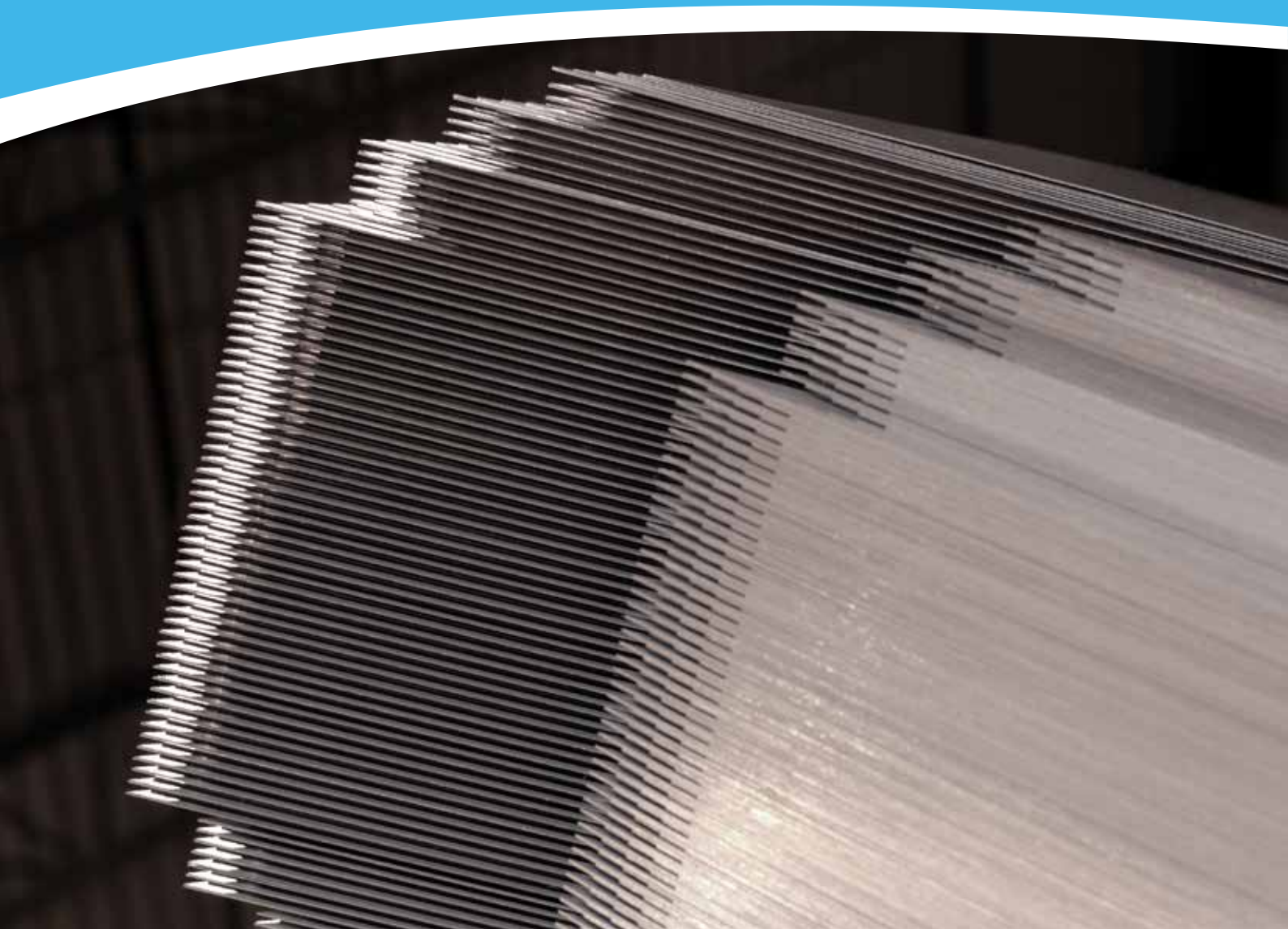
cogent™
A Tata Steel Enterprise

Altogether more powerful

Non-oriented electrical steel

ALTOGETHER MORE POWERFUL

Cogent Power provides a broad range of high quality products manufactured to customers' most demanding requirements, and has a responsive approach to the market.



Our business

Cogent Power is a Tata Steel Enterprise. The specialist product range from Cogent Electrical Steels ranges from high permeability grain oriented steels for power transformers to fully processed silicon steels for all sizes of rotating machines, including thin gauge materials for high speed machines operating at medium to high frequencies.

Electrical steels are manufactured on two sites: Surahammar Bruks, in Sweden produces non-oriented fully processed electrical steels. These steels are iron-silicon alloys with varying silicon content and have similar magnetic properties in all directions in the plane of the sheet.

