



## CORPORATE PURCHASING SPECIFICATION

AA10916

Rev No. 08

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**COLD ROLLED NON-GRAIN ORIENTED SHEET STEEL – Gr: 350****1 GENERAL**

This specification governs the quality requirements of Un-insulated and insulated (double side), cold rolled, non-grain oriented magnetic steel sheet or coil in finally annealed condition in 0.50 and 0.65 mm thickness.

**2 APPLICATION**

Laminations of Electrical Machines

**3 CONDITION OF DELIVERY**

**3.1** Cold rolled, finally annealed.

**3.2** The material shall be supplied in straight lengths (sheet form) or in coils, to the ordered thickness as specified in BHEL order.

**3.3** Magnetic steel sheets or coils shall be supplied with or without insulation coating, as detailed below and as called for on BHEL order.

a) 0.50mm/0.65mm Thick - insulated (6 Microns)\*

Double side insulated with an average of  $6 \pm 1$  micron thickness coating on each side. This insulation of coating shall comply with clause 3.4 and 8.6 of this specification.

b) 0.50mm/0.65mm Thick - insulated (5.5 Microns)\*

Double side insulated with an average of  $5.5 \pm 1.5$  micron thickness coating on each side. The insulation shall comply with clause 3.4 and 8.6 of this specification.

c) 0.50mm/0.65mm Thick – Un-insulated\*

Un-insulated, protected on both sides by rust preventive coating of thickness  $2 \pm 1$  microns.

**\*NOTE**

i) The supplier shall furnish the details of such coatings along with the quotation. (for insulation coating, these details shall be furnished as per Annexure-1 of BHEL standard AA0851711) for approval of BHEL prior to the first time supply and / or as when the type of coating is changed subsequently with the prior approval of BHEL.

ii) The surface finish of the material shall be such as to allow subsequent uniform varnishing, if required, without any problem.

**3.4 Type of insulation coating**

The insulation coating used for the steel sheets referred in clause 3.3 (a) shall be uniformly applied, tightly adherent and shall be as per BHEL specification AA27541 or as per AISI, C-6 of the filler base type on both sides, pigmented varnish coating (in which case it shall be compatible to varnish as per AA27541) and also suitable for fully impregnated electrical machines (VPI) and shall meet the requirements detailed in clause 8.6.

**Revisions:**

Brought upto date

**APPROVED:**

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**CORPORATE PURCHASING SPECIFICATION****4 COMPLIANCE WITH NATIONAL STANDARDS**

Material shall comply with the requirements of the following national standards and also meet the requirements of this specification.

IS 648-2006

Gr: 50C350 for 0.5mm thick and } Non-oriented electrical steel sheets and strips for magnetic circuits  
Gr: 65C350 for 0.65mm thick }

Material offered to EN 10106-2015, Gr: M350-50A for 0.50mm thick and M350-65A for 0.65mm thick is also acceptable.

**5 DIMENSIONS AND TOLERANCES****5.1 Sizes**

Magnetic steel sheet shall be supplied to the dimensions and coating specified on BHEL order.

**5.2 Tolerances****5.2.1 Thickness**

The permissible deviation in nominal thickness shall be  $\pm 8\%$ . The variation in thickness in a direction parallel to the direction of rolling shall not exceed  $\pm 8\%$  of the nominal thickness.

The variation in thickness in a direction perpendicular to the direction of rolling shall be  $\pm 0.020\text{mm}$  for a nominal thickness of 0.50mm and  $\pm 0.030\text{mm}$  for 0.65mm thick. The measuring points should be at least 40mm away from the edges of the sheets.

**5.2.2 Width**

The tolerance for width of material supplied with trimmed edges shall be as follows:

Width (mm)		Tolerance (mm)	
Over	Upto & incld.	Plus	Minus
-	150	0.3	0
150	500	0.5	0
500	1250	1.5	0

**5.2.3 Length**

When supplied in sheet form the tolerance on length shall be  $+1\%$ , but shall not exceed  $+10$  mm.  
 $-0$

**5.2.4 Straightness/Edge camber**

The straightness tolerances for the longitudinal edge (edge camber) over a gauge length of 2000mm shall not exceed 4mm for width up to and including 150mm and 2mm for widths exceeding 150mm.

