Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड़ नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

Indian Standard
COLD ROLLED NON-ORIENTED ELECTRICAL STEEL SHEET AND STRIP — FULLY PROCESSED TYPE — SPECIFICATION
(Fifth Revision)

ICS 77.140.40
FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1955 and subsequently revised in 1962, 1970, 1980 and 1994. While reviewing this standard in the light of experience gained during these years, the Committee decided to revise it to bring in line with the present practices being followed by the Indian industry and overseas standards of cold rolled non-oriented electrical steel sheet and strip.

In this revision the following modifications have been made:

a) Title of the standard has been changed to 'Cold rolled non-oriented steel sheets and strips—Fully processed type — Specification',
b) Amendment No. 1, 2 and 3 have been incorporated,
c) Scope of the standard has been modified. Silicon free, hot rolled uninsulated and semi processed electrical steel sheet have been deleted,
d) A new clause on references has been incorporated,
e) Number of grades have been reduced to twenty seven, and
f) Designation system has been modified.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO standard may also be followed as an alternate method.

A conversion factor table is given in Annex A for information.

The composition of the Committee responsible for formulation of standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
[Foreword, Para 3, Sl No. (e)] — Substitute the following for the existing:

‘e) Number of grades with this amendment will be thirty eight.’

[Page 3, Table 1 (see also Amendment No. 2 and 3)] — Insert the following new grades in the existing table at the end:

Table 1 Designation of Electrical Steel Grades
(Clause 4, 6.1.3, 7.1.1.2, 7.1.2.1, 7.1.2.4.1 and 9.2)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Designation</th>
<th>Nominal Thickness mm</th>
<th>Maximum Core Loss at 50 Hz (W/kg)</th>
<th>a.c. Magnetization (50 Hz) Minimum values of B Max Tesla</th>
<th>Anisotropy of Total Specific Loss at 1.5 T (% Max)</th>
<th>No. of Bends (Min)</th>
<th>Assumed density kg/dm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td>0.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxxii</td>
<td>35C230</td>
<td>0.95</td>
<td>0.95</td>
<td>1.49</td>
<td>1.60</td>
<td>±17</td>
<td>2</td>
</tr>
<tr>
<td>xxxiii</td>
<td>35C235</td>
<td>0.95</td>
<td>2.35</td>
<td>1.49</td>
<td>1.60</td>
<td>±17</td>
<td>2</td>
</tr>
<tr>
<td>xxxiv</td>
<td>50C940</td>
<td>0.50</td>
<td>4.20</td>
<td>1.62</td>
<td>1.72</td>
<td>±8</td>
<td>10</td>
</tr>
<tr>
<td>xxxv</td>
<td>65C310</td>
<td>0.65</td>
<td>1.25</td>
<td>1.49</td>
<td>1.60</td>
<td>±15</td>
<td>2</td>
</tr>
<tr>
<td>xxxvi</td>
<td>100C600</td>
<td>1.00</td>
<td>2.60</td>
<td>1.53</td>
<td>1.63</td>
<td>±10</td>
<td>2</td>
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<tr>
<td>xxxvii</td>
<td>100C700</td>
<td></td>
<td>3.00</td>
<td>1.54</td>
<td>1.64</td>
<td>±8</td>
<td>3</td>
</tr>
<tr>
<td>xxxviii</td>
<td>100C800</td>
<td></td>
<td>3.60</td>
<td>1.56</td>
<td>1.66</td>
<td>±6</td>
<td>5</td>
</tr>
</tbody>
</table>

NOTE — a.c. magnetization can be checked and reported in any value between 5 000 to 10 000 A/m as per mutual agreement apart from above (2 500, 5 000 and 10 000 A/m).
Amend No. 5 to IS 648 : 2006

(Page 4, clause 7.2.4) — Substitute the following for the existing clause:

"7.2.4 Material when supplied with insulation, the nature of the insulation and its properties shall be subject to mutual agreement between the purchaser and the manufacturer."

(Page 4, clause 7.2.5) — Delete.
AMENDMENT NO. 4 OCTOBER 2011
TO
IS 648 : 2006 COLD ROLLED NON-ORIENTED
ELECTRICAL STEEL SHEET AND STRIP — FULLY
PROCESSED TYPE — SPECIFICATION
(Fifth Revision)

(Page 4, clause 7.1.2.1) — Substitute the following for the existing:

‘The specified values of maximum total specific loss at 50 Hz to be guaranteed at 1.5 T shall be as given in Table 1. They apply.

– for the thicknesses 0.35 mm, 0.50 mm and 0.65 mm to aged test pieces
– for the thickness 1.00 mm to non-aged test pieces

The values of the specific total loss at 1.0 T given in Table 1 are for information only.

NOTE — The ageing shall be carried out as specified in IS 649.’

(Page 4, clause 7.1.2.3) — Delete.

(Page 4, clause 7.2.5) — Substitute the following for the existing:

‘The minimum values for insulation resistance of coatings types C-3, C-4, C-5, C-6 and C-7 of Annex C shall be as given in Table 2.’