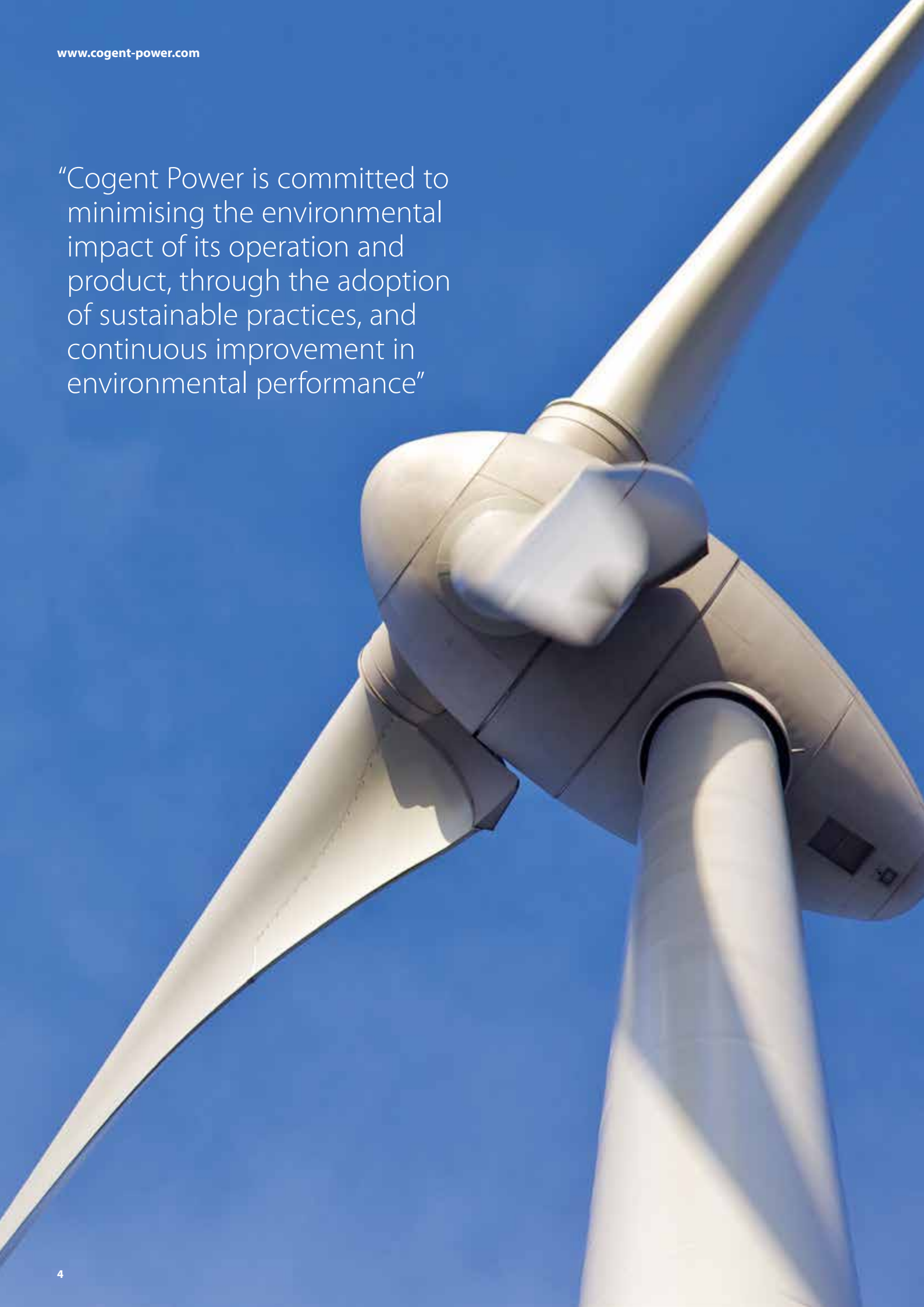
These non oriented electrical steels are principally used for motors, generators, alternators, small transformers and a variety of other electromagnetic applications. Thin gauge materials are also available which offer the superior performance required for high frequency applications, such as hybrid car motors, flywheels and harmonic filters. The full product range is marketed worldwide direct or through the Tata Steel International global sales offices.

Orb Electrical Steels, in the UK is responsible for the production and global sales of specialised grain oriented steels.

Cogent Power Inc., in Burlington, Ontario, is a world leader in the design and manufacture of transformer cores and components, including distributed gap cores, toroidal cores and flat-stacked cores. Cogent Power Inc. also makes amorphous cores. Cogent Power Inc. has a high quality slitting operation for electrical steels, used to support its own business and also to supply a range of grades across North America.