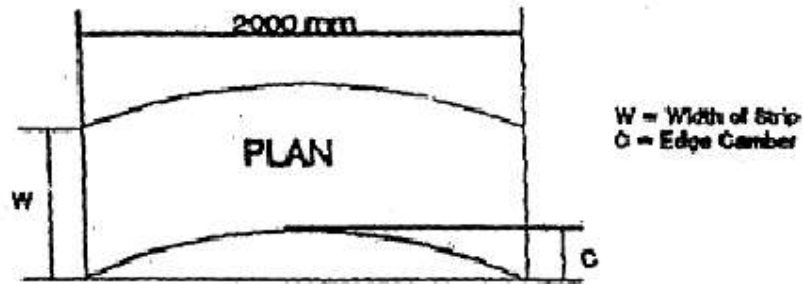


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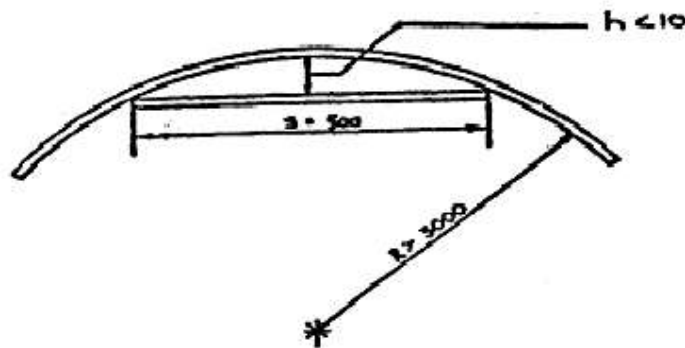
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**5.2.5 Edge Burr**

The height of edge burr shall not exceed 50 microns.

**5.2.6 Bowing – Coils**

The material when unwound from a coil shall be placed flat on a level smooth surface (surface plate) such that it has a radius not less than 3000mm. The specimen should be stood upright and free from constraint with one longitudinal edge on the surface of the plate. A straight edge with a length of 500mm, when placed against the specimen and when measuring the greatest distance 'h' between the straight edge and the product should not be more than 10 mm as detailed below:

**5.2.7 Waviness/Flatness**

The Waviness/Flatness shall not exceed 1.5% (i.e the ratio of the wave height to wave length).

**6 FINISH**

The material shall have a smooth surface and shall be free from loose scale, buckle or dents, waviness and internal stresses.

**7 TEST SAMPLES**

The test samples of the same heat/melt & thickness shall be selected from the consignment as follows

Upto 30 tonnes	1 sample
Above 30 to 60 tonnes	2 samples
Above 60 tonnes	3 samples

The test samples shall be sufficient in size to provide the necessary test pieces.

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**CORPORATE PURCHASING SPECIFICATION****8 PROPERTIES (AS RECEIVED)****8.1 Bend Test**

A test piece of 30mm width X 60mm long taken in rolling direction in the ordered thickness shall withstand the minimum number of bends specified below, without fracture, through 90° from initial position; then bend it through 180° in the reverse direction. Again bend the specimen through 180° in the first direction and continually through 180° reversals, over a 5mm radius jaws when tested to IS 649/ EN 10106.

0.50mm thick: 5 bends

0.65mm thick: 2 bends

**8.2 Stacking Factor**

The surface quality of the sheets when measured in terms of stacking factor as per IS 649 (on a minimum of 16 samples under a pressure of 35 N/cm<sup>2</sup>) shall be as follows:

0.50mm and 0.65mm thick double side coating (insulated) : 95.5%, minimum

0.50mm and 0.65mm thick un-insulated : 96.0% minimum

**8.3 Total Specific Loss**

The total specific loss on aged specimens (a specimen which has been heated for 24 hrs. at 225±3°C) for 0.50mm thick and on unaged specimen for 0.65mm thick sheet shall be as follows, when tested as per IS 649 at a frequency of 50 Hz for the specified flux density.

- 3.50 watts/kg, Maximum – At 1.5 Tesla
- Note: A tolerance of +2% on the above value is allowed.

**8.4 A.C Magnetization**

When tested to IS 649, the AC magnetic field (H) in ampere/metre (Peak), shall show the following minimum corresponding values of magnetic induction (B) in Tesla (Peak) for 0.50mm and 0.65mm thick material.