(Page 4, Title of Table 2) — Substitute the following for the existing:

‘Minimum Values for Insulation Resistance’

(MTD 4)

Reprography Unit, BIS, New Delhi, India
AMENDMENT NO. 3 MAY 2011
TO
IS 648 : 2006 COLD ROLLED NON-ORIENTED ELECTRICAL STEEL SHEET AND STRIP — FULLY PROCESSED TYPE —
SPECIFICATION

(Fifth Revision)

"Number of grades with this amendment will be thirty one" (Foreword, third para, item "e") — Substitute the following for the existing:

[Page 3, Table 1 (see also Amendment No. 1)] — Substitute the following for the existing table:

Table 1 Designation of Electrical Steel Grades
(Clauses 4, 6.1.3, 7.1.1.2, 7.1.2.1, 7.1.2.4.1 and 9.2)

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Designation</th>
<th>Nominal Thickness mm</th>
<th>Maximum Core Loss at 50 Hz (W/kg)</th>
<th>Bc Max (50 Hz)</th>
<th>Minimum Values of D (%) Max</th>
<th>Anisotropy of Total Specific Loss at 1.5 T (%) Max</th>
<th>No. of Bends (Min)</th>
<th>Assumed Density kg/dm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td>i</td>
<td>35C250</td>
<td>0.35</td>
<td>1.00</td>
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<td>1.49</td>
<td>1.69</td>
<td>1.70</td>
<td>1.70</td>
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<tr>
<td>ii</td>
<td>35C270</td>
<td></td>
<td>1.10</td>
<td>2.70</td>
<td>1.49</td>
<td>1.69</td>
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<td>iii</td>
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<td>3.00</td>
<td>1.49</td>
<td>1.69</td>
<td>1.70</td>
<td>1.70</td>
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<td></td>
<td>1.30</td>
<td>3.30</td>
<td>1.49</td>
<td>1.69</td>
<td>1.70</td>
<td>1.70</td>
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<tr>
<td>v</td>
<td>35C360</td>
<td></td>
<td>1.45</td>
<td>3.60</td>
<td>1.49</td>
<td>1.69</td>
<td>1.70</td>
<td>1.70</td>
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<tr>
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<td>1.05</td>
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<td>1.69</td>
<td>1.70</td>
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<tr>
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<td>50C270</td>
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<td>1.10</td>
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<td>1.69</td>
<td>1.70</td>
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<tr>
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<td>1.25</td>
<td>3.30</td>
<td>1.49</td>
<td>1.69</td>
<td>1.70</td>
<td>1.70</td>
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<td>1.70</td>
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<td>7.00</td>
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<td>1.69</td>
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<td>1.77</td>
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<tr>
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<td>1.70</td>
<td>1.78</td>
<td>1.78</td>
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<td>1.70</td>
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<td>1.78</td>
</tr>
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<td>1.81</td>
</tr>
<tr>
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<td>1.75</td>
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<td>1.70</td>
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<tr>
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<td>1.56</td>
<td>1.66</td>
<td>1.76</td>
<td>1.76</td>
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<tr>
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<td>7.00</td>
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<td>1.67</td>
<td>1.77</td>
<td>1.77</td>
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<td>8.00</td>
<td>1.60</td>
<td>1.70</td>
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<td>10.00</td>
<td>1.61</td>
<td>1.71</td>
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<tr>
<td>x</td>
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<td>4.40</td>
<td>10.00</td>
<td>1.58</td>
<td>1.68</td>
<td>1.75</td>
<td>1.75</td>
</tr>
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<td>5.80</td>
<td>13.00</td>
<td>1.60</td>
<td>1.70</td>
<td>1.78</td>
<td>1.78</td>
</tr>
</tbody>
</table>

NOTE — Bc magnetization can be checked and reported in any value between 5 000 to 10 000 A/m as per mutual agreement apart from above (2 500, 5 000 & 10 000 A/m).

(Handwritten note: "Check & Approve")
(Page 5, Table 3) — Substitute the following for the existing table:

**Table 3 Tolerances of Trimmed Edges**

*(Clause 8.2.2)*

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Nominal Width, l</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
</tbody>
</table>
| i)     | \( \leq 150 \)   | +0.2  
        |                  | -0.0  |
| ii)    | 150 \( \geq 300 \) | +0.3  
        |                  | -0.0  |
| iii)   | 300 \( \geq 600 \) | +0.5  
        |                  | -0.0  |
| iv)    | 600 \( \geq 1000 \) | +1.0  
        |                  | -0.0  |
| v)     | 1000 \( \geq 1250 \) | +1.5  
        |                  | -0.0  |

**NOTE** — As per agreement, width tolerance can be -ve or +ve or both -ve and +ve subject to tolerance band as above table.

(Page 5, clause 8.2.3) — Substitute the following for the existing:

‘For materials supplied with as rolled edges and/or widths above 1 250 mm the tolerances on nominal width should be the subject of agreement while ordering.’

(Page 6, clause 9.1) — Substitute the following for the existing:

‘The surface quality of cold rolled sheet/strip when measured in terms of stacking factor as specified in IS 649 shall comply with minimum values given in Table 4, for uninsulated or insulated as the case may be.’

(Page 7, Table 4, col heading 2) — Substitute ‘Nominal Thickness’ for ‘Normal Thickness’.

(Page 13, Annex B) — Substitute the following for the existing formula:

‘\( P \text{ percent} = \frac{(P_a - P_i)}{(P_a + P_i)} \times 100 \)’
AMENDMENT NO. 2 MARCH 2009

TO

IS 648 : 2006 COLD ROLLED NON-ORIENTED ELECTRICAL STEEL SHEET AND STRIP — FULLY PROCESSED TYPE — SPECIFICATION

(Fifth Revision)

[Page 3, Table 1, Sl No. (xvii)] — Insert the following after Sl No. (xvii) and renumber the subsequent serial numbers and add the note at the end of the existing table:

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Designation</th>
<th>Nominal Thickness mm</th>
<th>Maximum Core Loss at 50 Hz (W/kg)</th>
<th>a.c. Magnetization (50 Hz) Minimum Values of B Max Tesla</th>
<th>Anisotropy of Total Specific Loss at 1.5 T (% Max)</th>
<th>No. of Bends (Min)</th>
<th>Assumed Density kg/dm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>xviii)</td>
<td>50C900</td>
<td>0.50</td>
<td>3.8 9.00 1.61 1.70 1.78 ± 10</td>
<td>1.61 1.70 1.78 ± 10</td>
<td>10 10 7.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xix)</td>
<td>50C1000</td>
<td>0.50</td>
<td>4.4 10.00 1.62 1.72 1.81 ± 10</td>
<td>1.62 1.72 1.81 ± 10</td>
<td>10 10 7.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE — a.c. magnetization can be checked and reported in any value between 5 000 to 10 000 A/m as per mutual agreement, apart from above (at 2 500, 5 000 & 10 000 A/m).

