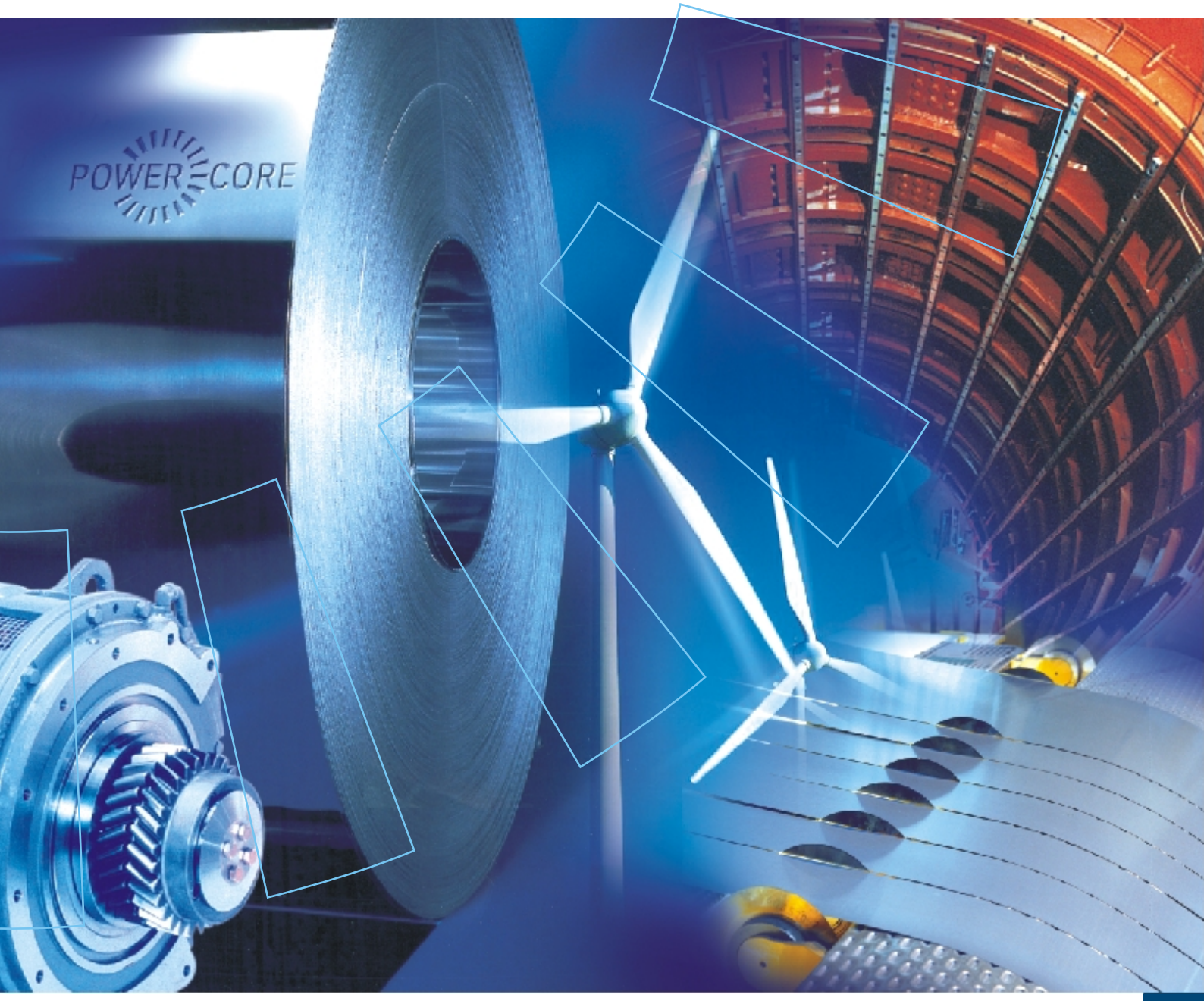
Our Products
PowerCore Solutions



A company
of ThyssenKrupp
Steel

ThyssenKrupp Electrical Steel India Private Limited

ThyssenKrupp

Assignment

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Editor
ThyssenKrupp Electrical Steel India Private Limited

Responsible For Contents
Sales & Marketing
Application Engineering

Contents

About Us

ThyssenKrupp Electrical Steel India Private Limited (TKES India), a wholly owned subsidiary of ThyssenKrupp Steel, Germany, was formed in September 2000.

Our core business is Electrical steel: An Energy Efficient Steel of national importance for electrical equipment.

Electrical steel products of ThyssenKrupp are called "PowerCore" in all forms worldwide. TKES India is the only company in India producing & offering entire range of non-ageing, electrical steel.

Our PowerCore products are Cold Rolled Non Grain Oriented Electrical Steel in fully & semi processed varieties (NGO FP & NGO SP) and Cold Rolled Grain Oriented Electrical Steel.

We also produce special qualities of Carbon Steel products for Automotive, White Goods and Engineering Applications.

Quality and Environment Management systems of ISO 9001 and ISO 14001, updated to latest revision, ensure our efficiency and a responsible treatment of environment. The quality of our products outperform national and international standards.

TKES India is providing complete business solutions and enjoys long-term trust and business association of customers in India and worldwide.

Application Engineering

The Application Engineering activities at ThyssenKrupp Electrical Steel India are focused to meet the demand of our customers with centralized R & D support from Europe. Main task of our Application Engineering are:

1. Improvement of magnetic, mechanical and technological properties of our standard products as well as development of new grades of electrical steel by:
   - Development of appropriate insulation varnish for various requirements of our customers.
   - Optimization of processing steps

     Analysis of feasibility and application of new technologies for improving production process.

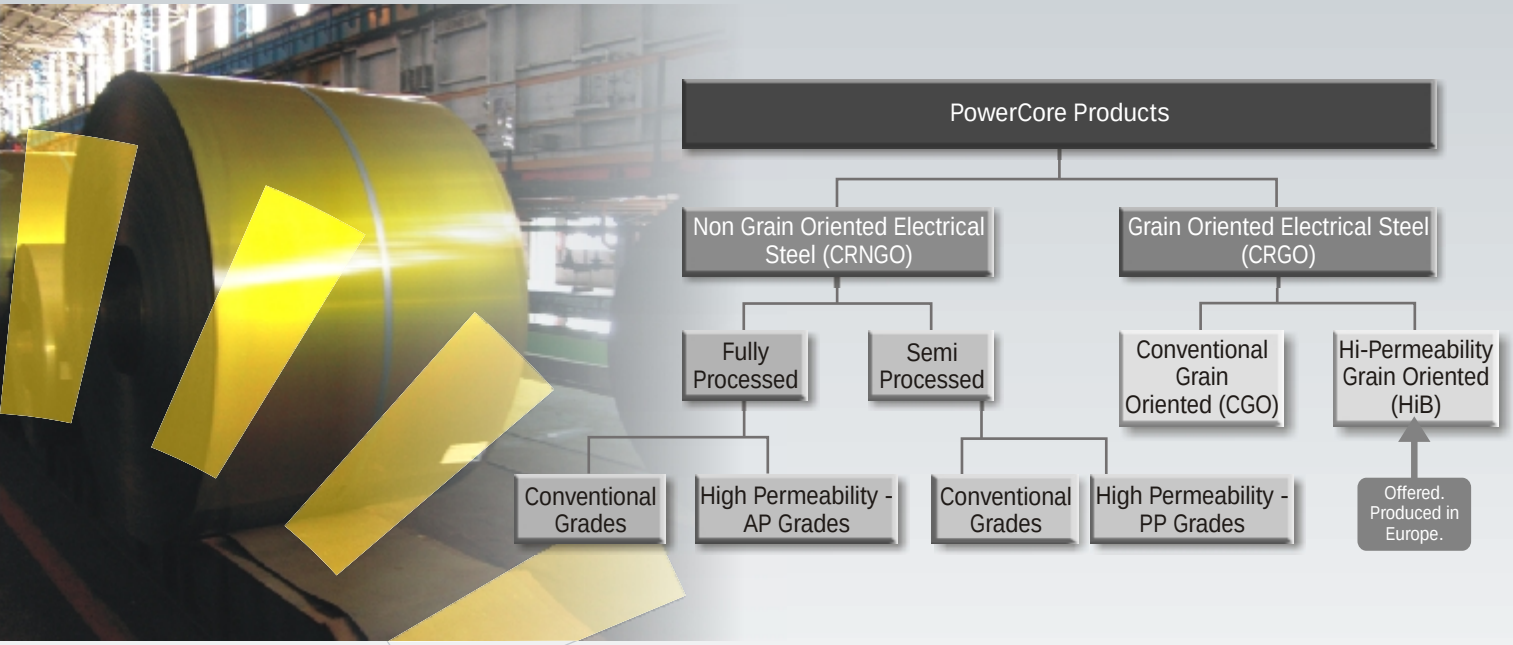
2. Co-operation with customers in developing optimal solutions for the electromagnetic systems by:

   Development of tailor made grades for special application.

   Right choice and economic use of electrical steel for various applications.

The vast technological know how and experience within ThyssenKrupp enable us to carry out Application Engineering activities.

