



**Grain oriented
electrical steel**



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Designation and registered trademarks

Grain oriented electrical steel from Orb Electrical Steels is supplied under the trademarks of Unisil and Unisil-H

Unisil refers to conventional grain oriented steel and Unisil-H refers to high permeability grain oriented material. The trademark of Magnite describes heat resistant insulation coatings applied to these products.

The information and data in this brochure are accurate to the best of Cogent's knowledge, but are intended for general information only. Applications suggested for the materials are described only to help the reader make his or her own evaluation and decision, and are neither guarantees nor to be construed as expressed or implied warranties of suitability for these and other applications. Cogent and its subsidiaries accept no liability in respect thereof.

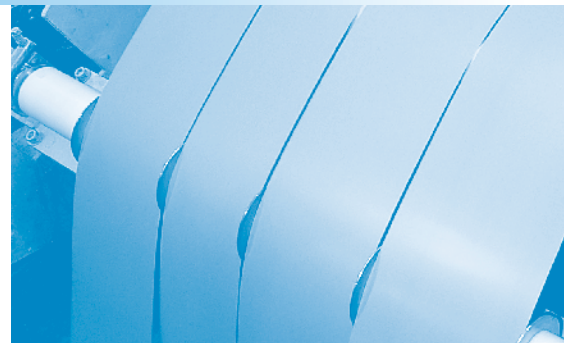
Cogent Power provides a broad range of high quality products manufactured to customers most demanding requirements, and has a responsive approach to the market.



Our Business

The business is a wholly owned subsidiary of Corus, owned by Tata Steel. 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:

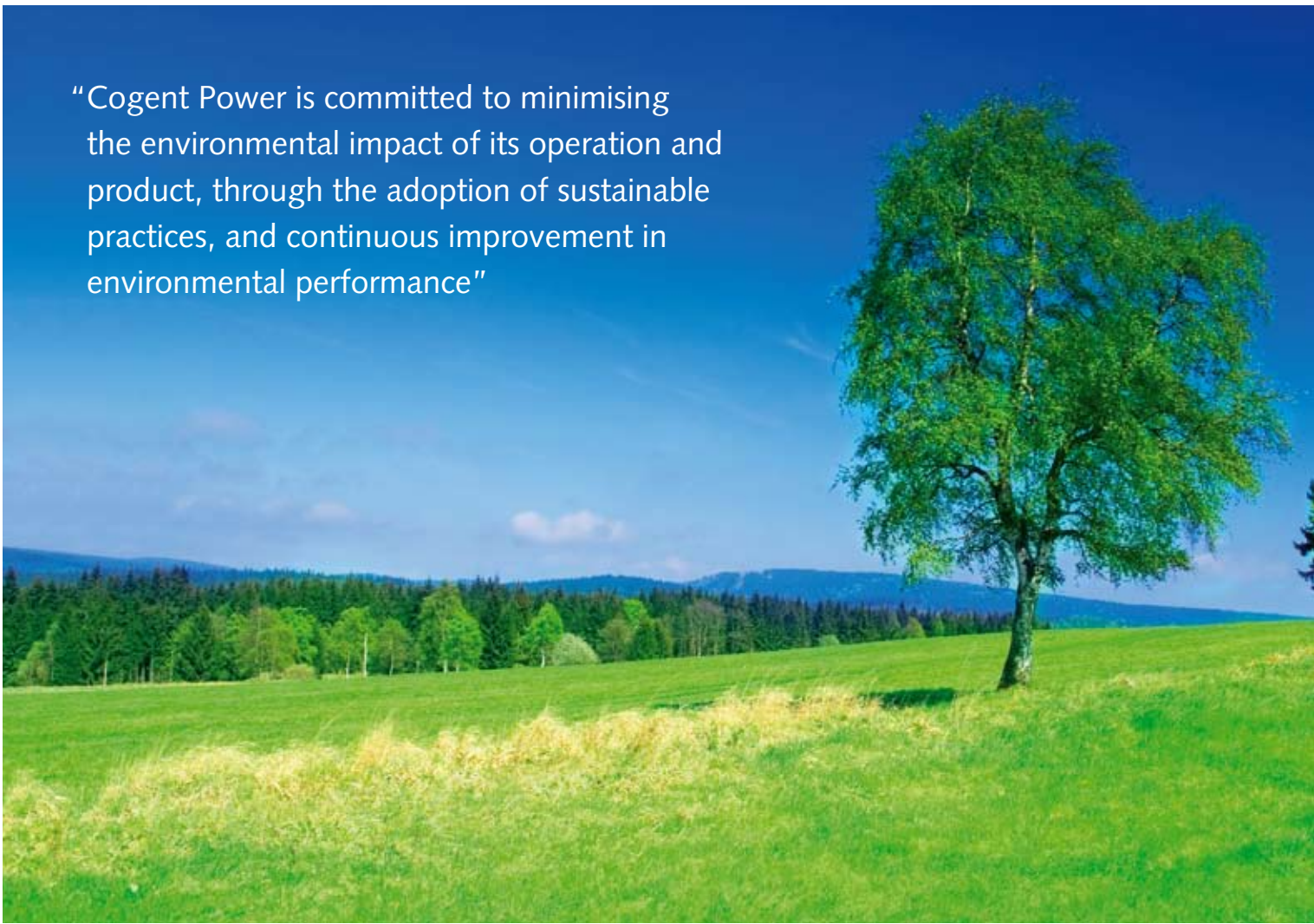
Orb Electrical Steels, in the UK is responsible for the production and global sales of specialised grain oriented steels as detailed within this product brochure.