Contents

"Cogent Power is committed to minimising the environmental impact of its operation and product, through the adoption of sustainable practices, and continuous improvement in environmental performance"



Health and safety

Cogent Power believes that all activities can be undertaken safely and will never compromise safety within the business. In both manufacturing and service processes, business is conducted in a way that ensures the health and well-being of all employees, contractors and anyone affected by our business activities.

Cogent Power employees are highly valued and work together in a culture of continuous improvement to develop health and safety performance within the Company and recognise throughout the business that this is essential for the business to maintain its success. Cogent Power's aim is to encourage a positive and progressive health and safety culture and produce high quality electrical steels, where safety comes first.

Environmental management

Cogent Power is committed to minimising the environmental impact of its operation and product, through the adoption of sustainable practices, and continuous improvement in environmental performance.

Cogent Power products influence energy efficiency worldwide. The need for low loss, high efficiency electrical steels has never been greater.

By continually working to optimise the properties of our electrical steel grades for specific applications, our products can significantly improve the total losses in the motor or transformer, and thereby offer more effective use of energy. By developing and producing steels to support the electrification of road transport vehicles Cogent Power contributes to the reduction in emissions. Surahammer Bruks is certified to ISO 14001:2004, and we continue to demonstrate our commitment to energy saving.

Cogent Power strives to produce energy efficient steel, in an energy efficient manner.

Quality assurance

The products described in this brochure are subject to rigorous quality control procedures throughout their manufacture.

The quality management system of Surahammer Bruks is approved by DNV Certification AB to the standard EN ISO 9001:2008.

Research and development

R&D has played a major role in Cogent Power for over 50 years. Although the basic types of electrical steels are based on established technologies, products and processes continue to be improved to meet increasing demands from users for enhanced properties and more cost effective solutions.

Today a major part of the R&D of Cogent Power is carried out in cooperation with experts in different fields outside the company. Important R&D partners are Tata Research Development and Technology and well renowned universities and research institutes. The company sponsors extensive research work into electrical materials through a number of Universities and works in close partnership with the Wolfson Centre of Magnetics at Cardiff University, which is globally recognised as a centre of excellence for magnetics.

Lean

Cogent Power has been specifically utilising the Lean Thinking business philosophy and models since 2003. It strives to maintain the principles of lean thinking and continuous improvement throughout the organisation to be able to deliver added value products and services, robustly and efficiently.

Cogent Power strives to develop its Lean Enterprise by creating vision, strategy, effective leadership and engaging people throughout the organisation and supply chain. Improving and developing people and conditions, and processes and products through continuous investment whilst eliminating wastes, are key to improving value for the electrical steels market today, and the future.

Non-grain oriented electrical steel products

Cogent Power's non-oriented fully processed electrical steels enable our customers to use electrical steels with the best magnetic properties and coatings, confident in the knowledge that the materials are supported by reliable delivery and strong technical support.

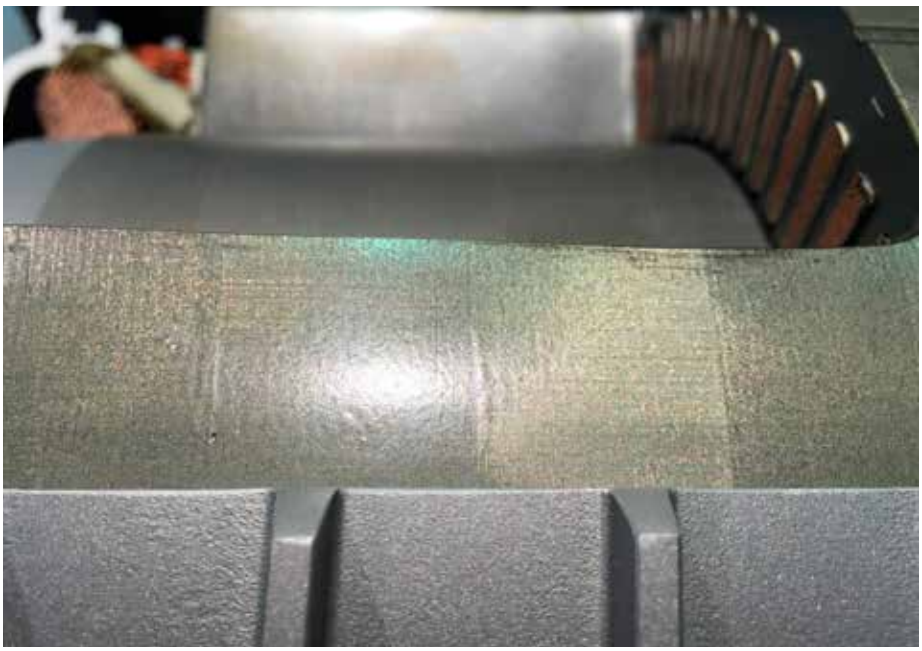
Non-oriented electrical steels between 0.10 mm and 1.00 mm thick are critical in the manufacturing of rotating machines of all sizes, as well as in small transformers and a variety of other electromagnetic applications. Their magnetic properties are combined with tailored insulation coatings which offer the best performance required for the manufacturing process and final application.