(Page 4, clause 6.3.1) — Substitute the following for the existing:

‘The surface shall be smooth and clean, free from grease and rust (the same should not be confused with some coloration of insulation coating inherent in manufacturing process). Dispersed defects such as scratches, blisters, aesthetic type physical damages, etc, are permitted if they are within limits of thickness tolerance and not detrimental to method of working or correct use of supplied material. The limit, classification and disposition shall be subject to agreement between the purchaser and the manufacturer.’

(MTD 4)

Reprography Unit, BIS, New Delhi, India
AMENDMENT NO. 1 DECEMBER 2007
TO
IS 648 : 2006 COLD ROLLED NON-ORIENTED
ELECTRICAL STEEL SHEET AND STRIP — FULLY
PROCESSED TYPE — SPECIFICATION

(Fifth Revision)

(Page 9, Fig. 5, Step VIII) — Substitute ‘purchaser’ for ‘BHEL’.

(MTD 4)

Reprography Unit, BIS, New Delhi, India
Indian Standard

COLD ROLLED NON-ORIENTED ELECTRICAL STEEL SHEET AND STRIP — FULLY PROCESSED TYPE — SPECIFICATION

(Fifth Revision)

1 SCOPE

1.1 This standard covers the requirement for non-oriented electrical steel with silicon content up to 3.5 percent, cold rolled, both insulated or uninsulated, fully processed electrical steel and strip primarily intended for static and rotating machines operating at power frequencies.

1.2 If required and agreed to between the purchaser and the manufacturer, the typical, physical and mechanical properties of the steel sheets/straps shall be supplied by the manufacturer to the purchaser.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>649 : 1997</td>
<td>Methods of testing steel sheets for magnetic circuits of power electrical apparatus (revised)</td>
</tr>
<tr>
<td>1885 (Part 1)</td>
<td>Electro technical vocabulary: Part 1</td>
</tr>
<tr>
<td>1961</td>
<td>Fundamental definition</td>
</tr>
<tr>
<td>8910 : 1978</td>
<td>General technical delivery requirements for steel and steel products</td>
</tr>
</tbody>
</table>

3 TERMINOLOGY

For the purpose of this standard the following definitions in addition to those given in IS 1885 (Part 1) shall supply.

3.1 Electrical Steel Sheet/Strip — Electrical steel/strip is a material used for making cores for rotating electrical machines and static apparatus.

3.2 Non-oriented Electrical Steel Sheet/Strip — Steel sheet/strip having substantially the same magnetic and electrical characteristics in all direction in the plane of the sheet.

3.3 Cold Rolled Electrical Steel Sheet/Strip — Electrical steel sheet/strip which is reduced to final gauge after cold rolling.

3.4 Silicon Steel — Electrical steel made with deliberate alloying addition of silicon.

3.5 Fully Processed Material — Material which does not require further processing by the purchaser to give the specified properties.

3.6 Sheet — A cold rolled flat product in rectangular section of thickness below 5 mm and supplied in straight lengths. The width is at least 100 times the thickness and the edges can be mill, trimmed and sheared.

3.7 Strip — A cold rolled flat product approximately in rectangular cross-section of thickness normally 12 mm or below with mill, rolled trimmed or sheared edges and supplied in coil form.

3.7.1 Wide Strip — Cold rolled strip of width normally equal to or greater than 600 mm.

3.7.2 Narrow Strip — Cold rolled strip of width normally less than 600 mm.

3.8 Coil Interleaves — Laps at the junctions between sub-coils for the purpose of building up larger continuous coils.

3.9 Coil Butt Welds — Butt welds at the junctions between sub-coils for the purpose of building up larger continuous coils.

3.10 Batch — A single charge of the product of one or more cast heat treated together with similar quality grading.

3.11 Stacking Factor — A numeric, less than unity and usually expressed as a percentage, which is defined as the ratio of the uniform solid height h of the magnetic material in a laminated core to the actual height h (core build up) when, measured under a specified pressure S is thus equal to the ratio of the volume of magnetic
material in a uniform laminated core to the overall geometric volume in the core.

3.12 Flatness (Wave Factor) — The property of a sheet or of a length of strip which is characterized by the wave factor, that is, by the relation of the height of the wave to its length.

3.13 Insulated Sheet — Insulated sheet shall mean electrical sheets in sheet/strip form coated on both sides with organic or inorganic or combined organic and inorganic materials to provide interlaminar insulation resistance.

3.14 Density — The ratio of mass to the volume of a magnetic material, in kg/m³.

3.15 Anisotropy of Losses — The anisotropy losses is the difference between the specific loss measured at right angles and parallel to the direction of the rolling expressed as percentage to the sum of two total specific losses measure

\[ P, \text{ percent} = \frac{(P_a - P_l)}{(P_a + P_l)} \times 100 \]

where

\[ P = \text{anisotropy of losses}; \]
\[ P_a = \text{total specific loss } P \text{ at } 1.5 \text{ Tesla perpendicular to the direction of rolling}; \]
\[ P_l = \text{total loss } P \text{ at } 1.5 \text{ Tesla parallel to the direction of rolling}. \]

4 CLASSIFICATION OF GRADES

This standard covers the grades listed in Table 1, with the forms and condition of supply as specified in IS 8910. The grades are classified according to the maximum value of total loss at a polarization of 1.5 T and according to the nominal thickness (0.35, 0.50, 0.65 and 1.00 mm).

5 DESIGNATION

The complete symbol for grade of magnetic sheet and strip shall consist of the following:

Example — Designation of cold rolled non-oriented, finally annealed magnetic strip of a grade symbolized by 50C470 (thickness 0.50 mm, total specific loss at 1.5 T not exceeding 4.70 W/kg).