Surahammar Bruks, in Sweden produces non-oriented fully processed 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. They are principally used for motors, generators, alternators, ballasts, 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.

This full product range is marketed worldwide direct or through the Corus global sales offices.

“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”



Downstream Integration

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.

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 losses occurring in the transmission and use of electricity from both non-renewable and renewable sources of energy, from the power station to the end user.

Reducing the energy lost in generation, transmission and distribution of electrical energy enables Cogent Power to make a significant contribution to the preservation of natural resources, through partly mitigating the environmental impact of increasing demand for energy, as well as increasing the competitiveness of renewable energy sources.

Orb is certified to ISO 14001:2004, and we continue to demonstrate our commitment to energy saving. In recognition of this, the Carbon Trust has produced a promotional video featuring Orb Electrical Steels.

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 Orb Electrical Steels is approved by Bureau Veritas to the Standard BS EN ISO 9001:2000.

Research and Development

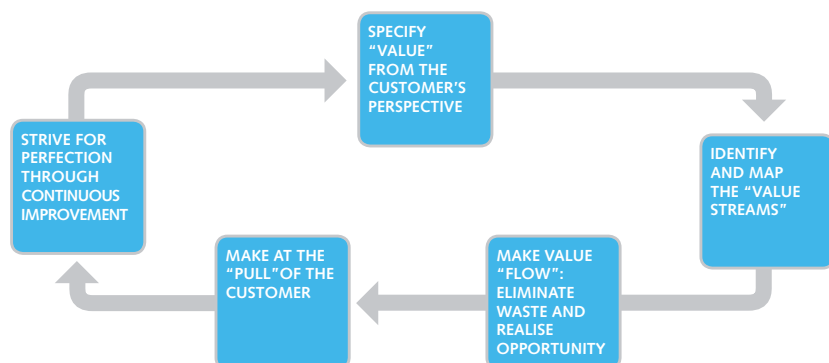
R&D has played a major role in Cogent Power for over 50 years. Although the basic types of electrical steels are based on established technologies, products and processes continue to be improved to meet increasing demands from users for enhanced properties and more cost effective solutions.

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 Corus Research Development and Technology and well renowned universities and research institutes. The company is also sponsoring the "Cogent Lectureship of Magnetics" at the Wolfson Centre of Magnetics at Cardiff University.

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.