PowerCore Product Family



Electrical Steel comprise of large family of Steels, generally called "soft magnetic materials". Without electrical steel the economic generation, distribution & utilization of electricity would not be practical. Wide diversity of electrical machines, equipment and systems requires specific electro-magnetic and mechanical behaviour of core material

Our PowerCore products come to you with a host of advantages like several choices of insulation coatings & nominal thicknesses, slit widths and cut sheets in rectangular or parallelogram shapes. The designer can select optimal grade required from standard high permeablity and superior core losses for applications starting from micro motors to power generators and transformers. Our highly skilled Application Engineering team works very closely with our customers to develop and supply customised PowerCore products.

PowerCore Non Grain Oriented Fully Processed Steel - NGO FP Properties

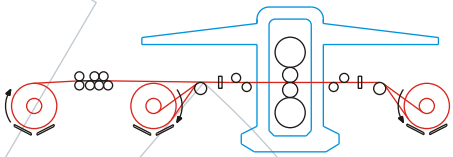
Thick-ness (mm)	PowerCore Grade (1)	Core Loss W/kg at 1.5T at 50Hz		Magnetic Polarization (2) B@2500 (A/m) (Tesla)	Magnetic Polarization B@5000 (A/m) (Tesla)		Hardness @1kg
		Guaranteed	Typical	Typical	Guaranteed	Typical	Vickers
0.35	35C250	2.50	2.45	1.53	1.60	1.63	220±15
0.35	35C270	2.70	2.60	1.53	1.60	1.63	215±20
0.35	35C300	3.00	2.85	1.55	1.60	1.63	200±20
0.35	35C330	3.30	3.15	1.58	1.60	1.63	180±15
0.50	50C250	2.50	<2.50	1.50	1.60	1.61	215±20
0.50	50C270	2.70	2.60	1.51	1.60	1.63	215±20
0.50	50C290	2.90	2.75	1.51	1.60	1.63	215±20
0.50	50C310	3.10	2.95	1.54	1.60	1.63	200±20
0.50	50C330	3.30	3.15	1.54	1.60	1.64	180±15
0.50	50C350	3.50	3.35	1.56	1.60	1.64	180±15
0.50	50C400	4.00	3.85	1.56	1.63	1.64	155±20
0.50	50C470	4.70	4.20	1.56	1.64	1.66	145±15
0.50	50C530	5.30	4.70	1.59	1.65	1.67	150±15
0.50	50C630	6.30	5.70	1.61	1.65	1.70	130±15
0.50	50C700	7.00	6.30	1.61	1.69	1.71	130±15
0.50	50C800	8.00	7.20	1.62	1.70	1.71	125±10
0.65	65C330	3.30	3.15	1.49	1.60	1.62	215±20
0.65	65C350	3.50	3.35	1.53	1.60	1.63	215±20
0.65	65C400	4.00	3.85	1.53	1.62	1.63	180±15
0.65	65C470	4.70	4.30	1.54	1.63	1.64	160±15
0.65	65C530	5.30	4.70	1.55	1.64	1.65	150±20
0.65	65C800	8.00	7.40	1.61	1.70	1.71	130±15

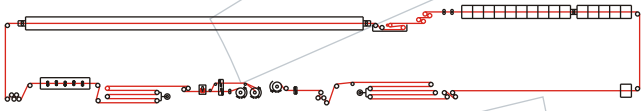
(1) For grades other than mentioned above please enquire separately.
(2) The Magnetic Polarization values at 2500 A/m are reference values and for information only.

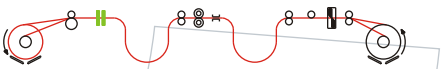
The quality characteristics of PowerCore fully processed grades are fully developed and guaranteed in as supplied condition. Typical Core Loss & Magnetic Polarization values outperform the standard values. Our extensive expertise in production processes, the use of modern testing equipment & updated measuring methods results in an extremely uniform product.

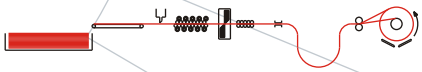
The Core Loss is influenced by Carbon, Silicon and Aluminum contents in steel. The Volume resistivity of metal increases with increasing alloying content reducing the eddy current loss. Additionally, the coercive field strength & the heat conductivity are reduced whereas hardness and strength increases.

PowerCore Non Grain Oriented Fully Processed Steel - NGO FP Production flow









Pickling

The starting material is ultra pure hot rolled coils supplied to precisely determined specifications by carefully selected suppliers. The hot rolled coils are cleaned and descaled in Pickling line.

Cold Rolling

After pickling the coils are cold rolled to desired thickness with very close thickness tolerances by using modern guage control methods.

Tandem Annealing, Decarburizing and Coating

The cold rolled coils are treated in state of the art continuous annealing, decarburizing and coating line. During decarburizing, the carbon content of the strip is reduced to a level which avoids magnetic ageing. Precisely controlled furnace parameters like strip speed, temperatures and composition of inert gas atmosphere are determined as per customer's requirement of properties. The strip is coated on both sides with one of our wide choice of insulations customized to final application requirements.

Slitting / Trimming

The finished coils, after extensive quality tests, are slitted / trimmed to the dimensions required by our customers with close width tolerances.

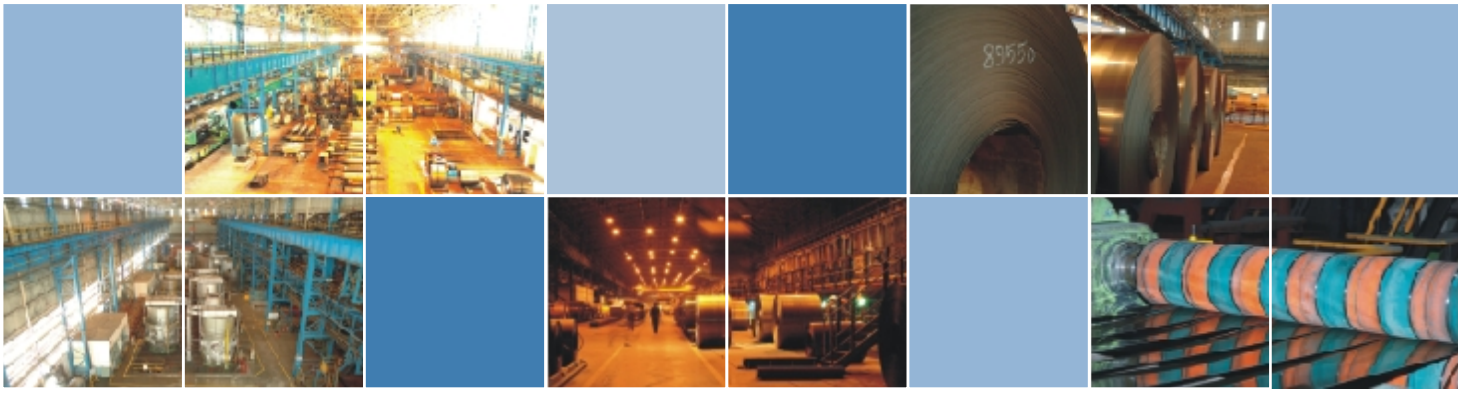
Cut to Length

Coils are sheared to customer's specified lengths. Coils can also be sheared in shapes like parallelogram etc.

PowerCore Non Grain Oriented Fully Processed Steel - NGO FP Grades according to standards

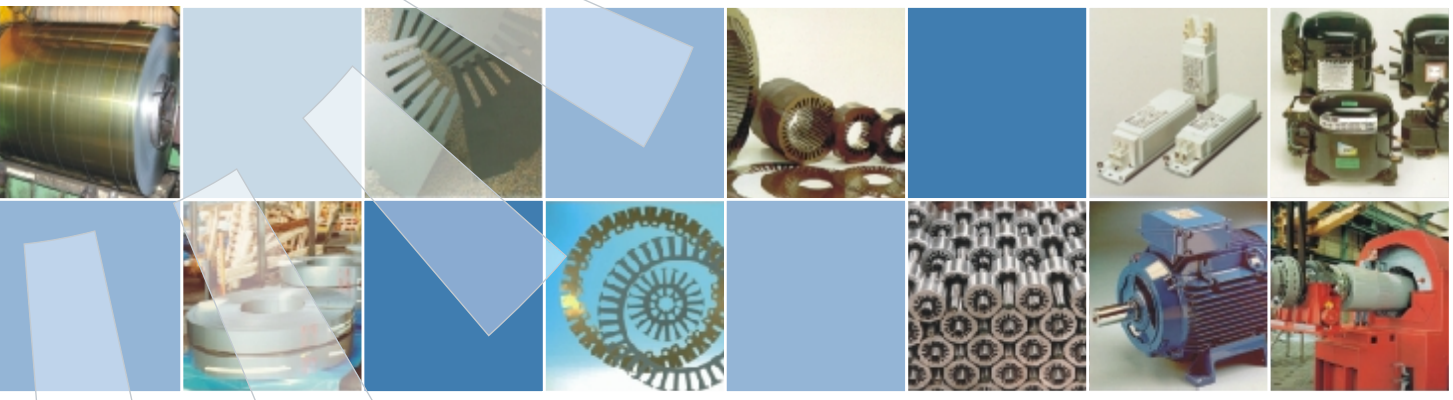
Thickness (mm)	Core loss @1.5T, 50Hz (W/Kg)	PowerCore Grade	Grades according to				
			IEC 60404-8-4: 1998	IS 648: 2006	JIS C 2552: 2000	ASTM A677M: 1999	Former AISI
0.35	2.50	35C250	M250-35 A5	35C250	35A250	36F145	M15
0.35	2.70	35C270	M270-35 A5	35C270	35A270	36F155	M19
0.35	3.00	35C300	M300-35 A5	35C300	35A300	36F175	M22
0.35	3.30	35C330	M330-35 A5	35C330	-	36F185	M36
0.50	2.50	50C250	M250-50 A5	-	50A250	-	-
0.50	2.70	50C270	M270-50 A5	50C270	50A270	-	-
0.50	2.90	50C290	M290-50 A5	50C290	50A290	47F165	M15
0.50	3.10	50C310	M310-50 A5	50C310	50A310	47F180	M19
0.50	3.30	50C330	M330-50 A5	50C330	50A330	47F190	M27
0.50	3.50	50C350	M350-50 A5	50C350	50A350	47F200	M36
0.50	4.00	50C400	M400-50 A5	50C400	50A400	47F240	M43
0.50	4.70	50C470	M470-50 A5	50C470	50A470	47F280	-
0.50	5.30	50C530	M530-50 A5	50C530	-	-	M45
0.50	6.30	50C630	M630-50 A5	50C630	-	-	-
0.50	7.00	50C700	M700-50 A5	50C700	50A700	47F400	M47
0.50	8.00	50C800	M800-50 A5	50C800	50A800	47F450	-
0.65	3.30	65C330	M330-65 A5	65C330	-	-	-
0.65	3.50	65C350	M350-65 A5	65C350	-	64F200	M19
0.65	4.00	65C400	M400-65 A5	65C400	-	64F225	M27
0.65	4.70	65C470	M470-65 A5	65C470	-	64F275	M43
0.65	5.30	65C530	M530-65 A5	65C530	-	-	-
0.65	8.00	65C800	M800-65 A5	65C800	65A800	-	(M47)