AC Magnetic field Strength 'H' A/m (Peak)	Magnetic Induction Min. (Peak)	(B) Tesla
Thickness	0.50 mm	0.65 mm
2500	1.50	1.49
5000	1.60	1.60
10000	1.70	1.70



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**8.5 Anisotropy of Losses**

When tested to IS 649/EN 10106 as detailed below, the Anisotropy losses shall not exceed:

±12% for 0.50mm thick sheet

±14% for 0.65mm thick sheet

To determine the loss ANISOTROPY the specific total loss should be measured separately on specimens taken parallel and perpendicular to the rolling direction. The loss Anisotropy, in percent, is found from the following expression

$$\frac{P_a - P_l}{P_a + P_l} \times 100 \text{ where}$$

$P_a$  denotes specific total losses perpendicular to the rolling direction.

$P_l$  denotes the specific total losses parallel to the rolling direction.

**8.6 Testing of insulation coating**

The insulation coating when tested in accordance with BHEL standard AA0851711: Test Methods for Insulation Coating on Magnetic Steel Sheets, shall show the following properties:

**8.6.1 Selection of Test Samples for Insulation Coating**

The outermost and innermost turn of coil or the topmost and bottommost of a stack of sheets, shall be considered as wrapping and not representing the properties of the remaining material and hence shall not be considered for test specimen.

In case of coils, the test specimens shall be preferably taken from the first external turn excluding the wrapping turn and in case of sheet, it shall be from the upper part of the stack. In special case, it can be taken from any other part also.

The test specimen shall extend over the entire sheet width and can be about  $350 \pm 2$  mm long. In case of sheet width, below 400mm, the specimen shall be  $500 \pm 2$  mm long.

The surface of the strip shall be free from contaminations & damages and shall be cut without deformation and as far as possible, without burrs. Any cleaning done shall not damage the insulation coating.

**8.6.2 Coating Layer Thickness**

Both sides of the sheet shall be coated and shall have a thickness as per applicable section of clause 3.3 on each side. At least 15 readings shall be taken on each side at equal intervals.

- None of the readings should be below 2.0 microns for insulation coating as per clause 3.3 b)
- 90% of the readings shall be between 4.5 to 9 microns for insulation as per clause 3.3.a)

The thickness of any pre-coating shall not be accounted for.

**8.6.3 Surface insulation Resistivity**

When tested as per ASTM A717 (Franklin's method) at a pressure of  $2\text{N/mm}^2$  at room temperature or any other international standard (in that case, approval to be taken by the supplier). The minimum average of 10 non-overlapping resistance measurements (5 on each side) shall be  $30 \text{ ohm-cm}^2$  with a minimum allowable individual value of  $10 \text{ ohm-cm}^2$ .

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**CORPORATE PURCHASING SPECIFICATION****8.6.4 Type Tests****8.6.4.1 Adherence Test**

The surface coating shall be sufficiently adherent so that it does not get detached during insulation and shearing. In the reverse bending test with a bending radius of 5mm, the surface coating shall not be detached after bending through 90°.

**8.6.4.2 Thermal Effect on Coating**

Twelve specimens of the coated strip shall be clamped together under a pressure of 1 N/mm<sup>2</sup> approximately and heated in a laboratory oven at a temperature of 180±3°C for a period of 7 days. After cooling to room temperature, the surface insulation resistivity values of the middle ten specimens shall not be less than the minimum specified values mentioned in clause 8.6.3.

**8.6.4.3 Resistance to Solvents, Oils & Ammonia**

The specimens shall be kept in a container filled with any of the following solvents/oil and boiled for 5 minutes. After removal and cooling to the room temperature the coating shall not get soft enough so that it can be wiped off. The insulation coating film shall be resistant to conventional organic solvents like trichloroethylene, methylated spirit, acetone, benzene, and oil, etc. In special cases and when specified on BHEL order, the insulating film shall be resistant to ammonia also.

\* Note

Type tests shall be carried out when, 'Type Approval' to a supplier is given and repeated once in five years for the approved supplier.

**9 TEST CERTIFICATES**

Three copies of test certificates shall be supplied, unless otherwise specified on order. In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information

AA10916-Rev 08 / IS 648, Gr: 50C350/Gr: 65C350/ EN 10106, Gr: M350-50A/Gr: M350-65A/ ASTM A 677

BHEL Order No.

Supplier's Name/Grade/Identification No.

Size & Weight

Melt No., Packet/Bundle No.

**Test results of**

- a) Dimensions & Tolerances
- b) Properties as per the concerned National standards & insulation coating, as above.