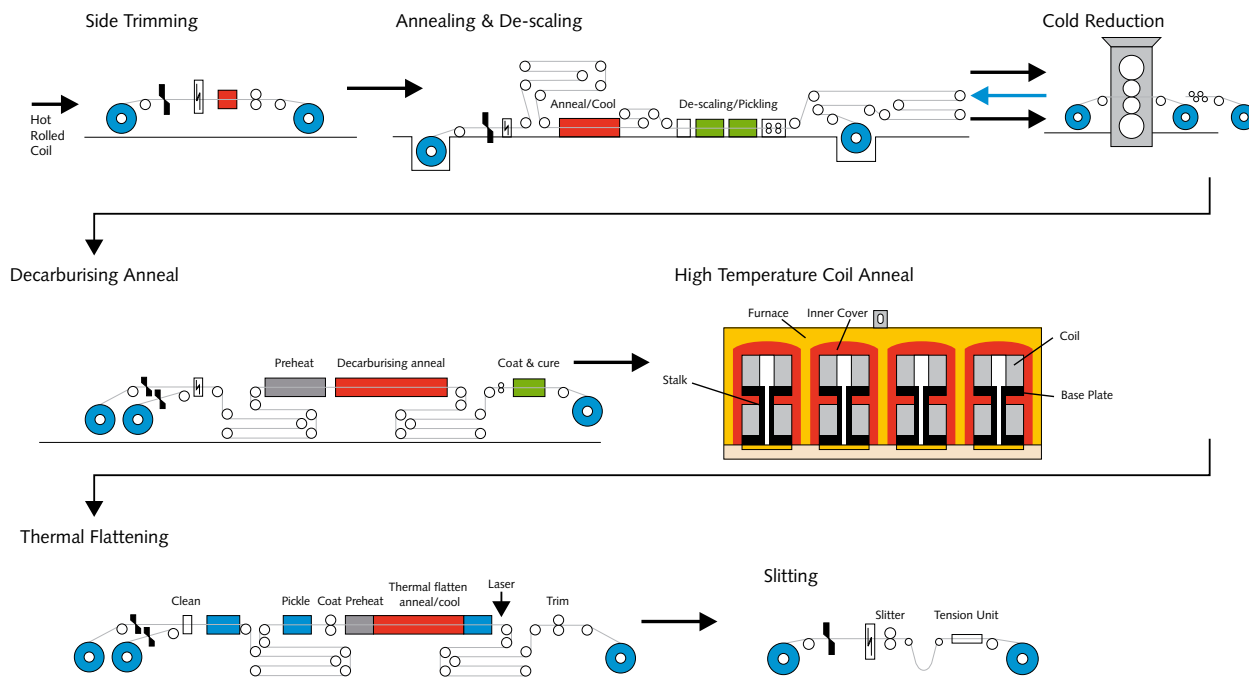
Products

Cogent Power Unisil products offer a wide choice of Grain Oriented electrical steels. All manufactured to the highest quality standards, Unisil is conventional grain oriented material between 0.23mm and 0.35mm thick and Unisil-H is high permeability grain oriented steel at a maximum thickness of 0.30mm. The product range also includes laser scribed products, which offer improved loss performance over traditional Unisil-H, through a sophisticated process of domain refinement.

Grain Oriented electrical steel is an essential material in the manufacture of energy efficient transformers

and large, high performance generators. Its unrivalled magnetic properties are a result of its unique grain structure, which is formed through a complex production process starting from high silicon hot rolled coil feedstock.

During the secondary recrystallisation process some grains grow to over 30mm in length. Whereas mild steels require a microscope to view the grain structure. The orientation of the enhanced grain structure provides significantly better magnetic properties in the rolling direction of the sheet.

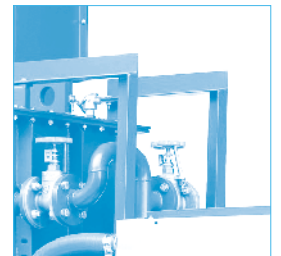
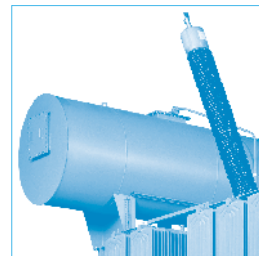
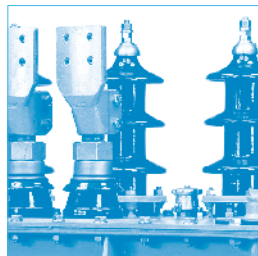