6 GENERAL REQUIREMENTS

6.1 Condition of Delivery

6.1.1 The product shall be supplied in the fully processed condition.

6.1.2 The material can be supplied either without insulation or with insulation on one or both sides. If the material is supplied with insulation, the nature of the insulation, its properties and stacking factor and their verification shall be agreed at the time of ordering (see 7.2.5 and 9.1).

6.1.3 The thickness of the material supplied for each grade shall be as given in Table 1. If the material is required in thicknesses other than those specified in Table 1, these may be supplied as per the properties mutually agreed to between the purchaser and the manufacturer.

6.1.4 The sizes of the strips and sheets supplied in coil or in cut length shall be subject to mutual agreement between the purchaser and the manufacturer.

6.1.5 When the material is supplied in coils, the following shall be considered as preferred dimensions of the coils for all the grades specified in this standard:

| Internal diameter | 400/430/450/510/610 |

6.1.6 When supplied in cut length form, the packet mass shall not be more than 3.5 tonnes.

6.1.7 Interleaves and Welds

Strips can occasionally exhibit welds or interleaves, resulting from the removal of defective zones subject to prior agreement between the parties. If necessary, marking of welds or interleaves may be agreed on at the time of ordering.

6.1.7.1 Small grade coils may be joined together by butt welding to form larger continuous coils in which case the welds shall be marked as for interleaves. The supplier shall ensure that the welds are made in such a manner as not to damage areas of the coils adjacent to the weld.

6.1.7.2 The edges of parts welded together shall not be so much out of alignment at to affect the further processing of the material.

6.1.8 Stability

Coils shall be sufficiently tightly wound to prevent collapse to an extent that would preclude their being mounted on a mandrel appropriate to the ordered internal diameter.
### Table 1 Designation of Electrical Steel Grades
(Clause 4, 6.1.3, 7.1.1.2, 7.1.2.1, 7.1.2.4 1 and 9.2)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Designation</th>
<th>Nominal Thickness mm</th>
<th>Maximum Core Loss at 50 Hz (W/kg)</th>
<th>D.C. Magnetization (50 Hz) Minimum Values of B Max Tesla</th>
<th>Anisotropy of Total Specific Loss at 1.5 T (% Max)</th>
<th>No. of Bends (M/m) Assumed Density kg/dm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>10T 15T 2.500 A/m 5.000 10.000 A/m</td>
<td>(4) (5) (6) (7) (8) (9)</td>
<td>(10) (11)</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>35C250</td>
<td>0.35</td>
<td>100 110 149 160 170 ±17 2</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii)</td>
<td>35C270</td>
<td></td>
<td>110 115 149 160 170 ±17 2</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii)</td>
<td>35C300</td>
<td></td>
<td>120 125 149 160 170 ±17 3</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv)</td>
<td>35C330</td>
<td></td>
<td>130 135 149 160 170 ±17 3</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>v)</td>
<td>35C360</td>
<td></td>
<td>145 140 149 160 170 ±17 3</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vi)</td>
<td>50C270</td>
<td>0.50</td>
<td>110 115 149 160 170 ±17 2</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vii)</td>
<td>50C290</td>
<td></td>
<td>115 120 149 160 170 ±17 2</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>viii)</td>
<td>50C300</td>
<td></td>
<td>125 130 149 160 170 ±14 3</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ix)</td>
<td>50C330</td>
<td></td>
<td>135 150 149 160 170 ±12 3</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x)</td>
<td>50C350</td>
<td></td>
<td>150 200 150 160 170 ±12 5</td>
<td>7.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xi)</td>
<td>50C400</td>
<td>0.65</td>
<td>170 230 153 163 173 ±12 5</td>
<td>7.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xii)</td>
<td>50C470</td>
<td></td>
<td>200 230 154 164 174 ±10 10</td>
<td>7.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xiii)</td>
<td>50C530</td>
<td></td>
<td>230 260 156 165 175 ±10 10</td>
<td>7.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xiv)</td>
<td>50C600</td>
<td></td>
<td>260 300 157 166 176 ±10 10</td>
<td>7.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xv)</td>
<td>50C630</td>
<td></td>
<td>280 300 155 165 176 ±10 10</td>
<td>7.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xvi)</td>
<td>50C700</td>
<td></td>
<td>300 300 160 169 177 ±10 10</td>
<td>7.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xvii)</td>
<td>50C800</td>
<td></td>
<td>360 360 160 170 178 ±10 10</td>
<td>7.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xviii)</td>
<td>65C330</td>
<td>0.65</td>
<td>135 230 149 160 170 ±15 2</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xix)</td>
<td>65C350</td>
<td></td>
<td>150 260 149 160 170 ±14 2</td>
<td>7.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xx)</td>
<td>65C400</td>
<td></td>
<td>170 200 152 162 172 ±14 2</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxi)</td>
<td>65C470</td>
<td></td>
<td>200 230 153 163 173 ±12 5</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxi)</td>
<td>65C530</td>
<td></td>
<td>230 260 154 164 174 ±12 5</td>
<td>7.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxi)</td>
<td>65C600</td>
<td></td>
<td>260 300 155 166 176 ±10 10</td>
<td>7.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxi)</td>
<td>65C700</td>
<td></td>
<td>300 300 157 166 176 ±10 10</td>
<td>7.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxi)</td>
<td>65C800</td>
<td></td>
<td>360 360 160 170 178 ±10 10</td>
<td>7.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxi)</td>
<td>65C1000</td>
<td></td>
<td>440 440 158 168 176 ±10 10</td>
<td>7.80</td>
<td></td>
<td></td>
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<tr>
<td>xxix)</td>
<td>100C1000</td>
<td></td>
<td>580 440 150 160 170 ±6 10</td>
<td>7.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>xxxix)</td>
<td>100C1300</td>
<td></td>
<td>580 130 160 170 178 ±6 10</td>
<td>7.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.2 Chemical Composition
The chemical composition of steel is left to the manufacturer's discretion. However, the chemical composition may be provided, if agreed to between manufacturer and the purchaser at the time of placing the order.