Also type test certificates, not older than 5 Years, shall be submitted along with each consignment.

**10 PACKING AND MARKING****10.1 Material Supplied in Straight Length**

Magnetic steel sheets shall be supplied in bundles. The packing shall be seaworthy and shall protect the material from damage during transit. A typical packing which would be suitable is shown below.

Each sheet shall be marked with supplier's grade/references.

These markings shall be along the rolling direction.

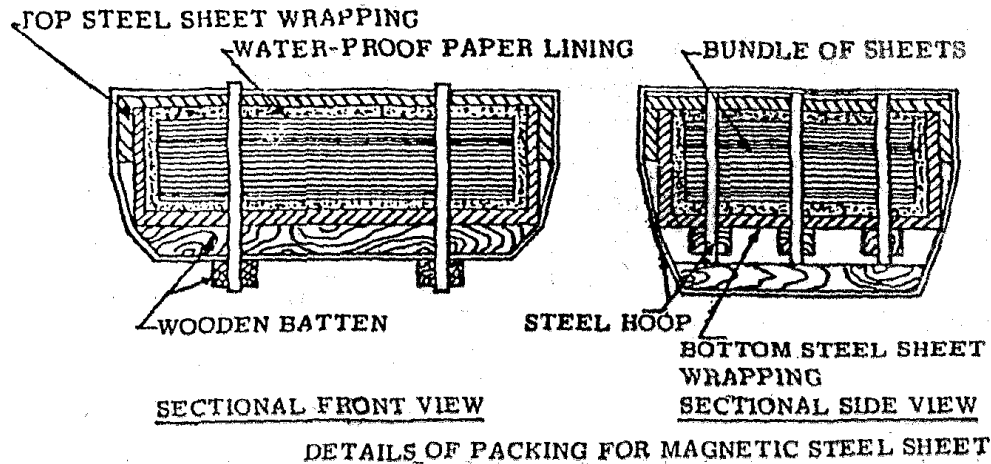


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Note:

- Water proof paper lining shall be preferably Volatile Corrosion Inhibitor (V.C.I) Coated Paper with an additional polythene (100 micron) enveloped.
- Approximate weight of each bundle shall be 2 to 3 metric tonnes. Bundle weighing 2 Metric tonnes is however preferred.
- The packing should ensure that there is no seepage of moisture and the sheets reach BHEL on completely rust free condition. It shall be strong enough to withstand handling at the docks, at sea on the road.

**10.2 Material Supplied in Continuous Coil**

The nominal weight of each coil shall be 1800-2000kg.

The nominal internal diameter of coil shall be 508mm.

Packing shall be sea-worthy and shall protect the coils from damage and rusting during transit. The supplier's grade /reference shall be marked at every one metre intervals throughout the coil length.

