDING TO NLMK ESTIMATES

# Production route

NLMK Group employs digital tools at all production chain stages to increase efficiency and reduce the share of repetitive operations for staff. More than 50 solutions from the Industry 4.0 technology package are currently integrated into the production process.

## MINING

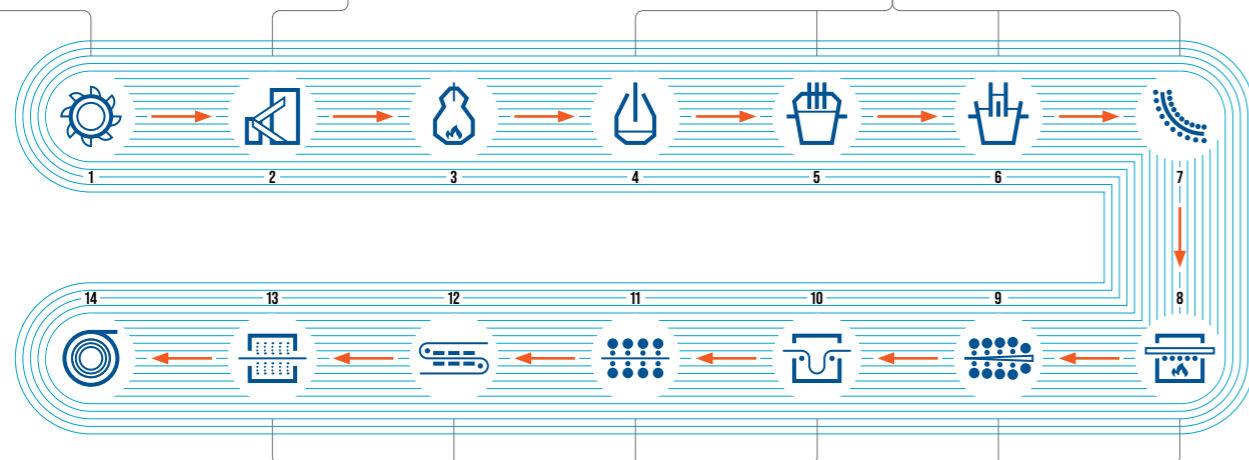
At the Stoilensky Mining and Beneficiation Plant opencast mine, NLMK Group uses the digital twin technology and a system visualizing the deposit structure and the ore bedding conditions, which helps optimize the mine development plan.

## SINTERING AND IRONMAKING

The plant needs a stable chemical composition to ensure optimal BF process thermodynamics. Our digital dynamic stacking service for iron ore sintering regulates lime consumption, which then allows for lower fuel consumption in blast furnaces and improved pig iron quality.

## STEELMAKING

Based on machine learning algorithms, we developed a service to calculate the exact composition and volume of ferroalloys when producing steel in BOF shops. Using big data about previous heats, the service analyses the parameters of the current heat and calculates the optimal composition.



Production route	
1	Mining
2	Sintering
3	Blast furnace
4	LD converter
5	Ladle furnace
6	RH vacuum degassing
7	Continuous caster
8	Heating furnaces
9	Mill 2000
10	Pickling line
11	Cold rolling mill
12	Continuous annealing line
13	Insulation coating
14	Finished products

## NGOES AND GOES SHOPS

Data on every produced item pools into a Steel Traceability system from four shops: BOF Shop No. 1, Hot Rolling Shop, NGOES Shop, and GOES Shop, covering processes from steelmaking to the final operations in electrical steel shops. In real time, the system tracks factors affecting the quality of products at this key production stage (steelmaking and cold and hot rolling of electrical steel) and accumulates comprehensive information about the entire process. In case of a deviation from the target parameters, the system promptly notifies the engineer.

## HOT ROLLING SHOP

Our service calculating the optimal slab discharge rate from reheating furnaces in the Mill 2000 section allows us to increase equipment productivity. A digital video assistant monitors steel rolling processes in the Hot Rolling Shop, helping prevent the tail end of the strip from tearing off and, consequently, to reduce unplanned downtime at Mill 2000. We use predictive analytics to assess the equipment condition at Mill 2000 downcoilers. The complex determines how the defects develop over time and how long it takes for them to become critical.

## Production upgrade to boost quality of current steel grades and develop new ones

RH degassing construction



Continuous annealing line upgrade

>50

SOLUTIONS FROM THE INDUSTRY 4.0 TECHNOLOGY PACKAGE ARE CURRENTLY INTEGRATED INTO THE PRODUCTION PROCESS



Steel preparation and cutting lines upgrade and construction



Reversing mill construction

## TECHNICAL PROPERTIES

### GUARANTEED EN 10106 PROPERTIES

Nominal thickness, mm	Steel grade	P <sub>1.5/50</sub> , W/kg, max.	B <sub>2500</sub> , T, min.	B <sub>5000</sub> , T, min.	ΔP <sub>1.5/50</sub> , %, max.	Bends, min.	Typical density, kg/dm <sup>3</sup>
0.35	M235-35A	2.35	1.49	1.60	±17	2	7.60
	M250-35A	2.50	1.49	1.60	±17	2	7.60
	M270-35A	2.70	1.49	1.60	±17	2	7.65
	M300-35A	3.00	1.49	1.60	±17	3	7.65
	M330-35A	3.30	1.49	1.60	±17	3	7.65
0.50	M250-50A	2.50	1.49	1.60	±17	2	7.60
	M270-50A	2.70	1.49	1.60	±17	2	7.60
	M290-50A	2.90	1.49	1.60	±17	2	7.60
	M310-50A	3.10	1.49	1.60	±14	3	7.65
	M330-50A	3.30	1.49	1.60	±14	3	7.65
	M350-50A	3.50	1.50	1.60	±12	5	7.65
	M400-50A	4.00	1.53	1.63	±12	5	7.70
0.65	M310-65A	3.10	1.49	1.60	±15	2	7.60
	M330-65A	3.30	1.49	1.60	±15	2	7.60
	M350-65A	3.50	1.49	1.60	±14	2	7.60
	M400-65A	4.00	1.52	1.62	±14	2	7.65