6.3 Surface Condition
6.3.1 The surfaces shall be smooth and clean, free from grease and rust (the same should not be confused with some coloration of the insulation coating inherent in manufacturing process). Dispersed defects such as scratches, blisters, cracks etc are permitted if they are within the limits of thickness tolerance and if not detrimental to the correct use of supplied material.

6.3.2 When an insulation coating is present on the surface of the material, it shall be sufficiently adherent so that it does not become detached during cutting operations. During an alternating bend test, the coating shall not detach after a bend of 90°. If the coating becomes detached during the test, the piece from which the sample was taken shall be subjected to shearing test. During the test, it shall not be admissible for large pieces of the coating to become detached. However, the slight chipping of this coating at the shearing edges shall be tolerated.

7 TECHNICAL REQUIREMENT

7.1 Magnetic Characteristics
7.1.1 Magnetization Test
7.1.1.1 a.c. magnetization test
The a.c. magnetization test shall be carried out as specified in IS 649.

7.1.1.2 The minimum values for various grades to be guaranteed are given in Table 1.

7.1.2 Total Specific Loss/Core Loss
7.1.2.1 The maximum values of total specific loss to be guaranteed at 1.5T are as per Table 1. The values apply for the thickness of 0.35, 0.50 and 0.65 mm to the aged sample and for 1.00 mm to non-aged sample. The values of total specific loss at 1.0 Tesla given in Table 1 are for information only.

7.1.2.2 The test sample shall be prepared and tested as described in IS 649 at a peak magnetic flux density of 1.5 T at 50 Hz. Wherever relevant the samples shall be annealed in accordance with the manufacturer's recommendations before testing.

7.1.2.3 The ageing shall be carried out as specified in IS 649 or this may be replaced by an accelerated ageing with duration of 24 h at a temperature of 225°C.

7.1.2.4 Anisotropy of losses
7.1.2.4.1 If required by the purchaser the anisotropy of losses (for testing, see Annex B) should be tested. The maximum values of Table 1 should be guaranteed.

7.1.2.5 If agreed to between the purchaser and the manufacturer, the manufacturer shall supply characteristics curves for properties agreed upon mutually.

7.1.2.6 If agreed to between purchaser and the manufacturer, the manufacturer should also give information for the following properties to the purchaser on request:

   a) Typical electrical resistivity values for each grade, and
   b) Typical thermal conductivity values for each grade.

7.2 Surface Insulation Characteristics
7.2.1 Unless otherwise specified, fully processed cold rolled electrical sheets shall be supplied without coating, they shall be coated with either organic or inorganic material as specified by the purchaser. The description of the coatings is given at Annex C.

7.2.2 The coating should have uniform color throughout the surface of the coil tightly adherent to both sides.

7.2.3 If insulated material is required for subsequent annealing this should be stated by purchaser on his enquiry and order. The coating supplied shall withstand annealing under condition specified by the supplier.

7.2.4 The thickness of insulation coating shall be as agreed between the manufacturer and the purchaser.

7.2.5 The minimum reference values for insulation resistance on both types of coatings shall be as given in Table 2.

| Table 2 Minimum Reference Values for Insulation Resistance |
|-------------|---------------|------------------|
| SI No. | Average of 10 Non-overlapping readings of IR (5 on Either Side of Sheet Ohm-cm²/La) | Individual Minimum Value of IR Ohm-cm²/La |
| (1) | (2) | (3) |
| i) | 2.5 | 1 |
| ii) | 5.0 | 1 |
| iii) | 10.0 | 1 |
| iv) | 15.0 | 2 |
| v) | 20 | 2 |
| vi) | 30 | 10 |
| vii) | 50 | 10 |
| viii) | 100 | 20 |
7.2.6 Method of measurement of insulation resistance shall be described in Annex D.

7.2.7 Thermal Effect on Coating

If agreed between the purchaser and the manufacturer, twelve specimens of the coated strip shall be clamped together under a pressure of 1 N/mm² approximately and heated in a laboratory oven at a temperature of 150°C for a period of 7 days. After cooling to the room temperature the insulation surface resistance (two sides coated) shall be not less than the minimum specified values mentioned in 7.2.5.

7.2.8 Resistance to Solvents and Cleanliness

If agreed between the user and the manufacturer, the specimens shall be kept in a container filled with boiling trichloroethylene or xylene for 5 min. After removal and cooling to room temperature, the film should not get soft enough so that it can be wiped off.

8 GEOMETRIC CHARACTERISTICS AND TOLERANCES

8.1 Thickness Tolerances

8.1.1 The allowable tolerance on the nominal thickness within the same acceptable unit shall be ± 8 percent of the nominal value for thicknesses 0.35 mm and 0.50 mm and ± 6 percent of the nominal value for thicknesses 0.65 mm and 1.00 mm. The additional thickness due to welds, with respect to the measured thickness of the steel sheet or strip shall not exceed 0.050 mm.

8.1.2 The difference in thickness in a direction perpendicular to the direction of rolling shall not exceed 0.020 mm for thicknesses of 0.35 mm and 0.50 mm and 0.030 mm for thicknesses of 0.65 mm and 1.00 mm, the measurements being made at least 30 mm from the edges. This measurement shall be made using a micrometer with an accuracy of 0.001 mm. These tolerances apply only to materials with a width greater than 150 mm. For narrow strip other agreements may be reached.

8.1.3 The height of the weld if any and edge burr shall not exceed 50 microns.

8.2 Width Tolerances

8.2.1 This tolerance is applicable to widths less than or equal to 1 250 mm. For the width tolerances a distinction is made between material supplied with edges in the as rolled condition and material delivered with trimmed edges.