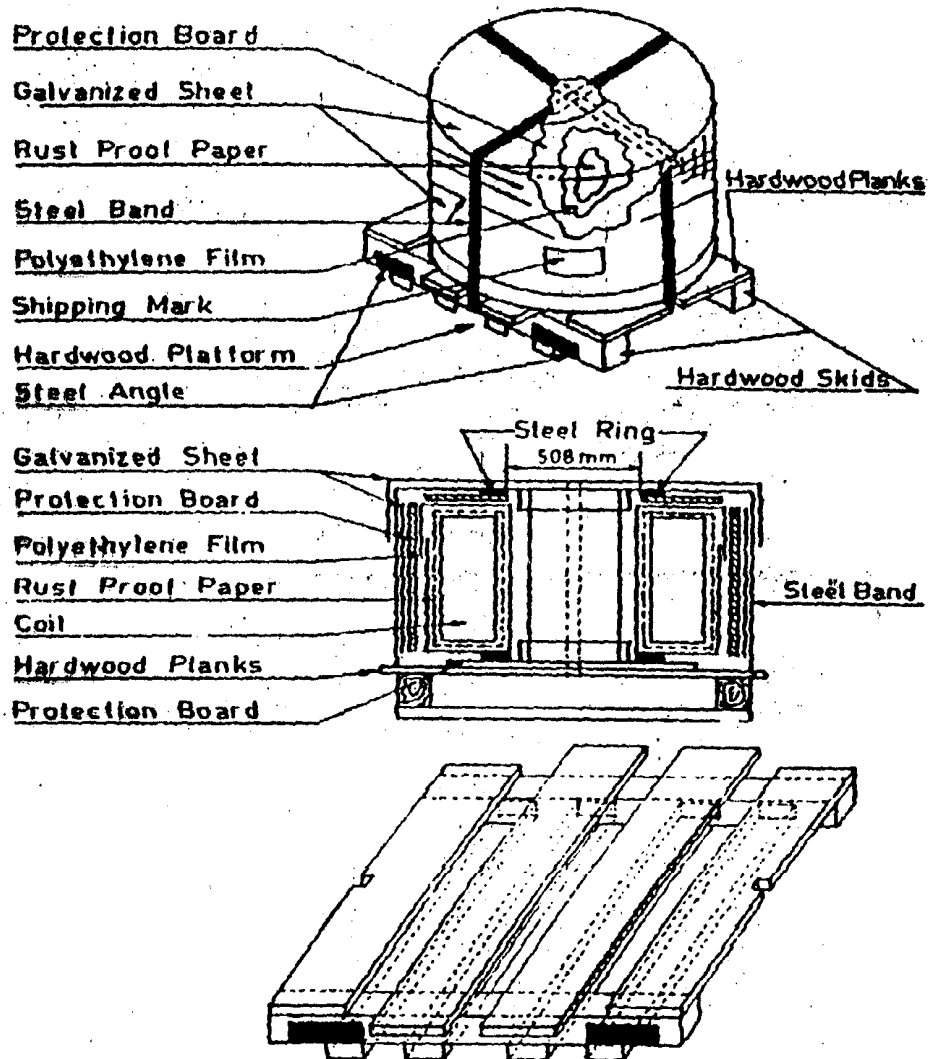
Coils shall be vertically packed according to the instructions and drawing given below:

- An annular protection board shall be placed at either end of coil.
- The coil shall then be wrapped with waterproof anti-rust proof by lapping axially all around the circumference.
- The coil shall then be covered by polyethylene sheet or anti-rust waterproof paper and the ends sealed properly.
- A galvanized sheet shall be wrapped on the outside of the coil and the top and bottom of the coils. Care shall be taken to ensure that the ends of the top and bottom of the coils extend sufficiently over the inside diameter of the coil.
- A galvanised sheet shall be wrapped on the inside of the coil. Care shall be taken that it overlaps sufficiently over the ends of the sheet mentioned in (d) above.
- Steel ring made from thick angle sheets shall be placed on the rim of the inner diameter at both ends of the coil. The rings shall be held at either ends at four points by steel bands.
- The coil should then be mounted on wooden skids held together by steel bands. Wooden skids must have cutouts to house the steel bands for tight fit and to avoid slippage.
- The packing shall ensure that there is no seepage of moisture and the coils reach BHEL in completely rust free condition. It shall be strong enough to withstand handling.

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- i) Coils shall be sufficiently tight-wound to prevent collapse to an extent that would preclude their being mounted on a mandrel appropriate to the ordered internal diameter.
- j) Each package should indicate the Sling Position, for lifting without damage. It is preferable to fix a suitable size of, 'Sheet Steel Angle', at the position where the Sling Rope is to be fitted to avoid slippage/damage/breakage of the wooden skid at four places.

**10.3 Marking**

A metal label/tag shall be securely attached with each bundle outside its wrapping and shall be legibly marked with the following information.

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BHEL Order No.

Supplier's Name/Grade/Identification No.

Size & Weight

Melt No., Packet/Bundle No.





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**11 REFERRED STANDARDS (Latest Publications Including Amendments)**

- 1) AA0851711
- 2) AA27541
- 3) IS 649
- 4) ASTM A717
- 5) AISI C-6
- 6) ASTM A 677

**GENERAL INFORMATION FOR CALCUALTION  
(NOT MANDATORY/TYPICAL VALUES)**

Density	: 7.65 kg/cm <sup>3</sup>	
Total specific loss at 1.0 Tesla	: 1.50 watts/kg for 0.50mm and 0.65mm thick	
Magnetic induction (B) (Peak) at 30,000 A/M	} Values to be furnished for information	
AC magnetic field strength (H) (Peak)		

**Mechanical Properties:**

Tensile strength	: 530 N/mm <sup>2</sup>
Yield strength	: 417 N/mm <sup>2</sup>
Elongation on 5.65 $\sqrt{S_0}$ GL	: 14%