Designation within "( )" indicates approximate equivalence



PowerCore Non Grain Oriented Fully Processed Steel - NGO FP Main applications

		PowerCore Grade												
	MACHINES	Gr1000	65C800 50C800	50C700	50C630	50C470 50C530 65C530	50C400	50C350 65C400	50C330	35C300 50C310	50C290	50C270 65C350	35C250 35C270 65C330	50C250
Rotating Machines	Large Rotating Machines							✸	✸	✸	✸	✸	✸	✸
	Medium Capacity Rotating Machines					✸	✸	✸						
	General Use A.C Motors				✸	✸								
	Hermetically Sealed Motors				✸	✸	✸							
	Home Appliance Motors		✸	✸	✸									
	Small Motors			✸	✸	✸								
	Fractional Horse Power Motor		✸	✸	✸									
	Domestic Fan & Industrial Motors	✸	✸											
Static Machines	Small Power Transformer							✸	✸	✸	✸	✸	✸	✸
	Reactor							✸	✸	✸	✸	✸	✸	✸
	Audio Transformer				✸	✸	✸	✸	✸					
	Instrument Transformer						✸	✸	✸	✸				
	Ballast			✸	✸	✸	✸	✸	✸					
	Welding Transformer						✸	✸						
	Magnetic Switches						✸	✸	✸					



PowerCore Non Grain Oriented Fully Processed High Permeability Steel - (AP) Type Properties and Applications

Thickness mm	PowerCore Grade (2)	Core Loss W/kg at 1.5 T at 50Hz		Magnetic Polarization Typical		Permeability Typical (1)
		Guaranteed	Typical	B@ 2500 (1) (A/m) (Tesla)	B@ 5000 (A/m) (Tesla)	μ
0.50	50C350 - AP	3.50	3.35	1.58	1.67	> 1100
0.50	50C400 - AP	4.00	3.85	1.56	1.66	> 1200
0.50	50C470 - AP	4.70	4.20	1.62	1.71	> 1600
0.50	50C630 - AP	6.30	5.50	1.63	1.73	> 2000

(1) The Magnetic Polarization values at 2500 A/m & permeability are reference values and for information only.
(2) For grades other than mentioned above please enquire separately.

PowerCore Non Grain Oriented Fully Processed High Permeability Steel has been developed for the first time in the country by TKES India with technological know-how provided by ThyssenKrupp, Germany. They are called "PowerCore AP Grades" and designated by suffix "AP".

Magnetic properties in all directions are significant for PowerCore AP grades. We achieve this by means of a special manufacturing technology which results in an advantageous isotropic texture in all directions in the plane of the sheet.
At medium field strength PowerCore AP grades can be more readily magnetized resulting into increased magnetic polarization value (Permeability).

PowerCore AP grades offer decisive advantages especially for higher field strength, mini motors in the field of application up to 200 Hz and medium sized motors for which a good heat conductivity of the steel sheet is important. For ballasts, these grades enable a higher rated working induction.

In general, PowerCore AP grades help in downsizing the motor and reduce the overall cost of electrical equipment due to reduced consumption of Copper as well as Steel.

The following points are note worthy for PowerCore AP Grades:

For a given core loss, these steels exhibit substantially higher Magnetic polarization values (by about 3-8%) than standard PowerCore Non grain Oriented Fully Processed Grades.
Permeability at 1.5 T is higher by more than 30% over standard PowerCore Non grain Oriented Fully Processed Grades.

Core Loss			Application
Higher	W 15/50 6.00 - 8.00 W/kg	→	Higher efficiency motors for consumer goods (Washing machines, food processors, car window motors, etc.)
Medium	W 15/50 3.50 - 6.00 W/kg	→	Hermetically sealed motors used in A.C. and refrigeration industries
Low	W 15/50 ≤ 3.50 W/kg	→	Electrical automobile engines and Hybrid motors

PowerCore Non Grain Oriented Semi Processed Steel - NGO SP Properties

Thickness mm	Power Core Grade (3)	Core Loss (1) W/kg at 1.5T at 50Hz		Magnetic Polarization(1,2) B@2500(A/m)(Tesla)	Magnetic Polarization(1) B@5000(A/m) (Tesla)		Hardness @1kg
		Guaranteed	Typical	Typical	Guaranteed	Typical	Vickers
0.50	50SP340E	3.40	3.20	1.58	1.62	1.64	205 ± 15
0.50	50SP390E	3.90	3.60	1.58	1.64	1.66	205 ± 15
0.50	50SP450E	4.50	3.80	1.59	1.65	1.67	180 ± 15
0.50	50SP560E	5.60	4.30	1.60	1.67	1.69	165 ± 15
0.50	50SP660D	6.60	4.80	1.62	1.70	1.70	150 ± 15
0.50	50SP890D	8.90	6.00	1.61	1.68	1.69	145 ± 15
0.50	50SP890DSHP	8.90	6.00	1.62	1.68	1.71	120 ± 10
0.50	50SP890DS	8.90	6.50	1.62	1.68	1.70	125 ± 10
0.65	65SP390E	3.90	3.60	1.56	1.62	1.65	205 ± 15
0.65	65SP630E	6.30	5.40	1.60	1.66	1.68	155 ± 10
0.65	65SP800D	8.00	6.30	1.61	1.70	1.71	160 ± 10
0.65	65SP1000DS	10.00	8.00	1.61	1.68	1.70	130 ± 12

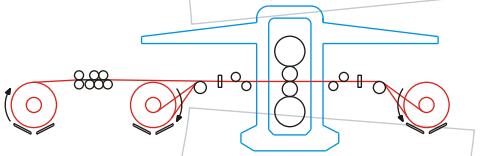
(1) Magnetic Properties are after Quality Evaluation Annealing by Epstein test.
(2) The Magnetic Polarization values at 2500 A/m are reference values and for information only.
(3) For grades other than mentioned above please enquire separately.

TKES India was the first company in India to develop Non Grain Oriented Semi Processed Steel confirming to national and international standards. We also offer ageing free predecarburized PowerCore grades enabling our customers to avoid decarburizing of lamination thereby use of expensive and explosive Hydrogen gas.
Our vast range of NGO SP steel is ideally suitable for motors 20HP or below.
In PowerCore Non Grain Oriented Semi Processed Steel, the magnetic properties are fully developed only after the Decarburization and Annealing of laminations. Magnetic properties are indicated in the test certificates, based upon annealing of Epstein samples according to the process conditions specified in IEC specifications (IEC 60404-8 -2 & IEC 60404-8-3). Typical magnetic properties vastly out performs the national and international standards.
PowerCore Non Grain Oriented Semi Processed Steel is supplied in uncoated condition with high matt finish to avoid lamination sticking in annealing.

PowerCore Non Grain Oriented Semi Processed Steel - NGO SP
Production flow

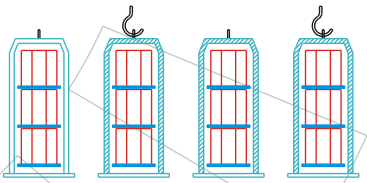
Pickling

The starting material is ultra pure hot rolled coils supplied to precisely determined specifications by carefully selected suppliers. The carbon content is maintained at lower levels to facilitate final decarburization of laminations. The hot rolled coils are cleaned and descaled in Pickling line.



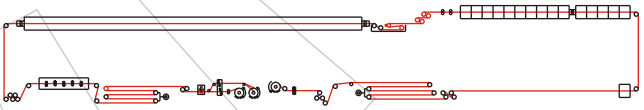
Cold rolling

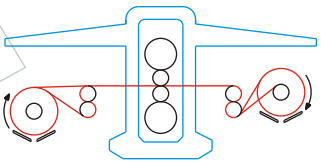
After pickling the coils are cold rolled to desired thickness with very close thickness tolerances by using modern guage control methods.