Surahammer Bruks has superior cold rolling which enables them to produce the thinnest cold reduced electricals steels with outstanding thickness control and exceptional magnetic properties.

The final annealing refines the final magnetic properties after which the bespoke insulation coating is applied.

Our in-house slitting and cutting lines make it possible to supply our materials in bespoke widths and lengths.

We have partnerships with several local companies within the Nordic Power Components network which allow us to serve our customers with laser cut laminations and stamped laminations.



Applications

The product range also includes the thin gauge grades, which offer the superior performance required for high frequency applications. Another recent addition to our product portfolio are our grades with guaranteed mechanical strength.

Cogent Hi-Lite products significantly reduce losses at higher frequencies compared to normal gauge electrical steels, opening a whole new array of design and application possibilities for your business.

Applications include

- Automotive (H) EV vehicles
- Ultra high speed motors e.g Flywheel Applications
- Aviation
- Power tools
- Household appliances (Vacuum cleaners)
- Transformers
- Filters
- Generators
- Magnetic bearings
- High speed pumps and compressors

Non-grain oriented electrical steel magnetic properties

Our extensive range of industry standard electrical steel grades all conform to EN10106 and IEC 60404-8-4 and are used in rotating machines of all sizes, as well as small transformers and a variety of other electromagnetic applications.

We have a comprehensive range of data on the magnetic, mechanical and physical properties of electrical steels which can be provided on request.

Table 1: Magnetic Properties

SURA Grade	Thickness (mm)	Maximum specific total loss at 50 Hz		Minimum magnetic polarization at 50 Hz			Conventional Density
		$\hat{J}$=1.5T	1.0T*	$\hat{H}$=2500	5000	10000 A/m	
		W/kg	W/kg	T	T	T	kg/dm³
M210-35A	0.35	2.10	0.90	1.49	1.60	1.70	7.60
M230-35A	0.35	2.30	0.95	1.49	1.60	1.70	7.60
M235-35A	0.35	2.35	0.95	1.49	1.60	1.70	7.60
M250-35A	0.35	2.50	1.00	1.49	1.60	1.70	7.60
M270-35A	0.35	2.70	1.10	1.49	1.60	1.70	7.65
M300-35A	0.35	3.00	1.20	1.49	1.60	1.70	7.65
M330-35A	0.35	3.30	1.30	1.49	1.60	1.70	7.65
M230-50A	0.50	2.30	1.00	1.49	1.60	1.70	7.60
M250-50A	0.50	2.50	1.05	1.49	1.60	1.70	7.60
M270-50A	0.50	2.70	1.10	1.49	1.60	1.70	7.60
M290-50A	0.50	2.90	1.15	1.49	1.60	1.70	7.60
M310-50A	0.50	3.10	1.25	1.49	1.60	1.70	7.65
M330-50A	0.50	3.30	1.35	1.49	1.60	1.70	7.65
M350-50A	0.50	3.50	1.50	1.50	1.60	1.70	7.65
M400-50A	0.50	4.00	1.70	1.53	1.63	1.73	7.70
M470-50A	0.50	4.70	2.00	1.54	1.64	1.74	7.70
M470-50HP	0.50	4.70	2.20	1.63	1.71	1.81	7.70
M530-50A	0.50	5.30	2.30	1.56	1.65	1.75	7.70
M530-50HP	0.50	5.30	2.30	1.63	1.71	1.81	7.80
M600-50A	0.50	6.00	2.60	1.57	1.66	1.76	7.75
M700-50A	0.50	7.00	3.00	1.60	1.69	1.77	7.80
M800-50A	0.50	8.00	3.60	1.60	1.70	1.78	7.80
M310-65A	0.65	3.10	1.25	1.49	1.60	1.70	7.60
M330-65A	0.65	3.30	1.35	1.49	1.60	1.70	7.60
M350-65A	0.65	3.50	1.50	1.49	1.60	1.70	7.60
M400-65A	0.65	4.00	1.70	1.52	1.62	1.72	7.65
M470-65A	0.65	4.70	2.00	1.53	1.63	1.73	7.65
M530-65A	0.65	5.30	2.30	1.54	1.64	1.74	7.70
M600-65A	0.65	6.00	2.60	1.56	1.66	1.76	7.75
M600-65HP	0.65	6.00	2.60	1.63	1.72	1.82	7.80
M700-65A	0.65	7.00	3.00	1.57	1.67	1.76	7.75
M800-65A	0.65	8.00	3.60	1.60	1.70	1.78	7.80
M600-100A	1.00	6.00	2.60	1.53	1.63	1.72	7.60
M700-100A	1.00	7.00	3.00	1.54	1.64	1.73	7.65
M800-100A	1.00	8.00	3.60	1.56	1.66	1.75	7.70
M1000-100A	1.00	10.00	4.40	1.58	1.68	1.76	7.80

1. $\hat{J}$ represents the peak magnetic polarisation in Tesla. $\hat{H}$ represents the peak magnetic field strength in A/m.