8.2.2 For material supplied with trimmed edges, the tolerances of Table 3 shall apply.

<table>
<thead>
<tr>
<th>Table 3 Tolerances of Trimmed Edges</th>
</tr>
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<tbody>
<tr>
<td><strong>(Clause 8.2.2)</strong></td>
</tr>
<tr>
<td><strong>Sl No.</strong></td>
</tr>
<tr>
<td><strong>No.</strong></td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>i)</td>
</tr>
<tr>
<td>ii)</td>
</tr>
<tr>
<td>iii)</td>
</tr>
<tr>
<td>iv)</td>
</tr>
<tr>
<td>v)</td>
</tr>
</tbody>
</table>

8.2.3 For materials supplied with as rolled edges, the tolerances on nominal width should be the subject of agreement when ordering.

8.3 Length Tolerance

The tolerance on length for sheets in relation to length ordered shall be ± 0.5 percent but with a maximum of ± 6 mm.

8.4 Tolerances on sizes other than those covered under 8.1, 8.2 and 8.3 shall be subject to an agreement between the purchaser and the manufacturer.

8.5 Tolerance on Shape

8.5.1 Out of Squareness

Out of square, tolerances shall not be more than 1 percent of the length and the width (see Fig. 1).

8.5.2 Edge Camber

The tolerances on edge camber of strip in coil shall not exceed 4 mm in 2 m length cut from a coil (width > 30 ≤ 150 mm) and 2 mm (width > 150 mm) (see Fig. 2).

8.5.3 Residual Curvature

The verification of residual curvature does not apply to material of width less than or equal to 100 mm.

A requirement concerning residual curvature can be specified by agreement when ordering in this cast, the distance between the bottom edge of the test specimen and the supporting plate shall not exceed 35 mm for the products of thicknesses 0.35 mm, 0.50 mm and 0.65 mm. For the thickness 1.00 mm, this distance shall be subject to an agreement between the supplier and the purchaser.

8.6 Flatness (Wave Factor)

This tolerance is applicable to material of width more than 100 mm. The wave factor, expressed as a percentage, shall not exceed 2 percent (see Fig. 3).
8.7 Sheet and Strip for Specific Purposes

Material required to tolerances other than those specified in 8.1 and 8.6 shall be subject to agreement between the purchaser and the manufacturer.

9 TECHNOLOGICAL CHARACTERISTICS

9.1 Stacking Factor

The surface quality of the uninsulated cold rolled sheet/strip and when measured in terms of stacking factor as specified in IS 649 shall comply with minimum values given in Table 4.

9.2 Bend Test

The bend test shall be carried out as specified in IS 649. The test piece shall withstand the number of bends as given in Table 1. The radius of jaws shall be 5.0 mm.

10 RETESTS

10.1 Should a test sample fail, two further samples shall be selected at random from the same batch of material and tested in a same manner.

10.2 If either of both of the retest samples on testing indicate that the core loss is greater than maximum loss specified for the respective grade, the batch represented by these samples shall be taken as not complying with the requirements of that grade.

11 PACKING

11.1 The sheets/strips shall be suitably packed in metal protected containers lined with water-proof material
Table 4 Stacking Factor  
(Clause 9.1)

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Normal Thickness</th>
<th>Uninsulated Cold Rolled Non-oriented Electrical Steel Fully Processed Type</th>
<th>Insulated Cold Rolled Non-oriented Electrical Steel Fully Processed Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>i)</td>
<td>0.35</td>
<td></td>
<td>95</td>
</tr>
<tr>
<td>ii)</td>
<td>0.50</td>
<td></td>
<td>97</td>
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<td>iii)</td>
<td>0.65</td>
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</tr>
<tr>
<td>iv)</td>
<td>1.00</td>
<td></td>
<td>98</td>
</tr>
</tbody>
</table>

lining to avoid any damage and to ensure protection from rust during transit. The method of packing shall be subject to the approval by the purchaser before shipment from manufacturer's works.

11.2 Some typical methods of packing are given in Fig. 4 to Fig. 8.

12 MARKING

12.1 Every bundle/coil of sheet/strip shall be legibly marked with the following:

a) Manufacturer's name;
b) Grade and thickness;
c) Gross and net mass (at the top of bundle);
d) Cast number or identification mark by which the sheets/stripis may be traced to the cast from which they were made; and
e) Type of coating, if coated.

12.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

12.2.1 The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

13 TEST CERTIFICATE

The manufacturer shall provide with each consignment, a test certificate giving the following as per the agreement between the manufacturer and the purchaser at the time of placing the order:

a) Grade/Thickness;
b) Dimension;
c) Chemical composition;
d) Density;
e) Specific total loss for each coil/packet;
f) a.c. magnetization;
g) Anisotropy;
h) Insulation resistance, if coated;
j) Insulation thickness;
k) Adherence;
m) Resistance to solvent;
n) Thermal effect;
p) Number of bends, and
q) Stacking factor.

14 ORDERING INFORMATION

While placing an order for cold rolled non-oriented electrical steel sheet and strip (fully processed type) covered by this standard, the purchaser should specify clearly the following:

a) Grade of electrical steel sheet/strip required (see Table 1);
b) The length, width and thickness of sheets or the width, thickness, maximum and minimum acceptable mass and internal diameter of coils required (see Table 1, 6.1.5, 8.2 and 8.3);
c) The number of interleaves and/or butt welds acceptable in a coil (see 6.1.7.2);
d) Type of coating and nominal thickness;
e) Any optional test required; and
f) Any special requirements (see 4, 6.1.4, 8.4, 8.7 and 10.1).
THICK ANGLE STEEL BANDS TO BE PROVIDED ON OUTSIDE DIAMETER TO AVOID BUCKLING OF COIL

COIL SHOULD BE WRAPPED IN COMPLETELY WITH ANTI-RUST PAPER AND THEN WITH POLYTHENE SHEET AND SEALED. SIDES OF THE COIL SHOULD BE PROVIDED WITH PROTECTION BOARD TO PREVENT FROM PUNCTURE DURING HANDLING

SECTION-AA

1. Protection Board
2. Anti-Rust Paper
3. Polythene Sheet
4. Galvanized Sheet
5. Protection Board
6. Steel Ring Both Inside and Outside

FIG. 4 DETAILS OF PACKING FOR ELECTRICAL STEEL SHEET AND STRIP IN COIL FORM (HORIZONTAL)
STEP I — An annular protection board should be placed at either end of the coil.