Applications

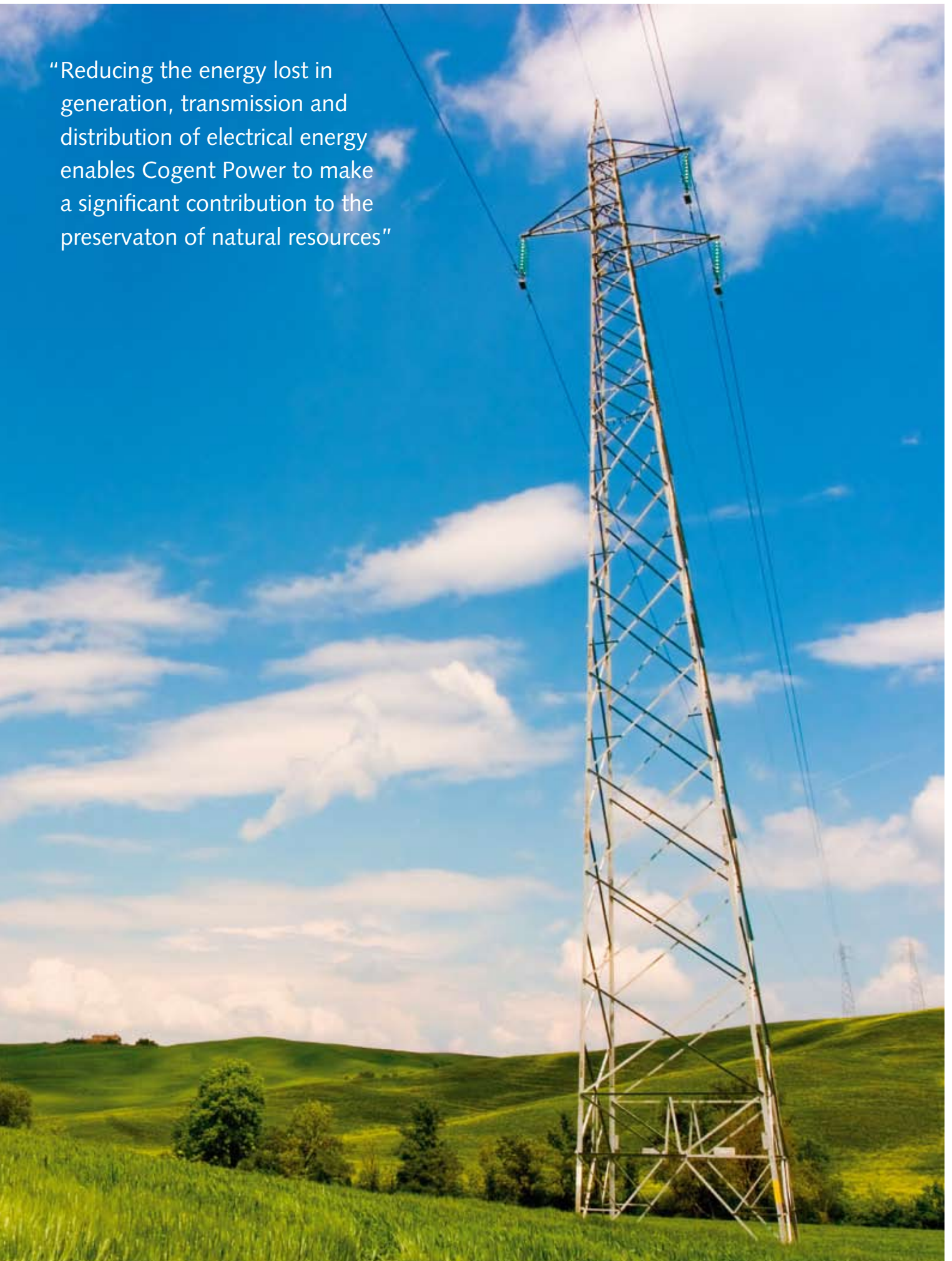
Grain Oriented electrical steels are normally used in applications where they are magnetised under AC conditions. Low power loss and high permeability characteristics are advantageous where energy efficiency, low noise and core size are important.