Hi-Lite Thin Gauge Grades

The Hi-Lite range of advanced thin gauge electrical steels are specifically designed to improve the performance of energy efficient applications. Hi-Lite products reduce iron losses to a minimum at high magnetisation frequencies. This results in smaller, lighter and highly efficient solutions for applications such as high speed rotational motors; generators for hybrid and full electric vehicles; flywheels, aerospace and filters for high frequency harmonics.

For these applications, critical aspects such as yield strength and high frequency losses are given in below table. The typical losses at P10/400 indicate Hi-Lite grades outperform maximum guarantees given by industry standards.

Hi-Lite products can be suplied in small quantities supporting prototype build through to full series supplies and come with Suralac 7000 or Suralac 9000 (bonding coating).

Table 2: Hi-Lite Magnetic and Mechanical Properties

Grade	Gauge	Max $P_{10/400}$	Max $P_{10/700}$	Max [1] $P_{10/2500}$	Typ $P_{10/400}$	Typ $R_{p0.2}$	Conventional density [2]	EN 10303:2015
	mm	W/kg		W/kg	W/kg	Mpa	kg/dm3	
NO10	0.10	13.0	—	135	12.1	370	7.65	NO 10
NO12	0.127	13.5	—	152	11.8	370	7.65	—
NO15	0.15	14.0	—	171	12.1	370	7.65	NO 15
NO18	0.178	14.3	—	186	12.2	370	7.65	—
NO20-1200	0.20	12.0	28.0	195	11.4	440	7.60	—
NO20	0.20	13.5	30.5	215	12.3	370	7.65	—
NO25-1400	0.25	14.0	34.0	—	12.9	440	7.60	NO 25-14
NO25	0.25	17.0	40.0	—	14.8	370	7.65	NO 25-17
NO27-1500	0.27	15.0	37.0	280	13.7	440	7.60	NO 27-15
NO27	0.27	18.0	41.0	-	15.9	370	7.65	NO 27-18
NO30-1600	0.30	16.0	41.0	320	15.1	440	7.60	NO 30-16
NO30	0.30	19.0	45.0	—	17.0	370	7.65	NO 30-19

1. The losses at 2500 Hz are not defined in EN 10303:2015
2. The conventional density may differ from EN 10303:2015

High Strength Electrical Steels

The magnetic characteristics of the electrical steel originate from silicon hot rolled coil feedstock which can then heat treated and cold rolled to give outstanding thickness control.

Cogent recognises that new motor designs continue to ask for improved performance parameters from materials and for fast rotating machines, and in particular for rotors with "very narrow" load bearing parts (e.g. internal permanent magnet rotors), the strength of the material is an important factor.

Cogent offer a number of grades with guaranteed mechanical strength levels. In addition to our service offerings we can offer guaranteed mechanical properties combined with detailed fatigue and durability analyses.

Table 3: Mechanical Properties

Grade	Thickness	Min $R_{P0.2}$	Typ $R_{P0.2}$	Typ $P_{15/50}$	Typ $P_{10/400}$
	mm	MPa	MPa	W/kg	W/kg
M330-35HT	0.35	320	340	2.94	23.5
M330-35HS	0.35	330	380	2.94	18.8
M250-35HS	0.35	400	455	2.35	17.1
NO50	0.50	400	450	2.48	24.0

Global Standards

Electrical steel grades are designated according to guaranteed maximum specific total loss at a peak magnetic polarisation of 1.5 T and 50Hz