Recrystallization Annealing

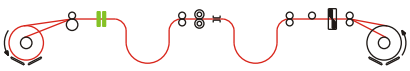
The cold rolled coils are annealed in hydrogen atmospheres in batch or continuous furnace as per customer need.





Critical Deformation

Subsequent skin pass rolling ensures good mechanical properties. This operation enables development of large grains during lamination annealing.

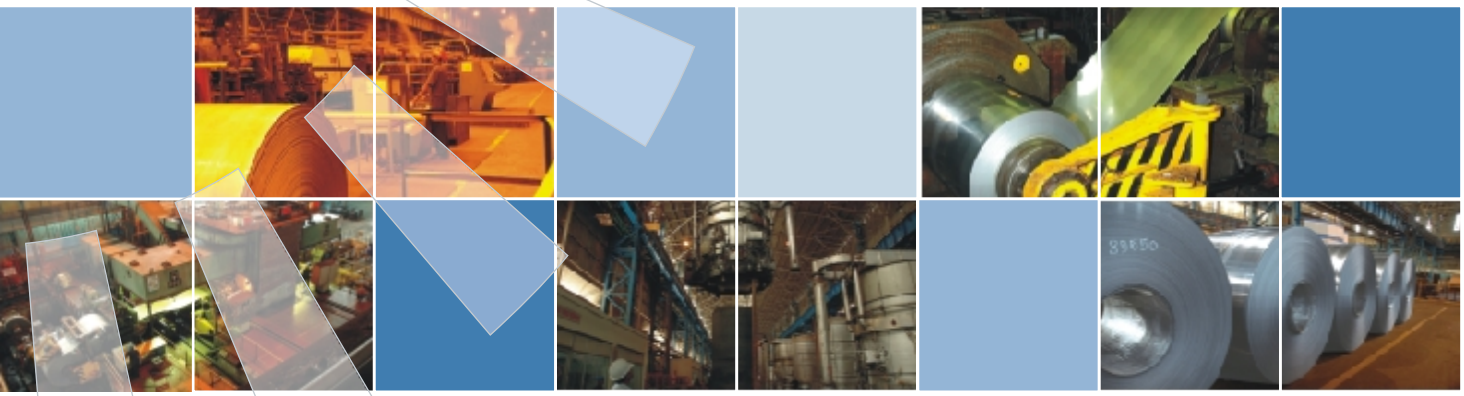


Slitting / Trimming

The finished coils, after extensive quality tests, are slitted / trimmed to the dimensions required by our customers with close width tolerances.

PowerCore Non Grain Oriented Semi Processed Steel - NGO SP Grades according to standards

Core loss @ 1.5T, 50Hz (W/Kg)	Thickness (mm)	PowerCore Grade	Grades according to		
			EN10126/165: 1996	IEC 60404-8-2 & IEC 60404-8-3: 1998	IS 15391: 2003
3.40	0.50	50SP340E	M 340-50 E	M 340-50 E 5	50SP340E5
3.90	0.50	50SP390E	M 390-50 E	M 390-50 E 5	50SP390E5
4.50	0.50	50SP450E	M 450-50 E	M 450-50 E 5	50SP450E5
5.60	0.50	50SP560E	M 560-50 E	M 560-50 E 5	50SP560E5
6.60	0.50	50SP660D	M 660-50 D	M 660-50 D 5	50SP660D5
8.90	0.50	50SP890D	M 890-50 D	M 890-50 D 5	50SP890D5
8.90	0.50	50SP890DSHP	-	-	-
8.90	0.50	50SP890DS	-	-	-
3.90	0.65	65SP390E	M 390-65 E	M 390-65 E 5	65SP390E5
6.30	0.65	65SP630E	M 630-65 E	M 630-65 E 5	65SP630E5
8.00	0.65	65SP800D	M 800-65 D	M 800-65 D 5	65SP800D5
10.00	0.65	65SP1000D	M 1000-65 D	M 1000-65 D 5	65SP1000D5



PowerCore Non Grain Oriented Semi Processed High Permeability Steel - (PP) Type Properties

Thickness mm	PowerCore Grade	Core Loss W/Kg at 1.5T at 50 Hz		Magnetic Polarization B@5000 (A/m) (Tesla)	Permeability μ at 1.5 T
		Guaranteed	Typical	Typical	Typical
0.50	390-50 PP	3.90	3.50	1.73	> 2500
0.50	560-50 PP	5.60	4.80	1.74	> 2800

Properties in the above table are after SRA (i.e 790 ^{0}C for 2 hrs in neutral or reducing atmosphere).
For other grades, please enquire separately.

PowerCore Non Grain Oriented Semi Processed High Permeability Steel has been developed for the first time in the country by TKES India with technological know-how provided by ThyssenKrupp. They are called “PowerCore PP Grades” and designated by suffix “PP”.

Magnetic properties in all directions are significant for PowerCore PP grades. PowerCore PP grades optimize two related characteristics of various electrical steels which are important for the designer: the low core loss of high alloyed grades and the high magnetic polarization of low alloyed grades. A strongly developed texture provides especially good longitudinal and transverse magnetic properties. PowerCore PP grades are supplied in predecarburized condition with anti stick weldable insulation coating.

PowerCore PP grades develop final magnetic properties after Stress Relief Annealing of laminations and decarburization annealing is avoided. PowerCore PP grades offers better punchability over standard semi processed grades even on alloy steel tools due to lower Yield Strength to Tensile Strength ratio and insulation coating. PP grades are ideal choice for energy efficient motors and motors for home appliances working at medium field strength.

PowerCore Pole Sheets Properties

Thickness mm	PowerCore Grade	Yield Strength YS Guaranteed (min) N/mm²	Tensile Strength UTS Guaranteed (min) N/mm²	% Elongation (80GL) Guaranteed (min) %	Magnetic Polarization AT 15000 AT/M Guaranteed (min) (Tesla)
	250-200TF	250	325	16	1.83
	300-200TF	300	375	15	1.82
	350-200TF	350	425	13	1.81
2.00	400-200TF	400	450	10	1.80
	450-200TG	450	550	14	1.79
	600-200TG	600	700	10	1.78
	250-100TF	250	325	16	1.83
	300-100TF	300	375	15	1.82
1.00	350-100TF	350	425	13	1.81
	400-100TF	400	450	10	1.80
	450-100TG	450	550	14	1.79
	550-100TG	550	650	12	1.78

For grades in other thickness, please enquire separately.

Cold rolled pole sheets, also called tensile steel, are graded according to the 0.2% proof stress. Minimum values of tensile strength and elongation are defined as is magnetic polarization at field strength of 15,000 AT/m.

Hot rolled material is carefully selected and processed according to a production technology related to the grades, enabling us to guarantee minimum values for our PowerCore grades. PowerCore grades are preferred for use in the poles of large high speed machines for poles and rims.

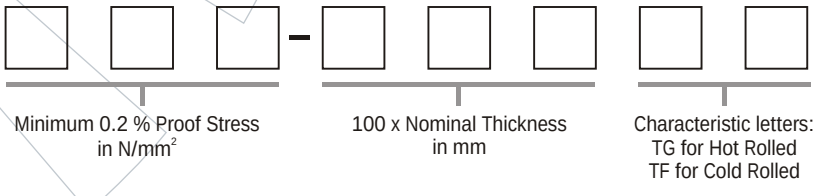
PowerCore grades in thickness of ≤ 1.0 mm can also be delivered with C6W insulation for better surface resistivity.

Dimensions, tolerances and geometric deviations are confirmed for PowerCore grades according to specification IEC 404-8-5: 1998.

Grades according to the standards

PowerCore Grade	Grades According to	
	IEC 404-8-5: 1998	JIS C 2555
250-...TF	250-...TF183	PCYC250
300-...TF	300-...TF182	PCYC300
350-...TF	350-...TF181	PCYC350
400-...TF	400-...TF180	PCYC400
450-...TG	450-...TG179	PCYH450
550-...TG	550-...TG178	PCYH550
600-...TG	600-...TG178	PCYH600

Designation of Grades



PowerCore Non Grain Oriented Steel
Dimensions and Tolerances

Nominal Thickness (1)	mm	0.35	0.50	0.65
Maximum deviation from minimal thickness	%	± 8	± 8	± 6
Maximum thickness variation parallel to rolling direction within a sheet or strip with a length of 2 m.	%	8	8	6
Maximum thickness variation transverse to rolling direction mm (measurements being made at least 30mm from slit edge)	mm	0.02	0.02	0.03
Minimum Width	mm	50	50	50
Standard Width	mm	1000	1000 & 1200*	1000
Maximum Width	mm	1120	1200*	1120
Minimum Length (2)	mm	1500	1500	1500
Standard Length	mm	2500	2500	2500
Maximum Length	mm	3500	3500	3500
Width Tolerance for width (3)				
Upto 150	mm	+ 0.20 / - 0.00		
151-300	mm	+ 0.30 / - 0.00		
301-500	mm	+ 0.50 / - 0.00		
501-1000	mm	+ 1.00 / - 0.00		
>1000	mm	+ 1.50 / - 0.00		
Length Tolerance	mm	+ 3.00 / - 0.00		

(1) For thickness > 0.65 mm please enquire separately.
(2) Material in sheet from available only for standard widths. For other requirements, please enquire separately.
(3) Negative tolerance available on specific agreement prior to ordering.
* Depends on the grade.
The specified tolerances on thickness, width and length can be customized to suit individual requirements on specific agreement prior to ordering.