These applications include

- Power generators
- Large power transformers
- Distribution transformers
- Small transformers
- Current transformers
- Shunt reactors
- Wound cores



“Reducing the energy lost in generation, transmission and distribution of electrical energy enables Cogent Power to make a significant contribution to the preservaton of natural resources”



Unisil

Guaranteed Magnetic Properties

EN 10107	Thickness (mm)	Maximum specific loss (W/kg)				Typical specific loss (W/kg)				Polarization J at H=800 A/m ¹	
		50 Hz		60 Hz		50 Hz		60 Hz		50 Hz	
		1.5T	1.7T	1.5T	1.7T	1.5T	1.7T	1.5T	1.7T	Min T / Typical T	
M110-23S	0.23	0.73	1.10		1.45	0.70	1.07	0.92	1.41	1.78	1.83
M120-23S	0.23	0.77	1.20		1.58	0.73	1.15	0.96	1.51	1.78	1.83
M127-23S	0.23	0.80	1.27		1.67	0.77	1.24	1.01	1.63	1.75	1.82
M120-27S	0.27	0.80	1.20		1.58	0.78	1.14	1.03	1.50	1.78	1.83
M130-27S	0.27	0.85	1.30		1.71	0.83	1.24	1.09	1.63	1.78	1.83
M140-27S	0.27	0.89	1.40		1.84	0.86	1.32	1.13	1.74	1.75	1.82
M130-30S	0.30	0.85	1.30		1.71	0.84	1.21	1.11	1.59	1.78	1.83
M140-30S	0.30	0.92	1.40		1.84	0.87	1.26	1.15	1.66	1.78	1.83
M150-30S	0.30	0.97	1.50		1.97	0.91	1.31	1.20	1.72	1.75	1.82
M140-35S	0.35	1.00	1.40		1.84	0.94	1.33	1.24	1.75	1.78	1.83
M150-35S	0.35	1.05	1.50		1.97	0.99	1.42	1.30	1.87	1.78	1.83
M165-35S	0.35	1.11	1.65		2.17	1.01	1.47	1.33	1.94	1.75	1.82

Note 1: J represents the peak magnetic polarisation in Teslas. H represents the peak magnetic field strength in A/m

Unisil Global Standards Equivalents

EN 10107	ASTM A876	JIS C2553
M110-23S		23 G 110
M120-23S	23 G 045, 23 H 070	
M127-23S		
M120-27S	27 H 074	27 G 120
M130-27S	27 G 051	27 G 130
M140-27S		
M130-30S		30 G 130
M140-30S	30 H 083	30 G 140
M150-30S	30 G 058	
M140-35S		35 G 145
M150-35S	35 H 094	35 G 155
M165-35S	35 G 066	



Unisil-H

Guaranteed Magnetic Properties

EN 10107	Thickness (mm)	Maximum specific loss (W/kg) at 1.7T		Typical specific loss (W/kg) at 1.7T		Polarization J at H=800 A/m ¹	
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	
M085-23P*	0.23	0.85	1.12	0.81	1.07	1.88	1.90
M090-23P*	0.23	0.90	1.18	0.86	1.13	1.88	1.90
M095-23P*	0.23	0.95	1.25	0.91	1.20	1.88	1.90
M100-23P	0.23	1.00	1.32	0.96	1.27	1.85	1.88
M090-27P*	0.27	0.90	1.18	0.87	1.14	1.88	1.90
M095-27P*	0.27	0.95	1.25	0.92	1.21	1.88	1.90
M103-27P	0.27	1.03	1.36	0.97	1.28	1.88	1.93
M100-30P*	0.30	1.00	1.32	0.97	1.28	1.88	1.93
M105-30P	0.30	1.05	1.38	1.02	1.34	1.88	1.93
M111-30P	0.30	1.11	1.46	1.08	1.42	1.88	1.93

Note 1: J represents the peak magnetic polarisation in Teslas. H represents the peak magnetic field strength in A/m

Note 2: The grades marked with * are enhanced lower loss, high permeability grades. These products may be laser scribed at the producer's discretion.

Domain Refined Material

The process of laser domain refinement does not affect the adherence or electrical resistance of the coating.