Table 4: Non-Orientated Electrical Steel

Core loss 1.5T 50 Hz W/kg	SURA Grade EN 10106	IEC 60404-8-4	JIS C2552	GOST 21427.2	Old AISI Grade	ASTM A667	Core Loss 1.5T	
							60 Hz	50 Hz
							(W/lb)	(W/kg)
2.35	M235-35A	M235-35A5	(35A230)					
2.50	M250-35A	M250-35A5	35A250	2413	(M-15)	(36F145)	1.45	2.58
2.70	M270-35A	M270-35A5	35A270	2412	(M-19)	(36F155)	1.55	2.76
3.00	M300-35A	M300-35A5	35A300	2411	(M-22)	(36F175)	1.75	3.10
3.30	M330-35A	M330-35A5	—	—	M-36	(36F185)	1.85	3.26
2.50	M250-50A	M250-50A5	50A250					
2.70	M270-50A	M270-50A5	50A270	2414				
2.90	M290-50A	M290-50A5	50A290	2413	M-15	47F165	1.65	2.86
3.10	M310-50A	M310-50A5	50A310	2412	(M-19)	47F180	1.80	3.12
3.30	M330-50A	M330-50A5			M-27	47F190	1.90	3.30
3.50	M350-50A	M350-50A5	50A350	(2411)	(M-36)	47F200	2.00	3.47
4.00	M400-50A	M400-50A5	50A400	2216	M-43	(47F240)	2.40	4.17
4.70	M470-50A	M470-50A5	50A470	(2214)	(M-45)	(47F280)	2.75	4.65
5.30	M530-50A	M530-50A5		(2211)	M-47			
6.00	M600-50A	M600-50A5	50A600	2112				
7.00	M700-50A	M700-50A5	50A700	2111		47F400	4.00	7.04
8.00	M800-50A	M800-50A5	50A800	2011		(47F450)	4.50	7.92
3.10	M310-65A	M310-65A5						
3.30	M330-65A	M330-65A5				(64F200)	2.00	3.38
3.50	M350-65A	M350-65A5			M-19	64F210	210	3.55
4.00	M400-65A	M400-65A5			(M-27)	(64F235)	2.35	3.98
4.70	M470-65A	M470-65A5			(M-43)	64F235	2.75	4.65
5.30	M530-65A	M530-65A5			(M-45)	(64f320)	3.20	5.46
6.00	M600-65A	M600-65A5						
7.00	M700-65A	M700-65A5						
8.00	M800-65A	M800-65A5				(64F500)	5.00	8.60
6.00	M600-100A	M600-100A5						
7.00	M700-100A	M700-100A5						
8.00	M800-100A	M800-100A5						
10.00	M1000-100A	M1000-100A5						

American standards

American standards are based on US units and a test frequency of 60 Hz. There is no exact conversion of loss data from 50 Hz to 60 Hz, but these approximate relationships may be used for losses at 1.5 T:

(W/kg at 50 Hz) = (WJlb at 60 Hz)

1.77 (for 0.35 mm grades)
1.74 (for 0.50 mm grades)
1.70 (for 0.65 mm grades)
1.64 (for 1.00 mm grades)

American standard thicknesses differ from metric standards, particularly at 0.50 mm:

EN/IEC ASTM
0.35mm 0.36mm (0.0140inch)
0.50mm 0.47mm(0.0185inch)
0.65mm 0.64mm (0.0250inch)

Conversion factors

1 Tesla (T) = 1 Weber/m2 (Wb/m2) = 10000 Gauss = 64.5 kilolines/sq.in.
1 A/m = 0.01 A/cm = 0.0254 A/in = 0.01257 Oersted
1 W/kg = 0.4536 W/lb (at the same frequency)
1 VA/kg = 0.4536 VA/lb (at the same frequency)
1 N/mm2 (MPa) = 145.0 psi (lbs/sq.in.)

Dimensions and tolerances

Our in house slitting and cutting lines make it possible to supply our materials in bespoke widths and lengths.

We have partnerships with several local companies within the Nordic Power Components network which allow us to serve our customers with laser cut laminations and stamped laminations.

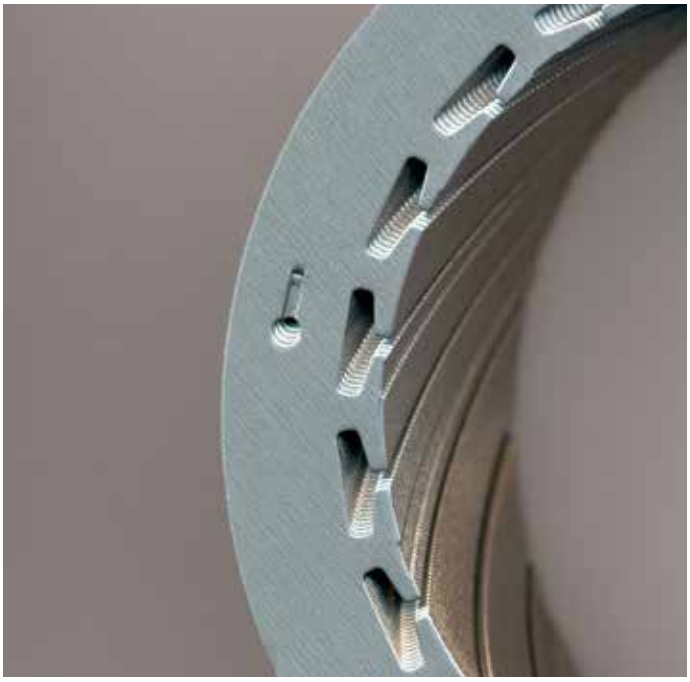
Thickness tolerance and other geometric characteristics
Cogent Power non-oriented fully processed electrical steels meet all the requirements on thickness tolerance and other characteristics such as edge camber and flatness as specified in the standards EN 10106 and IEC 60404-8-4.