Edge camber:

The edge camber shall not exceed for a measuring length of 1m.
- 0.5 mm for a nominal width > 150 mm.
- 1.00 mm for a nominal width between 30 - 150 mm.

Flatness:

Flatness does not apply to materials of width less than or equal to 100mm.
The wave factor expressed as ratio of wave height to wavelength in percentage will be below 1.5%.

Burr level:

The burr level of CR slit edge will be 50 microns max, typically it will be 30 microns.

PowerCore Grain Oriented Steel Properties

Property	Grades of TKES India					
	PowerCore C 120-27		PowerCore C 130-27		PowerCore C 140-27	
Equivalent Grade as per IEC 60404-8-7 : 1998	-		M 130-27S 5		M 140-27S 5	
Equivalent Grade as per JIS C 2553 : 2000	27G120		27G130		27G140	
IS 3024 : 2006	27CG120		27CG130		27CG140	
Coating designation at TKES India	C 5 (G)		C 5 (G)		C 5 (G)	
Equivalent Coating designation as per AISI : 1983	C5 over C2		C5 over C2		C5 over C2	
Thickness in mm	0.27		0.27		0.27	
	Guaranteed	Typical	Guaranteed	Typical	Guaranteed	Typical
Tolerance Thickness in mm	± 0.03	+ 0.01/-0.02	± 0.03	+ 0.01/-0.02	± 0.03	+ 0.01/- 0.02
Core Loss in W/Kg at 50 Hz						
@ 1.70 Tesla	1.20	1.19	1.30	1.26	1.40	1.32
@ 1.50 Tesla (Indicative)	0.80	0.79	0.85	0.83	0.89	0.86
Magnetic polarization at 800 A/m	1.80 Min.	1.82	1.78 Min.	1.82	1.75 Min.	1.78
IR (cm^2/La)	10 Min.	> 10	10 Min.	> 10	5 Min.	> 5
Stacking factor (%)	95 Min.	96	95 Min.	96	95 Min.	96
Flatness: Wave height to Wave length ratio	1.5 % Max.	< 1.0 %	1.5 % Max.	< 1.0 %	1.5 % Max.	< 1.3 %

Grain oriented electrical steel consists of a Silicon iron alloy with a body-centered cubic lattice . The cube edges of the crystals are the direction of the easiest magnetization and the lowest core loss.

The concept of orienting grains in magnetically favorable direction was discovered by N.P.Goss. The corresponding texture (110), <001> is referred as Goss texture, also called Cube-on-Edge (COE)

CRGO steels are produced under carefully controlled conditions to develop optimum magnetic properties in the rolling direction. CRGO steel develops low core loss at high induction levels when used as a core material in designs with flux path parallel to rolling direction. This contributes to low core loss in the transformers.

Applications of CRGO

Power Transformers
Distribution Transformers
Welding Transformers
Instrument Transformers
Current Transformers
Potential Transformers
Rectifiers and Reactors
UPS & Inverters.

PowerCore Grain Oriented Steel
Further Processing Hints

Direction for use: As the best magnetic property exist in Rolling direction, it is absolutely necessary to constrain the magnetization in the whole magnetic circuit as exactly as possible in the rolling direction.

Stress : Mechanical stresses exert a significant effect on the magnetic properties of the grain oriented electrical steel. Such stresses can be introduced into the strip in many ways, like -by external forces (external stresses), by plastic deformation (internal stresses). External stresses may arise if the laminations in a magnetic core are pressed into a wavy or curved shape by excessive or uneven compression. Internal stresses are generated along the cut edges during each slitting operation and as a result of bending the sheet or subjecting it to tension beyond the yield point.

Stress relieving : By stress relief annealing it is possible to reduce these unavoidable stresses almost completely. This annealing can be done in a continuous furnace under air (short annealing cycle) or in a batch type furnace under nitrogen (batch annealing cycle).

Short term annealing cycle: For the annealing of laminations the short annealing cycle in a roller hearth or mesh belt furnace is advantageous. This cycle lasts only few minutes, the annealing time being 1-2 mins between 800-860 deg. C, in air atmosphere.

Long Term annealing cycle: The long term annealing cycle is recommended for wound or small stacked cores. It is performed continuously in a mesh-belt furnace or as batch annealing in a bell type furnace. For such an annealing cycle the following cycles are recommended.

- Soaking temp.-820 deg C, max 840-850^0 C.
- Soaking time:2 hours.
- Cooling : preferably within the furnace to about 200-300^{0}C.
- Protective atmosphere: preferably 90 % Nitrogen 10 % Hydrogen.
- Traces of oxygen (1000 ppm max) are allowed.

Insulation Types

PARAMETER AISI CLASS	C3 M Organic C3	C3 ML Organic C3	C3 Y Organic C3
Coating type	Water Soluble Polyster Base	Water Soluble Polyster Base	Water Soluble Modified Phenolic Resin
Range of application	Small and Medium Electrical Machines	Small and Medium Electrical Machines	Medium to Large Machines, Traction Motors, High Voltage machine & Turbogenerators
Colour[1]	Golden Yellow	Light Golden Yellow	Grey
Avg.coating Thickness[2] µm	3.0 ± 1.0	1.5 ± 0.5	5.0 ± 1.0
Space factor (%) / Stacking factor[3]	>97.0	>97.5	>96.0
Typical average Insulation resistivity[4] In amps	0.23	0.40	0.17
Stress relief Annealing in neutral/ Reducing atmosphere	Cannot Withstand	Cannot Withstand	Cannot Withstand
Weldable	No	*	No
Pencil hardness	8H	8H	8H
Punchability[5]	3.0 X	3.0 X	2.0 X
Corrosion Resistance	Good	Satisfactory	Very Good
Resistant to Organic solvents oil & lubricant oil	Resist	Resist	Resist
Resistant to Freon gas	--	--	--

1 - Colour deviation is possible without effect on coating properties.
2- Coating Thickness is checked by FISCHER DELTASCOPE Coating Thickness Tester.
3 - Space factor is checked in accordance, with IS 649 : 1997.
4 - Insulation Resistivity is checked in accordance, with IS 649 : 1997.
5 - x - Punchability of Bare Steel.
6 - Only for PowerCore CRGO
* - Yes (Conditions Apply).

C3 M / C3 ML: The C3 M / C3 ML coating, equivalent to C3 of AISI, improves punchability up to three times as compared to uncoated electrical steel. It is resistant to normal operating temperatures & is highly corrosion resistant (C3 M / C3 ML coatings can be used as a corrosion undercoat for C6 coatings) but will not withstand stress-relief annealing (SRA). It is suitable for applications where high level of inter laminar resistance is required. Suitable for small & medium sized motors as well as small transformers.

C3Y: C3Y coating equivalent to C3 of AISI, provides thick coating with excellent surface insulation resistivity. This coating has better corrosion resistance than C3M/C3ML. This coating cannot with stand stress relief annealing. It is suitable for applications where very high level of inter laminar resistance is required such as in medium to large machines, traction motors, high voltage machines & turbogenerators.

C6A : C6A coating, equivalent to C6 of AISI, provides ridge free thick coating and therefore increases surface insulation resistivity. Inorganic fillers are added to increase the insulating ability of the coating .It has good punchability & withstands high temperature " burn off " treatments used during rebuilding of motors. This coating exhibits low shrinkage (compressibility) and has excellent thermal coefficient of expansion due to high pigment concentration.

Suitable for large and medium sized motors, H_2 cooled generators & large turbo generators. Ideal for magnetic

	C6 A Semi Organic C6	C6 WH Weldable C5	C6 W Weldable C5	C6 U Semi Organic C5	C5 (G) Inorganic C5
	Water Soluble modified Phenolic Resin	Polyacrylo Nitrile Resin in Chromate Base	Polyacrylo Nitrile Resin in Chromate Base	Inorganic Organic Pigmented Phosphate base	Phosphate over glass film
	Large Machines, H_2 Cooled Generators, Compatible for motor with Epoxy impregnated Resins	All round varnish for Small to medium Motors	All round varnish for Small to medium Motors	All round varnish for Small to medium Motors	Power & Distribution transformer
	Grey	Apple Green	Light Apple Green	Grey	Grey
	7.0 ± 1.5	1.5 ± 0.50	0.60 ± 0.30	1-4	2-5
	>96.0	>97.5	>97.5	>97.0	>96.0
	0.08	0.50	0.70	>0.38	>0.38
	Cannot Withstand	Can Withstand	Can Withstand	Can Withstand	Can Withstand
	No	Yes	Yes	Yes	-
	8H	8H	8H	8H	-
	1.5 X	2.0 X	2.0 X	1.5 X	-
	Very Good	Satisfactory	Satisfactory	Good	Good
	Resist	Resist	Resist	Resist	Resist
	--	Resist	Resist	Resist	-

cores of contactors and high frequency application because of it's capability to withstand vibration.

C6WH / C6 W : C6W coating, equivalent to C5 of AISI, provides good surface resistivity both before and after stress relief annealing. Presences of organic part ensures improved punch and die life during stamping operations. During annealing, the organic part of the coating volatilizes but inorganic part remains to provide an adherent film with a high level of surface resisitivity. No significant flaking occurs at the punched edges of laminations. Significant punchability improvement (min 2 times of bare steel) & adequate surface insulation resistance despite low coating thickness are obtained with this type of coatings.

