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BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

Draft *Indian Standard*

TINTED OR COLOURED FLOAT GLASS – SPECIFICATION

भारतीय मानक मसौदा

रंगीन प्लव काँच — विशिष्टि

ICS 81.040.20

Glass, Glassware & Laboratoryware Sectional Committee, CHD 10

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FOREWORD

(Formal clauses will be added later)

Tinted Float glass is a glass which is a body coloured glass. It excludes all other glasses which do not have uniform colour within the body like in case of painted or coated glasses.

In the formulation of this standard, considerable assistance has been derived from the following publications:

EN 572-2: 2012	Glass in building – Basic soda lime silicate glass products part 2- Float glass

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.

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Tinted or Coloured Float Glass – Specification

1 SCOPE

1.1 This standard prescribes requirements, method of sampling and tests for Tinted flat glass, tinted float glass having glossy, plain and smooth surfaces.

1.2 This standard covers jumbo, cut sizes or stock sheets square, rectangular and of other shapes.

2 REFERENCES

The standards listed below 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 revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 1382 : 1981	Glossary of terms relating to glass and glassware
IS 4905 : 2016	Random Sampling and Randomization Procedures (*first revision*)
IS 14900 : 2018	Transparent float glass - Specification (*first revision*)
IS 16231 (Part 2) : 2019	Use of Glass in Buildings — Code of Practice Part 2 Energy and Light (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1382, IS 16231-2 and IS 14900, and in addition to the following shall apply:

3.1 Colour – Color or colour is the visual perceptual property deriving from the spectrum of light interacting with the photoreceptor cells of the eyes. Color categories and physical specifications of color are associated with objects or materials based on their physical properties such as light absorption, reflection, or emission spectra. By defining a color space colors can be identified numerically by their coordinates.

3.2 Colour Band – Linear fault results in the irregular colour of the glass.

3.3 Ridge Line – Broad streaks occurring in parallel with the flow direction of ribbon.

3.4 Colour Delta (ΔE) – Delta E is the standard calculation metric which correlates the human visual judgment of differences between two perceived colours. This standard quantifies this difference and is used to calculate the deviation from the benchmark standards which allows a tolerance level to be set (based on L*a*b coordinates). Delta E levels are the difference between the displayed color and the original color standard of the input content. Lower Delta E figures indicate greater accuracy, while high Delta E levels indicate a significant mismatch.

3.5 Tinted Glass – Tinted Float glass is a glass which is a body coloured glass. It excludes all other glasses which do not have uniform colour within the body like in case of painted or coated glasses.

Or as per IS 16231 (Part 2):

A normal flat glass to which colourants (normally metal oxides) are added during manufacturing process to achieve tinting and solar radiation absorption properties. It is also referred to as body tinted glass.

BIS Comment: Subcommittee to finalize the definition of tinted glass.

4 TYPES

Based on the Visual Light Transmittance characteristics with respect to the 5 mm thick sample of a given tint, the tinted glass is categorized into three types:

4.1 ***Light Tint*** **–** having VLT greater than 45 %.

4.2 ***Medium Tint*** **–** having VLT from 30 % to 45 %.

4.3 ***Dark Tint*** **–** having VLT less than 30 %.

5 REQUIREMENTS

5.1 Colour Characteristics & Spectral Properties

5.1.1 *Visual Light Transmittance*

The value for visual light transmittance for a float tinted glass, when measured in accordance to the method specified in **5.11.4** of IS 16231 (Part 2), shall lie within ± 3 unit of the value declared by the manufacturer as also specified in the table 1.

For Example: If the manufacturer declares a Visual Light Transmittance value of 50%, then the measured value of Visual Light Transmittance shall lie within a range of 47% to 53%.

5.1.2 *UV-Transmittance*

The value for UV-Transmittance for a float tinted glass, when measured in accordance to the method specified in **9** of IS 16231 (Part 2), shall lie within ± 3 unit of the value declared by the manufacturer as also specified in the table 1.

For Example: If the manufacturer declares a UV-Transmittance value of 50%, then the measured value of UV-Transmittance shall lie within a range of 47% to 53%.