Unisil-H Global Standards Equivalents

EN 10107	ASTM A876	JIS C2553
M085-23P*		23 R 085
M090-23P*	23 Q 054	23 P 090
M095-23P*		23 P 095
M100-23P	23 P 060	23 P 100
M090-27P*		27 R 090
M095-27P*	27 Q 057	27 R 095
M103-27P	27 P 066	27 P 100
M100-30P*		
M105-30P		30 P 105
M111-30P		30 P 110



Specific Total Loss

Single Sheet Tests

Orb Electrical Steels samples, tests, and grades all coils of Unisil and Unisil-H in the single sheet non-annealed condition.

The method of measurement of the power loss used at Orb Electrical Steels is that described by IEC 60404-3. It is of key importance that this standard incorporates an informative annex to correlate single sheet and Epstein tests in grain oriented material. The range of conversion factors, which are declared in the standard IEC 60404-3 Annex C, has been accepted by Orb Electrical Steels and is used to provide an Epstein result on the test certificate.

Annealed Epstein samples are taken at regular intervals for process control purposes.



Magnetic Properties

The Magnetic Testing Laboratory reports the magnetic properties of every coil of Unisil and Unisil-H on a test certificate. In addition to the specific total loss at the guarantee level of peak magnetic flux ($J=1.5T$ or $1.7T$), measurements are reported for the specific apparent power, magnetic field strength and permeability. The customer receives a comprehensive summary of loss and magnetic properties for each coil of material purchased.

Dimensions, Ranges and Tolerances

Dimension	Standard coil (mm)	Slit widths (mm)
Inside diameter	508	508
Width	950-1000	>10

Dimension Tolerances

Thickness tolerance	mm
Max. variation on nominal thickness	+/- 0.030
Max. variation in thickness parallel to rolling direction within 1500mm	0.030
Max. variation in thickness perpendicular to rolling direction at min distance of 40mm from edge	0.020
Width tolerance	mm
Standard widths - side trimmed	+2/-0
Slit widths	
<150mm	+0/-0.2
>150-400	+0/-0.3
>400-750	+0/-0.5
>750-1000	+0/-0.6

Note 1: For 0.23mm the maximum variation on nominal thickness is +/-0.025mm



Other Characteristics

Residual Curvature	mm
Edge camber	
Max. edge camber for measuring length 1500mm on material >150mm	0.5
Flatness	
Burr height for slit coil, max.	0.025

Weight per Unit Area	
Nominal thickness mm	Weight per unit area kg/m ²
0.23	1.721
0.27	2.023
0.30	2.257
0.35	2.654

Measurement methods for thickness and width are given in the product standard EN10107 and IEC 60404-8-7.

All other measuring methods and definitions are available in EN10251 and IEC 60404-9

Insulation Coatings

Unisil and Unisil-H products are covered on both sides with a thin inorganic coating. This is applied over the glass film layer, which is formed during the high temperature annealing process.

The coating is approximately 3 microns thick per side and provides a good electrical resistance with only a marginal effect on the stacking factor. The coating has good adherence properties and will withstand normal punching operations, and is resistant to annealing up to 840 degrees centigrade. The coating is chemically resistant to any fluid contamination during the production process. It gives some protection against corrosion and is unaffected by different types of transformer oils.

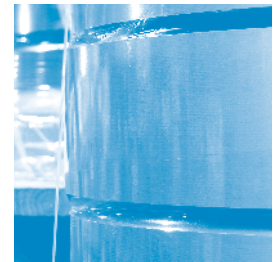
The coating applied to the Unisil product range does not contain chromium bearing compounds.

Magnetostriction and Noise

The magnetostriction coefficient of the transformer core lamination is a significant parameter in determining the acoustic noise output of the transformer. The Magnite coating is beneficial in controlling the magnetostriction of the material by creating a tension in the steel.

Typical Physical Properties

Density kg/dm ³	7.65
Silicon content %	3.1
Resistivity microhm-cm	48
0.2 % Proof Stress N/mm² (kg/mm²)	
Parallel to rolling direction - Unisil/Unisil H	310/320 (31.6/32.6)
Perpendicular to rolling direction - Unisil/Unisil H	330/340 (33.7/34.7)
Ultimate tensile strength N/mm² (kg/mm²)	
Parallel to rolling direction	350 (35.7)
Perpendicular to rolling direction	400 (40.8)
% elongation on 80mm gauge length	
Parallel to rolling direction	10
Perpendicular to rolling direction	30
Hardness HV 2.5kg	175
Bend Test	>6
Stacking Factor % (minimum)	
0.23mm	96.0
0.27mm	96.0
0.30mm	96.5
0.35mm	97.0



Packing

As part of the ongoing commitment to health and safety, Orb Electrical Steels, after palletisation, uses 100% plastic packaging, on both full width and slit coils.