STEP II — The coil should then be wrapped with waterproof anti-rust crepe kraft paper by lapping axially all around the circumference.

STEP III — The coil shall then be covered by polythene sheet or waterproof kraft paper and the ends sealed properly.

STEP IV — A galvanized sheet should be wrapped on the outside of the coil and the two ends. Care should be taken to ensure that the ends extend sufficiently over the inside diameter of the coil.

STEP V — A galvanized sheet should be wrapped on the inside of the coil; care should be taken that it overlaps sufficiently over the ends of the sheet mentioned in (IV) above.

STEP VI — Steel rings made from thick angle sheets should be placed on the rims of the inner and outer diameters at both ends of the coil. The rings should be held at either ends at four points by steel bands.

STEP VII — The coil should then be mounted on wooden skids held together by steel bands.

STEP VIII — The packing should ensure that there is no seepage of moisture and the sheets reach BHEL in completely rust free condition. It should be strong enough to withstand handling at the docks, at sea and on the road.

STEP IX — Coils should 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.

STEP X — The strip shall be of constant width and wound in such a way that the edges are superimposed in a regular manner and that the side faces of the coil are substantially flat.

**Fig. 5 Details of Packing for Electrical Steel Sheet and Strip in Coil Form (Vertical)**
**Fig. 6** Details of Electrical Steel Sheet Packings in Cut Lengths

(For details see Fig. 7A and 7B)

**Note** — Read this matter along with Fig. 6

**Step I** — Wrap the pack all round with polythene sheet and then with waterproof hessian cloth as shown at 'A'.

**Step II** — Wrap the pack in metal sheet and bend metal sheet on the sides on top to cover one-third portion of the top. Cover the top with single metal cover bent over the sides. (A box type cover on top if possible is preferred to avoid water seeping inside). Care has to be taken to ensure that top sheet is not made up of number of sheets from which water may seep inside the back.

**Step III** — Keep assembled pack on three longitudinal wooden skids approximately 75 mm x 75 mm cross section and fasten with 32 mm wide, 20 gauge iron hoop as shown at 'B'.

**Step IV** — Nail three transverse skids to the longitudinal skids and fasten with band/stripes as shown at 'D'.

**Fig. 7** Details of Electrical Steel Sheet Packings in Cut Lengths
NOTES
1. Waterproof paper lining shall be preferably volatile corrosion inhibitor (V.C.I.) coated paper with an additional polythene (100 micron) enveloped.
2. Approximate weight of each bundle shall be 2 to 3 metric tonnes. Bundles weighing 2 metric tonnes is however preferred.

**Fig. 8 Details of Packing Electrical Steel Sheet in Cut Lengths**
### ANNEX A

(Foreword)

**CONVERSION FACTOR**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Multiply</th>
<th>By</th>
<th>To obtain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnetizing Force</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oersted (Oe)</td>
<td>7.958 × 10</td>
<td>Ampere per meter (A/m)</td>
<td></td>
</tr>
<tr>
<td>Oersted (Oe)</td>
<td>2.021</td>
<td>Ampere per inch (A/in)</td>
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ANNEX B
(Clause 7.1.2.4.1)

METHOD FOR DETERMINING ANISOTROPY OF LOSSES

B-1 For determining the anisotropy of losses, the total specific loss shall be measured separately on sample strips taken parallel and perpendicular to the direction of rolling. The anisotropy of losses is to be calculated from the formula

\[ P \text{ percent} = \left( \frac{(P_\alpha - P_\pi)(P_\alpha + P_\pi)}{2} \right) \times 100 \]

where

- \( P \) = the anisotropy of losses;
- \( P_\alpha \) = the total specific loss \( P \) at 1.5 T parallel to the direction of rolling; and
- \( P_\pi \) = the total loss \( P \) at 1.5 T perpendicular to the direction or rolling.

ANNEX C
(Clause 7.2.1)

CLASSIFICATION OF INSULATING COATINGS FOR ELECTRICAL STEEL

C-0 Oxide that is formed naturally on the steel surface during mill processing. This oxide layer is thin, tightly adherent, and provides sufficient insulating quality for most small cores. The oxide layer will withstand normal stress-relief annealing temperature. The insulation quality is affected by the oxidizing potential of the user's anneal, that is the oxidized surface condition may be enhanced by controlling the atmosphere to be more or less oxidizing to the surface. It is not appropriate to assert a maximum acceptable Franklin test current for this coating.

C-1 User-formed oxide that is created on the steel surface by contact with an oxidizing furnace atmosphere at the end of the heat-treating cycle. This coating usually is bluish to grey in colour and used for various electrical steel applications. It is not appropriate to assert a maximum acceptable Franklin test current for this coating.

C-2 Inorganic insulating coating predominantly comprised of magnesium silicate and used on grain-oriented electrical steel. The coating is formed from the reaction of the coating with the steel surface during high-temperature annealing. The resulting coating often is referred to as 'mill glass' or 'glass film' even though the coating is not technically a glass. The coating is very abrasive and hence is not typically used for stamped lamination. The primary application of this coating is air-cooled or oil-immersed would distribution transformers. This coating will withstand normal stress-relieves annealing temperatures. It is not appropriate to assert a maximum acceptable Franklin test current for this coating.