5.1.3 *Solar Factor*

The value for solar factor for a float tinted glass, when measured in accordance to the method specified in **7** of IS 16231 (Part 2), shall lie within ± 3 unit of the value declared by the manufacturer as also specified in the table 1.

For Example: If the manufacturer declares a Solar Factor value of 50%, then the measured value of Solar Factor shall lie within a range of 47% to 53%.

5.1.4 *Colour Delta* (*ΔE*)

The value for Colour Delta for a float tinted glass, when calculated in accordance to the method specified in **Annex A**, shall not be more than 3 as also specified in the table 1.

5.1.5 *Colour Band and Ridge Line*

Colour band and Ridge line when measured as per method specified in **Annex-B,** shall not be visible from 3 meters distance in normal inspection system (Representing day light).

Table 1 Tolerance on Colour Characteristics & Spectral Properties
(*Clause* 5.1.1, 5.1.2, 5.1.3, 5.1.4, 5.1.15)

Sl No.	**Characteristic**	**Measured Value**	**Declared value**	**Requirement**	**Method of test**
(1)	(2)	(3)	(4)	(5)	(6)
i.	Visual Light Transmittance	$\tau_{v,m}$	$\tau_{v,d}$	$\tau_{v,m} = \tau_{v,d} \pm 3$ Unit	**5.11.4** of IS 16231 (Part 2)
ii.	UV-Transmittance	$\tau_{UV,m}$	$\tau_{UV,d}$	$\tau_{UV,m} = \tau_{UV,d} \pm 3$ Unit	**9** of IS 16231 (Part 2)
iii.	Solar Factor	$\tau_{e,m}$	$\tau_{e,d}$	$\tau_{e,m} = \tau_{e,d} \pm 3$ Unit	**7** of IS 16231 (Part 2)
iv.	Colour Delta (ΔE)	$L^*,a^*,b^*,_m$	$L^*,a^*,b^*,_d$	$\Delta E \leq 3$ Unit	**Annex A**
v.	Colour Band and Rigid Line	-	-	Shall not be visible from 3 meters	**Annex B**

NOTE: ± 3 Unit depicts ± 3 unit of declared value. For example, if Light transmittance declared value is 50%, then the requirement is 47%~53% Light transmittance.

5.2 Tinted float glass shall satisfy the requirements of a float glass as specified in table 2.

Table 2 Requirements for Float Tinted Glass
(*Clause* 5.2)

Sl No.	**Characteristic**	**Requirement**	**Test Method**
(1)	(2)	(3)	(3)
i.	Characteristic UV-Test	**5.2.1**	IS 14900, **Annex A**
ii.	Thickness	Table 2 of IS 14900	**5.2.2**
iii.	Dimensions (Length and Width)	± 5 mm on nominal length and width	**5.2.3**
iv.	Squareness	Table 3 of IS 14900	**5.2.4**

v.	Optical faults	**5.2.5**	IS 14900, **Annex C**
vi.	Spot faults	**5.2.6**	IS 14900, **Annex D**
vii.	Reams, strings and lines	**5.2.7**	IS 14900, **Annex E**
viii.	Linear faults	**5.2.8**	IS 14900, **Annex E**
ix.	Defects on cut side	**5.2.9**	**5.2.9**
x.	Bloom (Optional) NOTE: This requirement is not applicable in case of dark tinted glass	**5.2.10**	IS 14900, **Annex F**

5.2.1 *Characteristic UV-Test*

A glass shall be deemed to be manufactured using float glass technology if the tin side of the glass can be identified by the UV light test as prescribed in **Annex-A** of IS 14900.

5.2.2 *Thickness*

Float tinted glass thickness shall be measured with micrometer or calipers, which is graduated to 0.01 mm or with a measuring instrument having an equivalent accuracy. The tolerances on thickness shall be as specified in the Table 2 of IS 14900.

5.2.3 *Dimensions (Length and Width)*

5.2.3.1 The nominal dimensions, that is, width (W) and length (L) shall be as agreed to between the purchaser and the supplier. However, the finished pane shall not be larger than a prescribed rectangle of dimensions (W + v, L + v), or smaller than a prescribed rectangle of dimensions (W - v, L ‑ v), where v is the maximum tolerance on nominal dimensions. The corresponding sides of the prescribed rectangles shall be parallel to each other and these rectangles shall have a common centre (*see* Fig.1).