Table 5: Dimensions and Tolerances

Coil width standard tolerances			Coil width special tolerances		
Over	Up to and including	Width tolerance	Over	Up to and including	Width tolerance
mm	mm	mm	mm	mm	mm
10	150	0/+0.2	10	300	±0.08
150	300	0/+0.3			
300	600	0/+0.5	300	600	±0.20
600	1000	0/+1.0	600	1250	±0.30
1000	1250	0/+1.5			

Strip thickness	Loss Range	Width range* for slit coils and sheets	Sheet length range
mm	W/kg	mm	mm
0. 10 - 0.30	All	12 - 1190	12 - 3500
0.35	> 3.00	12 - 1250	12 - 3500
0.35	≤ 3.00	12 - 1215**	12 - 3500
0.50	> 3.10	12 - 1250	12 - 3500
0.50	≤ 3.10	12 - 1215**	12 - 3500
0.65	> 3.50	12 - 1250	12 - 3500
0.65	≤ 3.50	12 - 1215	12 - 3500
1.00	> 6.00	12 - 1250	12 - 3500
1.00	≤ 6.00	12 - 1215	12 - 3500

*Widths outside this standard range are available on request for some products
** For grades M210-35A and M230-50A the maximum width is 1190 mm



"Electrical steels play a vital role in the generation, transmission, distribution and use of electrical power."

Insulation coatings

Cogent Power's electrical steels are supplied with customer specified coating to improve surface insulation resistance and precisely tailor the electrical steel to the customer's processing requirements.

Coatings have differing properties and the thickness can be tailored according to requirements.
New coatings combine performance with the environment.

We ensure that our materials are produced under safe and environmentally friendly conditions and this duty of care is carried forward into application.

Our formaldehyde free and organic coating, Suralac 7000FF ensures a clean working environment in application, free from potentially hazardous fumes.

Our new bonded coating, Suralac 9000, is now available for our thin gauge products. This coating may be heated to enable lamination stacks to bond together. This type of bonding delivers improved noise performance for large volume production of thin materials and is compatible with other traditional insulation coatings.