Used for refrigerator motors, small to large sized motor. C6W / C6WH coatings are useful for small and medium sized motors where high temperature resistance and weldability are required.

C6 U: Is a pigmented organic coating. It displays good weldablity and punchability at low coating thickness. It offers good corrosion protection and high elevated temperature strength. The insulation is ideal for operations where the material is exposed to thermal stresses i.e. welding, die casting, SRA etc.

C5 G: Grain oriented steel strips are usually delivered with a thin inorganic coating applied on both surfaces, on the top of the so called glass film layer formed during annealing. The coating thickness of 2-5 µm provides good electrical resistance simultaneously ensuring a high stacking factor. The stress relief annealing of wound cores or punched laminations, usually performed at temp. around 840^0C. It is unaffected by, and in turn does not affect, the various types of oils used in transformers.

PowerCore Non Grain Oriented Steel
Further Processing Hints

Steam Bluing
Applicable to Fully Processed Products coated with C6W Coating.

Bluing parameters		
1	Punching Oil on Lamination	The Laminations should be thoroughly cleaned to remove punching oil for better results
2	Furnace atmosphere	Controlled Oxidising & non Carburising atmosphere
3	Oxygen content in side the bluing furnace	< 1000 PPM
4	Heat Resistance in Open Air	200 ± 10°C
5	Introduction of Steam	Super saturated steam, Temp > 160°C to have a dew point in bluing furnace > 15°C. Steam purging to be started at 200°C and continue till 450°C.
6	Bluing Temperature	450 ± 10° C
7	Heating rate till 450° C	100° C / Hr
8	Soaking Time	1 to 2 Hrs Depending on Charge Weight in presence of steam
9	Unloading Temperature	200°C. Steam purging to be on till the furnace reaches down to 200°C

SRA (Stress Relief Annealing) & Bluing
Applicable to Fully Processed, PP grades and Pre-decarburized semi processed (Input Carbon < 50 PPM) Products coated with C6W Coating.

Annealing parameters		
1	Punching Oil on Lamination	The Laminations should be thoroughly cleaned to remove punching oil for better results
2	Furnace atmosphere	Preferably dry i.e. Neutral or reducing atmosphere. (N_2 80%, H_2 20 %). The Atmosphere should be non oxidizing & Non Carburising
3	Dew point of the gas inside the annealing furnace	Negative i.e. below 0°C
4	Oxygen content in side the annealing furnace	< 1000 PPM
5	Heat Resistance in Open Air	200 ± 10°C
6	Annealing temperature	790 ± 10°C
7	Heating rate till 790° C	200 °C / Hr
8	Soaking time	2 Hrs
9	Cooling rate till 450°C	25 °C / Hr
Bluing parameters		
10	Furnace atmosphere	Controlled Oxidising & non Carburising atmosphere
11	Oxygen content in side the bluing furnace	< 1000 PPM
12	Introduction of Steam	Super saturated steam, Temp > 160°C to have a dew point in bluing furnace > 15°C.
13	Bluing Temperature	450 ± 10°C
14	Soaking Time	1 to 2 Hrs Depending on Charge Weight in presence of steam
15	Unloading Temperature	200°C

Decarb Annealing & Bluing

Applicable to semi processed material (Input Carbon > 50 PPM)

Decarb & Annealing parameters		
1	Punching Oil on Lamination	The Laminations should be thoroughly cleaned to remove punching oil for better results
2	Furnace atmosphere	Preferably Wet Atmosphere (N_2 80%, H_2 20 %). The Atmosphere should be non oxidizing & Non Carburising
3	Dew point of the gas inside the annealing furnace	Positive i.e. between 15-30^{0}C, depending on H_2 / H_2O ratio.
4	Oxygen content in side the annealing furnace	< 1000 PPM
5	Annealing temperature	790 840 ± 10^0 C Depending on grade
6	Heating rate till 790^{0}C	Max. 200^0 C / Hr
7	Soaking time	Min 2 Hrs
8	Cooling rate till 450^{0}C	Max. 25 ^{0}C / Hr
Bluing parameters		
9	Furnace atmosphere	Controlled Oxidising & non Carburising atmosphere
10	Oxygen content in side the bluing furnace	< 1000 PPM
11	Introduction of Steam	Super saturated steam, Temp > 160^0 C to have a dew
12	Bluing Temperature	point in bluing furnace > 15^0 C. 450 ± 10^0 C
13	Soaking Time	1 to 2 Hrs Depending on Charge Weight in presence of steam
14	Unloading Temperature	200^0 C

Weldability

Applicable to fully processed and PP grade Products coated with C6W / C6WH Coating.

Welding parameters		
1	Punching Oil on Lamination	The Laminations should be thoroughly cleaned to remove punching oil for better results
2	Burr on Edges	< Than 30 microns
3	Type of Welding	Plasma TIG Welding
4	Shielding Gas	Argon (99.9 % Purity)
5	Argon Gas Flow	4-5 Lit / Min
6	Electrode Dia	1.6 mm
7	Gap Between Electrode and Material	1.8 - 3.2 mm
8	Clamping Pressure	5 Kg / cm, min.
9	Welding Current	18 - 24 Amps
10	Torch Speed	30 - 35 cm / Min

Packing

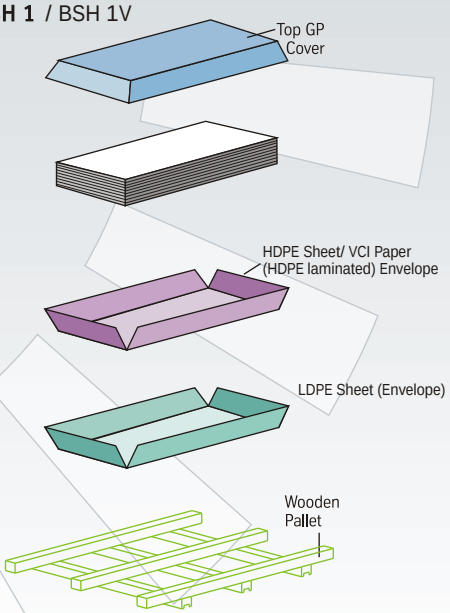
Extensive efforts are made in packaging of our products to ensure the safe receipt of material by our customers depending on the mode of transportation, material handling methods and climatic conditions.

The packing methods are constantly upgraded with improvements in packing materials. Over and above the standard packing codes, special efforts are made to accommodate the customized packing request from our customers.

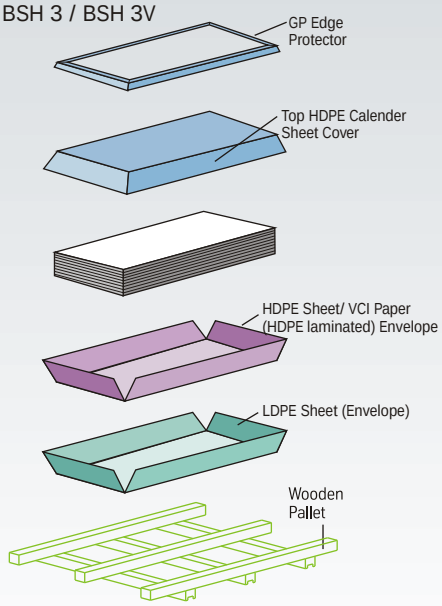
Material used in our packing is either bio-degradable or recyclable. VCI paper, HDPE, LDPE and Stretch film can be disposed off along with other solid waste in accordance with Central/State/Local pollution and environment control regulations.

Sheet Packing

BSH 1 / BSH 1V

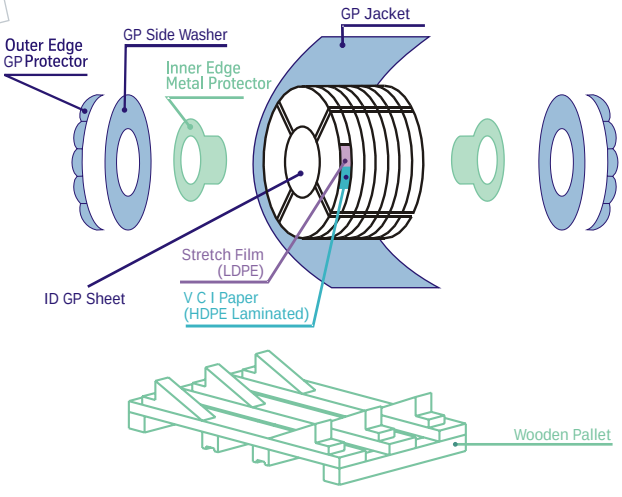


BSH 3 / BSH 3V

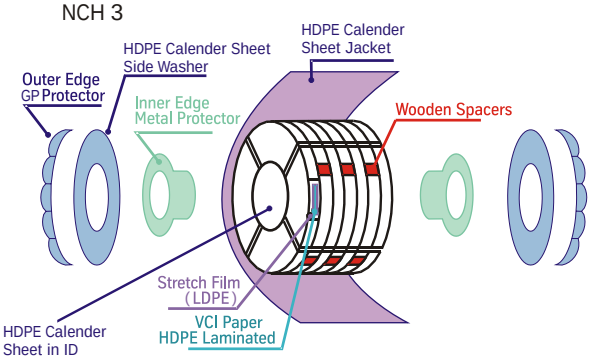


Slit Coil Packing

NCH 1



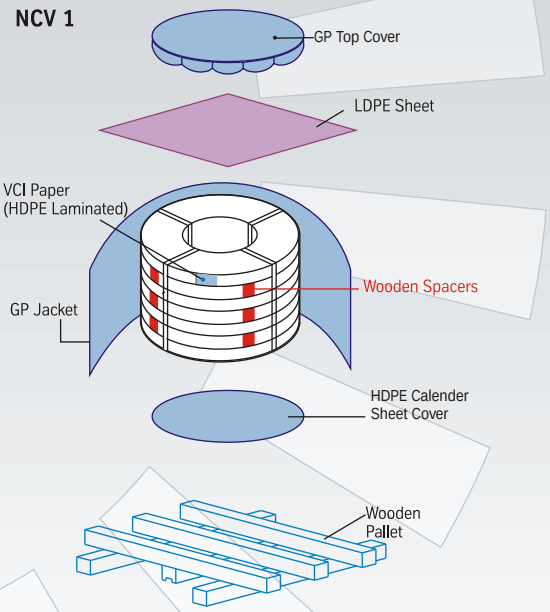
NCH 3



Above are schematic drawings of normal packing. The actual packing shall be as per packing code schemes agreed at the time of ordering.