C-3 Organic varnish/enamel coating that is applied to the steel surface and cured by heating. Used for fully processed non-oriented and other electrical steels. It is appropriate to designate a maximum Franklin test current for this type of coating. The required Franklin test current is subjected to agreement between the producer and user. This coating generally improves the punchability of the steel and hence is quite suitable for stamped lamination. This coating will not withstand typical stress-relief annealing temperatures. The coating normally is suitable for operating temperatures up to about 180°C.

C-4 Coating formed by chemical treating or phosphating of the steel surface followed by an elevated temperature curing treatment. This type of coating is used in application requiring moderate level of insulation resistance. This coating will withstand normal stress-relieves annealing temperatures but some reduction in surface insulation resistivity may occur during the anneal. It is appropriate to specify a maximum acceptable Franklin test current with a value agreed to by the manufacturer and the purchaser.

C-5 Inorganic or mostly inorganic coating similar to C-4, to which ceramic fillers or film-forming inorganic components have been added to increase the insulation ability of the coating. This coating typically is a phosphate, chromate or silicate applied to grain-oriented electrical steels and non-oriented electrical steels. C-5 coating may be applied over top of C-2 coating for application in which extra insulation is required for example sheared lamination of grain-oriented electrical steel for cores of power transformers.
C-6 Coating are used for applications requiring a high-surface resistivity. It is appropriate to designate a maximum Franklin test current for this type of coating before stress-relief annealing. The required Franklin test current is subject to agreement between the producer and user. The coating will withstand stress-relief annealing up to 845°C in neutral or slightly reduced furnace atmospheres but some reduction in surface insulation resistivity may occur during the anneal. The coating will withstand burn-off treatments at (315-540°C) used to remove stator winding insulation during rebuilding of motors. The coating can be used in air-cooled or oil-immersed cores.

In some cases, organic components may be added to C-5 coatings to enhance punchability. The application, use and properties of such coatings are similar to those of C-5 coatings. The user should consult the manufacturer if there are particular concerns with coating off-grassing during welding or elevated temperature exposure of the coated steel.

C-7 Organic based coating to which inorganic fillers have been added to increase the insulation ability of the coating. The coating is applied to the steel surface and cured by heating. C-6 coatings typically are used for fully processed non-oriented electrical steels. It is appropriate to designate a maximum Franklin test current for this type of coating. The required Franklin test current is subjected to agreement between the producer and user. The coating will withstand burn-off treatments used to remove stator winding insulation during rebuilding of motors done at 315-540°C but is not considered to be a coating that will withstand normal stress-relief annealing. The coating generally improves the punchability of the steel and hence is suitable for stamped lamination.

ANNEX D

(Clause 7.2.6)

INSULATION RESISTANCE TEST METHOD BASED ON FRANKLIN TEST METHOD

D-1 The method covers testing of single strips or punching of flat rolled electrical steel for surface insulation resistance under test voltage of 0.5 V dc, pressure of 300 psi and at a temperature of 25 or 150°C. The current from 10 metallic contact points, comprising of total area of 6.45 cm², through one insulating coating to the metal core of the lamination is measured. The current range is kept from zero to 1.0 A by using equivalent circuit resistance of 0.5 ohm. Based upon the input parameters defined above. Insulation resistance can be circulated by using the following formula:

\[ I.R (\text{in ohm-cm}^2/\text{La}) = 6.45l - 6.45 \]

where \( l \) is total current from 10 contact points.

NOTE — When conducting a test in accordance with this method, single reading should not be considered significant since the nature of test device and the specimen are such that successive measurement of a specimen often yield different values. The minimum average of 10 known non-overlapped resistance measurements (five on each side of sheet) should be taken
ANNEX E
(Foreword)
COMMITTEE COMPOSITION
Wrought Steel Products Sectional Committee, MTD 4

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SAIL, Rourkela Steel Plant, Rourkela
All India Induction Furnace Association, New Delhi
Atomic Minerals Division, Hyderabad/New Delhi
Bharat Heavy Electricals Ltd, Bhopal
Central Boilers Board, New Delhi
Consumer Protection Council, Rourkela
Defence Metallurgical Research Lab (DMRL), Hyderabad
DGS&D, Bhilai Nagar
Escorts R&D Centre, Faridabad
Institute of Steel Development and Growth, Kolkata
Jindal South West Steel Ltd, Vasind/Vijaynagar
M N Dastur & Co Ltd, Kolkata/New Delhi
Ministry of Defence (DGOFB), Kolkata
Ministry of Defence (DGQA), Ichapur
Ministry of Railways (RDSO), Lucknow
Ministry of Steel (Government of India), New Delhi
Mukand Ltd, Thane
National Metallurgical Laboratory, Jamshedpur
National Physical Laboratory, New Delhi
Nuclear Fuel Complex, Hyderabad
Power Grid Corporation, Gurgaon
Rashtriya Ispat Nigam Ltd (VSP), Vishakhapatnam
SAIL, Bhilai Steel Plant, Bhilai
SAIL, Bokaro Steel Plant, Bokaro

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Joint Director (I&L) (Alternate)
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Shri P K Datta (Alternate II)
Shri G B Pradhan
Dr M M S Sodhi (Alternate)
Organization

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SAIL, Research & Development Centre for Iron & Steel, Ranchi
SAIL, Salem Steel Plant, Salem
Steel Furnace Association of India, New Delhi
Steel Re-rolling Mills Association of India, Mandi Gobindgarh
Sunflag Iron & Steel Co Ltd, Faridabad/Bhandara
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Tata Steel Ltd, Jamshedpur
Thyssenkrupp Electrical Steel India Pvt Ltd, District Nasik
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Federation of Engineering Industries of India, New Delhi

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16
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This Indian Standard has been developed from Doc : No. MTD 4 (4633).

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