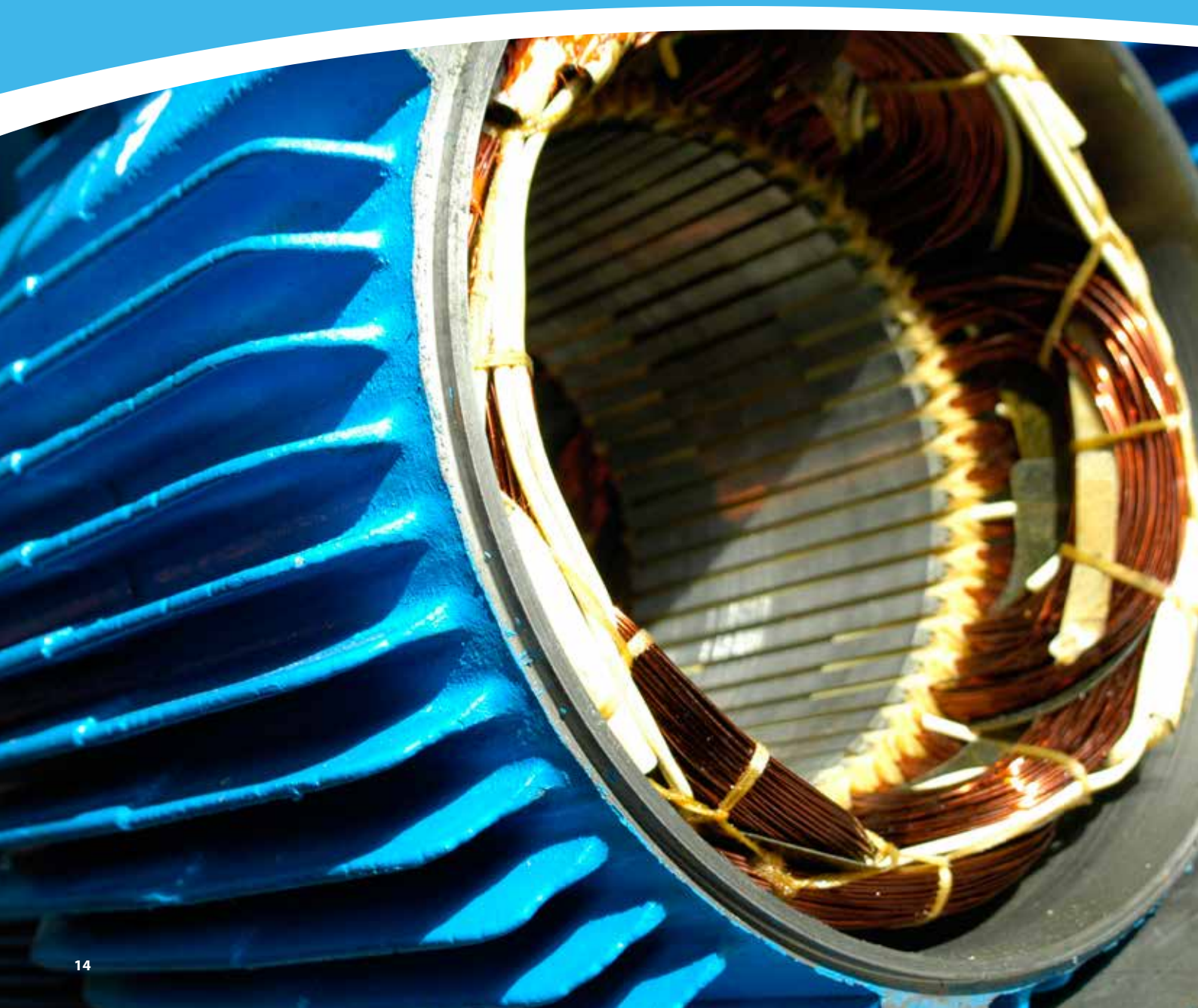


Table 6: Technical properties coatings

Designation	Suralac® 1000			Suralac® 3000 Suralac® 3000FF[1]		Suralac® 5000		Suralac® 7000			Suralac® 9000
Type	Organic			Organic with fillers		Semi-organic		Inorganic			Organic
Description	Organic synthetic resin			Organic synthetic resin with inorganic fillers FF = Formaldehyde free		Organic resin with phosphates and sulphates		Phosphate based with inorganic fillers and some organic resin			Epoxy based coating for bonding of stamped parts[2]
Class acc. IEC 60404-1-1	EC-3			EC-6		EC-5-P		EC-5-N / EC-5-AS			—
Class acc. ASTM A976-97	C-3			C-6		—		C-4 / C-5[3]			—
Thickness range, per side	0.7 - 6 µm			3.5 - 6 µm		0.7 - 1.2 µm		0.7 - 3.5 µm			3.5 - 5.5µm
Standard thickness	2.5 µm			6 µm		1.2 µm		1.5 µm			4.5 µm
Colour	Clear to brown			Grey		Brown to grey		Grey			Clear
Temperature capability:											
in air (continuous)	180°C			180°C		200°C		270°C			[2]
in inert gas (intermittent)	450°C			500°C		500°C		850°C			—
Withstands:											
Stress relief annealing[4]	—			—		—		YES			—
Burn-out repair	—			YES		—		YES			—
Aluminium casting	YES			YES		YES		YES			—
Chemical resistance:											
Stamping lubricants[5]	YES			YES		YES		YES			—[6]
Transformer oils	YES			YES		YES		YES			YES
Freon	YES			YES		YES		YES			YES
Typical pencil hardness	8 - 9 H			8 - 9 H		8 - 9 H		9 H			5 - 7 H
Typical thickness:											
µm per side	0.7	2.5	6	3.5	6	0.7	1.2	0.7	1.5	3.5	—
Typical welding[7]	good	spec	spec	spec	spec	exc	exc	exc	good	mod	—
Typical punching[7]	exc	exc	good	good	mod	good	exc	good	good	mod	good
Surface insulation resistance:											
(Franklin ASTM A717):											
Typical value, Ω·cm² per lamination	10	50	>200	>200	>200	3	7	20	40	>200	>200
Typical value, Amperes per side	0.45	0.1	<0.03	<0.03	<0.03	0.7	0.4	0.25	0.15	<0.03	<0.03

Notes:
1. Suralac® 3000FF is a formaldehyde free version of Suralac® 3000 with the same properties as this coating.
2. For properties related to bonded laminations please refer to the separate data sheet for Suralac® 9000.
3. Suralac® 7000 is classified as a C-5 coating however it can be used as a C4 coating.
4. Stress relief annealing in inert or preferably in slightly oxidizing atmosphere.
5. Testing involves all lubricants used by our present customers. New lubricants may need special consideration.
6. Lubricants used at stamping may impact on the bonding strength and are not recommended.
7. exc = excellent, good = good, mod = moderate, spec = special precautions/techniques needed.

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