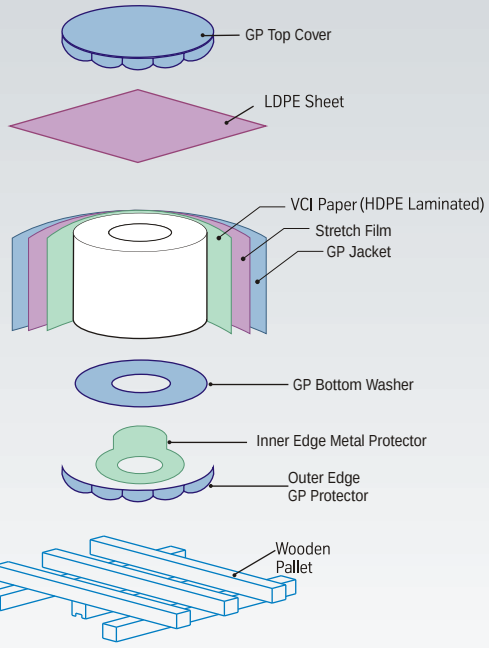
Slit Coil Packing

NCV 1



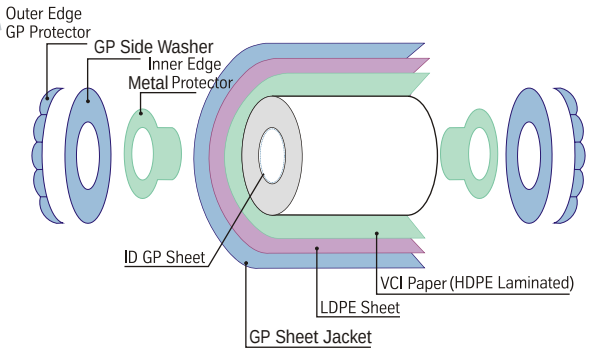
Wider Coil Packing

WCV 1

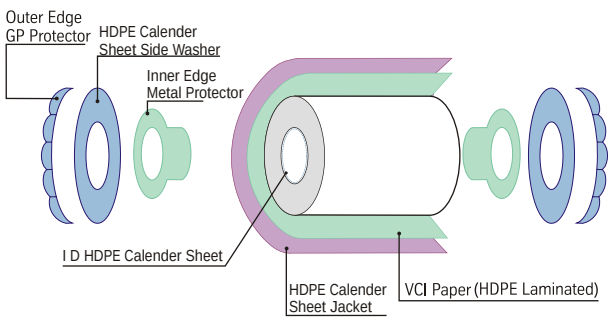


Wider Coil Packing

WCH 1

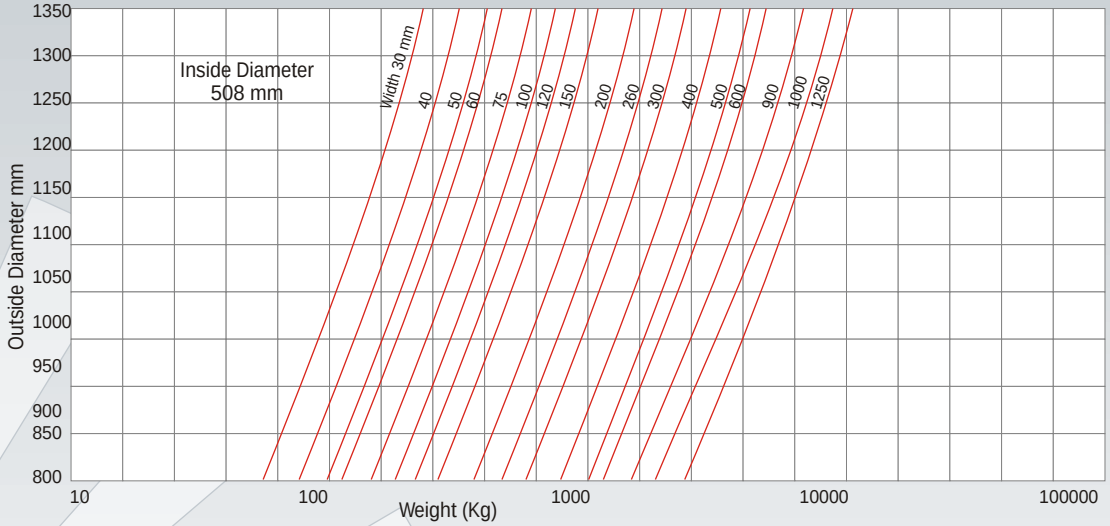


WCH 3



Out Side Diameter Of Coil And Storage Recommendations

Outside diameter of coil depending on coil weight and width



Recommended Storage Condition

All our products are packed in accordance with our standard packing or as per customer requirements, which are agreed in orders.

- Our products should be stored indoors, protected from rain, snow, dust, moisture & corroding agents (Smoke, steam, acid & lye vapours, chlorine, ammonia, etc.)
- Warehouses should be protected against temperature & humidity changes. The minimum & maximum Temperatures should be +5^{0}C and 40^{0}C respectively, while relative humidity inside should not be higher than 65%.
- While stacking the coils, care should be taken to avoid heavy load to the bottom coils.
- Adequate wedge protection to be provided in order to avoid rolling of coils.
- Our products should be consumed within the safe life prescribed for various products as shown below-
- Once after opening the packing, the material should be consumed at the earliest, since the protection given by the packing material is no longer effective.

Special recommendations for Electrical Steel

- Since, Electrical Steel is stress sensitive, high stress on the material during handling & storage may deteriorate the magnetic properties.
- It is strongly advised that all coils without pallets are stored in one high storage only.
- In case of coil with pallets, two-high storage is acceptable with proper handling.

Sr No	Product	Packing coils or sheets	Max. No. of days age*	
			Dry Season	Monsoon Season
1	CRFH	Without metal packing	30	25
		With metal packing	45	30
2	CRCA	Without metal packing	30	25
		With metal packing	45	30
3	CRNGO fully Finished	Without metal packing	45	35
		With metal packing	60	45
4	CRNGO semi Finished	Without metal packing	30	25
		With metal packing	45	30
5	CRGO	With metal packing	45	30

* Recommended maximum age from the date of finished goods to customer usage.

Packaging Specification

Item / Packing Code ▶	WCH1	WCH3	WCV1	NCV1	BSH1	NCH1	NCH3 #	BSH3
VCI paper laminated with HDPE	○	○	○	○		○	○	
HDPE					○■			○■
LDPE	○				○			○
Stretch film			○	○		○	○	
Inner metal edge protector (Both sides)	○	○				○	○	
Inner metal edge protector (Bottom end)			○					
Outer GP edge protector (Both ends & both sides)	○	○				○	○	○
GP side washer (Both ends)	○					○		
OD GP Jacket	○		○	○		○		
ID GP Sheet	○					○		
OD HDPE Calender Sheet Jacket		○					○	
HDPE Calender Sheet Side Washer (Both ends)		○					○	
ID HDPE Calender Sheet		○					○	
Outer GP edge protector (Bottom end)			○					
HDPE Calender Sheet Side Washer (Bottom)				○				
GP Sheet Side Washer (Bottom)			○					
Top GP cover (For Narrow slits)			○	○				
Top GP cover (For sheets)					○			
Top HDPE Calender Sheet Cover (For sheets)								○
Hard board sleeve	*	*	*					
Metal Sleeve	*	*						
Wooden pallet			○	○	○	○		○
Wooden Spacers				○			○	
Number of Circumferential strapping (Outside + Inside)	3 + 0	2 + 0	1 + 1	1 + 1	3 @	4 + 0	3 + 0	3 @
Number of Radial strapping (Outside + Inside)	3/4 + 0	3 + 0	2 + 4	2 + 4	3/4 !	5 + 2	4 + 2	3/4 !