Our products are packed to offer suitable protection for the mode of transport and the global destination point of the material.

Coils for delivery by road transport, are normally packed, bore vertical, wrapped in VCI (rust inhibitor) cling film with a rigid plastic top cap and strapped using 2 plastic bands to the pallet.

Coils that are transported by container vessels have in addition a bottom disc and a rigid plastic wrap around the outside secured by 3 circumferential bands, before being plastic strapped to the pallet. Coils are secured into containers on-site at Orb and checked for security. Any further wooden packing material is certified as necessary.



Photograph courtesy of Areva T&D



Further Processing

Grain oriented electrical steel is used for the manufacture of magnetic cores within transformers. The best magnetic properties are only found in the rolling direction due to the nature of the manufacturing process. If the material is magnetised outside the rolling direction the core losses increase significantly. The extent of this increase varies from a factor of three times at 90 degrees and four times at 60 degrees.

It is therefore essential that the material is magnetised as precisely as possible along the rolling direction throughout the magnetic circuit.

Mechanical Stress

Grain oriented electrical steel is sensitive to mechanical stress which can have a significant negative impact on the magnetic performance of the material. Mechanical stress can be imparted into the material in a variety of ways. External forces can impart stress through excessive or uneven compression upon the laminations. Internal stress is generated along the cut edges during slitting or cutting operations or as a result of bending the sheet or subjecting it to tension beyond the yield point.

Careful processing and the use of correctly adjusted sharp tungsten carbide tools and blades are necessary to minimize the introduction of residual stresses, which can cause a marked deterioration in the specific total loss. These stresses of processing, which are sometimes unavoidable, can be completely eliminated through stress relief annealing of the material.

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

Stress Relief Annealing

Several methods of stress relief annealing are available:

Batch Annealing (760 to 840 degrees centigrade, typically 800 degrees centigrade +/-20 degrees)

The material is packed carefully into an inner cover before annealing for two hours at the specified temperature in a dry atmosphere. Excessive temperature gradients during the heating and cooling cycles must be avoided to prevent lamination distortion. It should be noted that the size of the lamination would influence the duration of the annealing cycle.

Mesh Belt Annealing (800 degrees centigrade +/-10 degrees)

Stacks of laminations are annealed in a mesh belt furnace when it is required that they are held at the specified temperature for about one hour. Annealed laminations are subject to distortion, but this may be controlled by the adjustment of stack height and cooling rate in the inert atmosphere.

Roller Hearth Annealing (800 degrees centigrade +/- 10degrees)

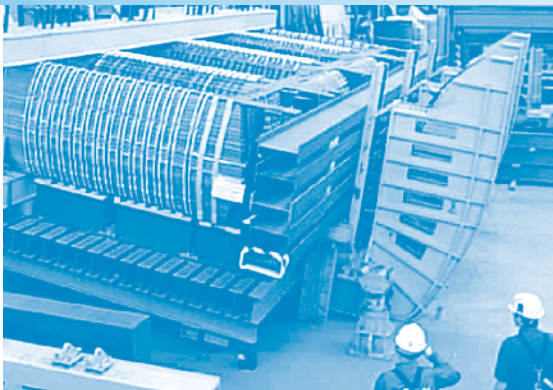
Roller hearth annealing (30 to 60 seconds at the specified temperature in an air atmosphere) of single laminations should result in the laminations being stress free and non-oxidised (the rapid anneal prevents oxidation).

Annealing of wound toroidal cores

Wound toroidal cores may be annealed in batch furnaces or in mesh belt furnaces under the conditions described above. It is important that the cores are not excessively stressed during winding and that they are not subjected to rapid rates of cooling

Domain Refined Material

Stress relief annealing of laser domain refined material reverses the reduction of the core losses produced by the laser treatment.



Photograph courtesy of Areva T&D



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