### GUARANTEED GOST 21427.2-83 PROPERTIES

Nominal thickness, mm	Steel grade	P <sub>1.5/50</sub> , W/kg, max.	B <sub>2500</sub> , T, min.	ΔP <sub>1.5/50</sub> , %, max.	ΔB <sub>2500</sub> , T, max.	Power factor*, min.	Bends, min.	Typical density**, kg/dm <sup>3</sup>
0.35	2413	2.5	1.50	±18	0.16	0.95	2	7.60
	2412	2.7	1.50	±18	0.16	0.95	2	7.60
	2411	3.0	1.50	±18	0.16	0.95	2	7.60
0.50	2414	2.7	1.49	±18	0.16	0.96 (0.95)	1	7.60
	2413	2.9	1.50	±18	0.16	0.96 (0.95)	1	7.60
	2412	3.1	1.50	±18	0.16	0.96 (0.95)	1	7.60
	2411	3.6	1.49	±18	0.16	0.96 (0.95)	1	7.60
	2312	3.8	1.58	±14	0.16	0.96 (0.95)	2	7.70
	2216	4.0	1.60	±12	0.13	0.96 (0.95)	3	7.75

\* For coated steel: Group A (Group B)

\*\* Not regulated, listed for reference

### GUARANTEED GOST 33212 PROPERTIES

Nominal thickness, mm	Steel grade	P <sub>1.5/50</sub> , W/kg, max.	B <sub>2500</sub> , T, min.	ΔP <sub>1.5/50</sub> , %, max.	Power factor, min.	Bends, min.	Typical density, kg/dm <sup>3</sup>
0.35	D250-35A	2.50	1.49	±17	0.95	2	7.60
	D270-35A	2.70	1.49	±17	0.95	2	7.65
	D300-35A	3.00	1.49	±17	0.95	3	7.65
	D330-35A	3.30	1.49	±17	0.95	3	7.65
0.50	D250-50A	2.50	1.49	±17	0.97	2	7.60
	D270-50A	2.70	1.49	±17	0.97	2	7.60
	D290-50A	2.90	1.49	±17	0.97	2	7.60
	D310-50A	3.10	1.49	±14	0.97	3	7.65
	D330-50A	3.30	1.49	±14	0.97	3	7.65
	D350-50A	3.50	1.50	±14	0.97	5	7.65
	D400-50A	4.00	1.53	±12	0.97	5	7.70
	D400-50A	4.00	1.53	±12	0.97	5	7.70
0.65	D310-65A	3.10	1.49	±15	0.97	2	7.60
	D330-65A	3.30	1.49	±15	0.97	2	7.60
	D350-65A	3.50	1.49	±14	0.97	2	7.60
	D400-65A	4.00	1.52	±14	0.97	2	7.65

## TECHNICAL PROPERTIES

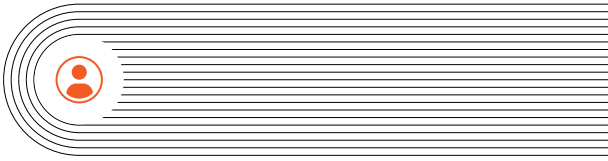
### PROPERTIES OF ELECTRICAL INSULATION COATINGS

Coating classification		Thickness, μm	Resistance factor, Ω·cm²	Thermal resistance	Freon resistance	Stampability	Weldability
ASTM A976	EN 10342						
C5	EN-5-N EN-5-P	≤1.0	≥1	450 °C, 2 hours in the air;	good	good	good
		0.4-1.5	≥5	750 °C, 2.5 hours in a protective environment			
C3	EC-3	0.6-1.5	≥1.5	200 °C, 24 hours in the air	good	excellent	satisfactory
		2.0-4.0	≥20				
C6	EC-6	4.0-7.0	≥40	200 °C, 24 hours in the air	good	good	satisfactory

### APPLICATIONS DEPENDING ON STEEL GRADES (GOST 33212/EN 10106)

	Д470-50А-Д600-50А/ М470-50А-М600-50А	М400-50А	М250-50А-М350-50А
<b>Rotating electric machines</b>			
Turbine and hydraulic generators for the electric power industry			●●
Large electric machines		●	●●
Motors, generators, and high-frequency converters		●	●●
V0V 63-40 asynchronous motors with a capacity of (kW):	50-400	●●	●
	10-50	●●	
	3.75-10	●	
Motors for refrigerators, air conditioners, and pumps	●●		
Motors for electric locomotives, cranes, and lifts	●●		
<b>Non-rotating electric machines</b>			
Low-voltage gear		●	●●
Electrothermal and welding equipment, high-voltage gear		●	●
Radio equipment transformers, radio frequency chokes		●●	●
Relays, DC magnetic poles, ballasts	●		





# CONTACT DETAILS

## **NLMK Customer Relations Department**

---

phone: +7 (800) 511 30 39

---

[sales@nlmk.com](mailto:sales@nlmk.com)

---

## **NLMK Trading**

---

phone: +41 91 985 30 40

---

[info\\_trading@nlmktrading.com](mailto:info_trading@nlmktrading.com)

---