* Metal sleeve is provided for CRFH & CRCA coils up to 0.4 mm thickness, Hard board sleeve is used up to 0.35mm for Electrical Steel coils
"@" Lateral
! Longitudinal
Wooden blocks are provided along with strapping on the edges of coil in radial direction.
■ VCI Paper Laminated with HDPE is used for Electrical Steel, semifinished and unoiled material

Conversion Table of Units

Term	To convert from	to be multiplied by
Magnetic flux density (*B*)	Tesla (Wb/m^2) to Gauss	10^4
	Gauss to Tesla (Wb/m^2)	10^{-4}
Magnetic field strength (*H*)	Ampere-turns/meter to Oersted	0.0126
	Oersted to Ampere-turns/meter	79.6
	Ampere-turns/meter to Ampere- turns/inch	0.0254
	Ampere-turns/meter to Ampere- turns/cm	0.01
Core Loss	Watt/kg to Watt/pound	0.4536
	Watt/pound to Watt/kg	2.205
	Watts/Kg at 60 Hz(1.5T) to Watts/Kg at 50Hz(1.5T)	0.75 for GO, 0.79 for NGO
	Watts/lb at 60 Hz(1.5T) to Watts/Kg at 50Hz(1.5T)	(approximate)1.65 for GO, 1.74 for NGO
Length (*l*)	Centimeter to Inch	0.3937
	Inch to centimeter	2.54
Area (*A*)	Square cm to Square inch	0.155
	Square inch to Square cm	6.45
Volume (*V*)	cm^3 to cubic inch	0.061
	cubic inch to cm^3	16.4
Mass (*m*)	gm to Ounce	0.0353
	Kg to pound	2.205
	Ounce to gm	28.35
	Pound to Kg	0.4536
Tensile strength (R_m)	N/mm^2 to Kg/mm^2	0.102
	Kg/mm^2 to N/mm^2	9.81
Temperature (*T*)	°C to °F	x 1.8 + 32
	°F to °C	x 0.556 - 17.8

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Contacts

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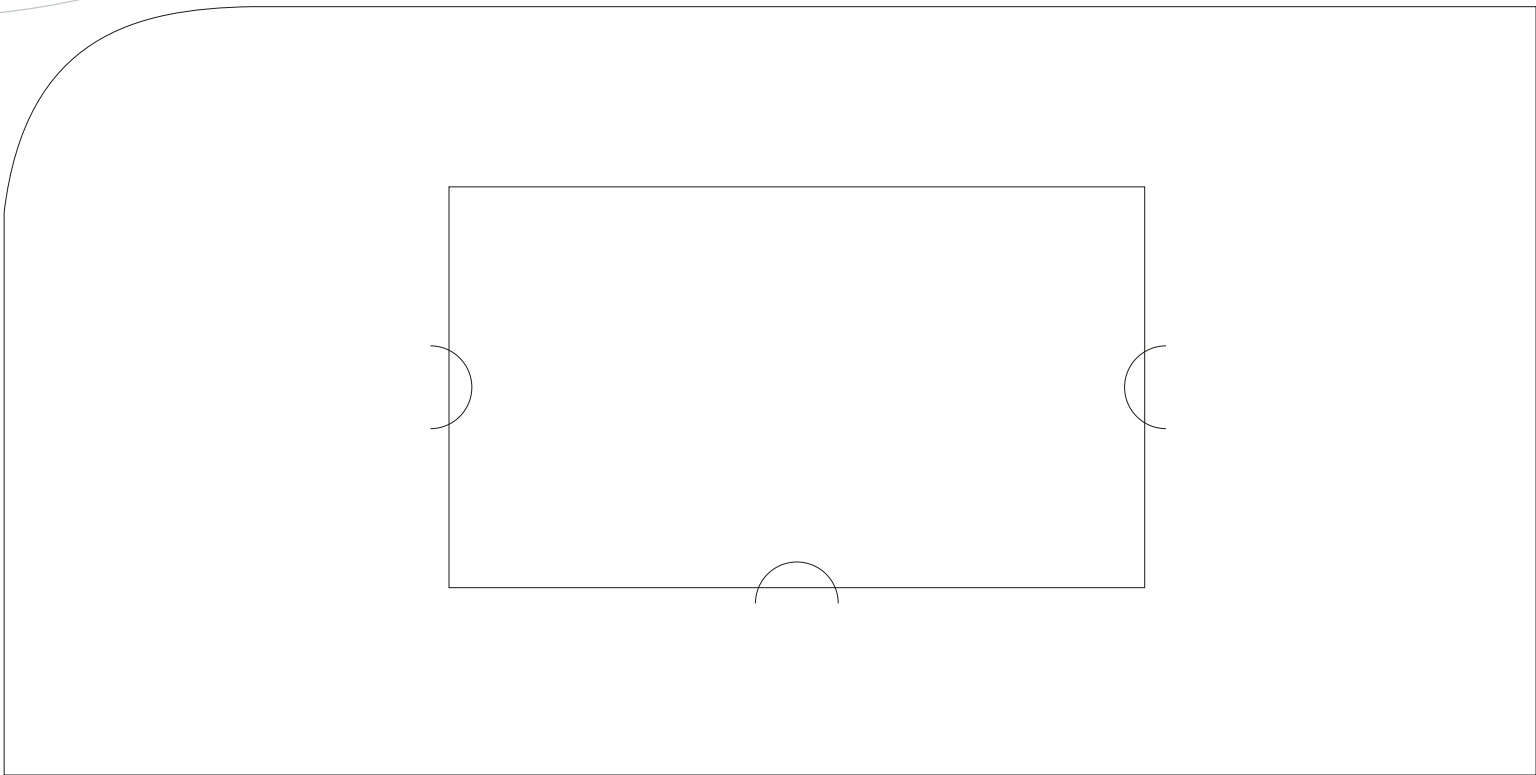

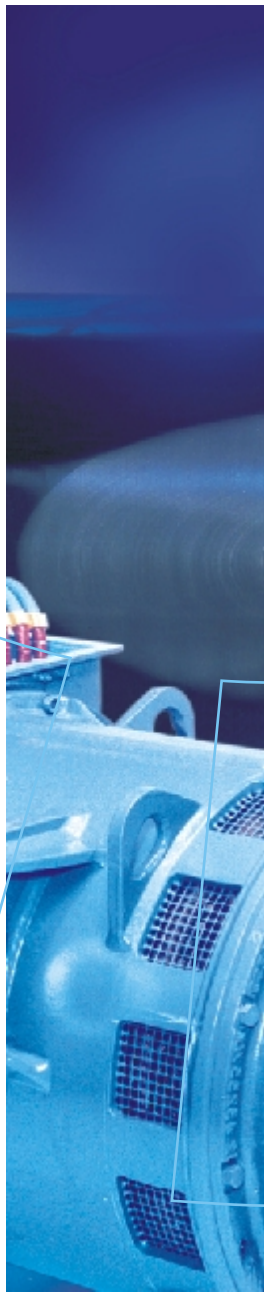

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Our Product
Mild Steel

A company of ThyssenKrupp Steel

ThyssenKrupp Electrical Steel India Private Limited

ThyssenKrupp

Mild Steel
Product Details

Introduction

Mild steel comprises a large family of steel, generally called 'Carbon Steel' which are usually used in Automobile Industry, White Goods Industry & Engineering Applications. Mild steel comprises of CRCA (Cold Rolled Closed Annealed) and CRFH (Cold Rolled Full Hard). Both the products are produced in Bright finish and Matt finish

Properties:

Grade	YS in MPa	TS in MPa	% E (80 GL)min.	Hardness HRB	r 90 min
D (Drawing)	240	275 - 370	28	65 max	-
DD (Deep Drawing)	220	275 - 350	34	57 max	1.30
EDD (Extra Deep Drawing)	210	275 - 350	38	50 max	1.60
IFS (Interstitial Free Alloyed)	180	275 - 350	40	40 max	1.80
CR Full Hard	-	55 min	-	85 min	-

* All above qualities are available in bright as well as matt surface finish.

Applications:

CRFH	Galvanizing, White Goods
D	Panels, Furniture Drums, White Goods
D / DD	General Engineering, White Goods Industry
IF / EDD / DD /D	Automobile Application

THICKNESS:

Specified Thickness (mm)		Tolerance for Thickness (mm)	
Above	Up to	Up to 650mm	Over 650mm
0.14	0.40	± 0.025	± 0.030
0.41	0.80	± 0.030	± 0.040
0.81	1.50	± 0.040	± 0.050
1.51	2.50	± 0.050	± 0.060
2.51	3.15	± 0.060	± 0.070

WIDTH:

Specified Width (mm)		Tolerance for Width (mm)		
Above	Up to	0.14 - 0.40	0.41 - 1.60	1.61 - 3.15
100	250	± 0.15	± 0.20	± 0.25
251	630	± 0.20	± 0.25	± 0.30
631	1270	± 0.40	± 0.50	± 0.50

Width tolerance can be one sided with above said band.

Length	For all length from 1000 - 4000mm, Tolerance is + 3.0mm / - 0.0mm

SURFACE FINISH: Bright finish and Matt finish.

Bright Finish	Suitable for electro plating & electro hot dip galvanizing products.
Matt Finish	Surface roughness for deep drawing & painting operation.

Comparison with standards:

IS 513 1994	JIS G3141 1994	EN 10130	DIN 1623 PART 1	BS 1449	ASTM	ISO 35741999
D	SPCC	FePO1	ST-12	CR4	A366	CR2
DD	SPCD	FePO3	ST-13	CR3	-	CR3
EDD	SPCEN	FePO4	ST-14	CR2	A620	CR4
IFS	-	FePO6	ST-15	CR1	-	CR5