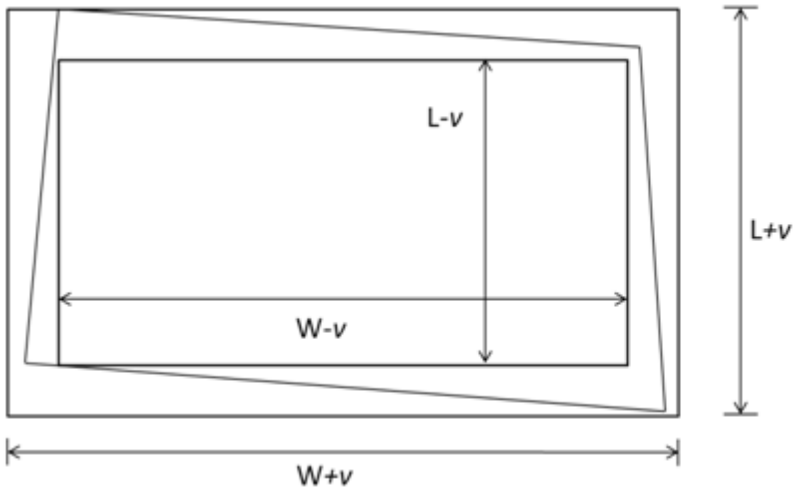

FIG. 1 TOLERANCE LIMITS FOR DIMENSIONS OF RECTANGULAR PANES

5.2.3.2 The length and width of the glass on cut sizes shall be measured with a steel scale (tape) which is graduated to 1 mm. The measurement shall be made on adjacent two sides.

The tolerances on nominal dimensions length L, and width W, shall be ± 5mm.

5.2.4 *Squareness*

The tolerances on diagonals shall be as specified in the Table 3 of IS 14900.

5.2.5 *Optical Faults*

The glass shall be viewed under the conditions of observation as described in **Annex C** of IS 14900, and the angle at which there is no optical distortion shall be noted. This angle shall not be less than the appropriate critical viewing angle as specified in the Table 8 of IS 14900.

5.2.6 *Spot Faults*

Spot faults are categorized based on their size (*see* Table 3). Determination of spot faults shall be done in accordance with **Annex D** of IS 14900. The maximum permissible number of the different categories of spot faults shall be as per Tables 4 and 5.

Table 3 Categories of Spot Faults
(*Clause* 5.2.6)

Sl No	**Category**	**Dimension of spot fault, mm**
(1)	(2)	(3)
i.	A	> 0.8 and ≤ 2.0
ii.	B	> 2.0 and ≤ 4.0
iii.	C	> 4.0 and ≤ 12.0
iv.	D	> 12.0

Table 4 Allowable Numbers in Jumbo Size
(*Clause* **5.2.6**)

Sl. No	**Category of Fault**	**Average (*max*)**	**Maximum in any pane**
(1)	(2)	(3)	(4)
i.	A	Any	Any
ii.	B	10	12
iii.	C	5	6
iv.	D	0.2	2, but faults that cause breakage are not allowed.

NOTE – The word average indicates a cumulative average over at least 20 tonnes of glass.

Table 5 Allowable Numbers in Split Size
(*Clause* 5.2.6)

Sl. No	**Category of Fault**	**Average per 20 m^2, (*max*)**	**Maximum in any pane**
(1)	(2)	(3)	(4)
i.	A	Any	Any
ii.	B	10	12
iii.	C	5	6
iv.	D	0.2	2, but faults that cause breakage are not allowed.

NOTE – The word average indicates a cumulative average over at least 20 tonnes of glass.

5.2.7 *Reams, Strings and Lines*

There shall be no reams, strings and lines distinguished visually when tested in accordance with Annex E of IS 14900.

5.2.8 *Linear / Extended Faults*

There shall not be any linear/extended faults when tested in accordance with **Annex E** of IS 14900.

5.2.9 *Defects on Cut Side*

Defects in shape such as chipping of cut side, shelling, protrusion, slicing off, corners on/off, etc as shown in Fig. 2 shall be such that the deviation from the cutting line when viewing perpendicularly to the surface of plate glass is not more than the nominal value of thickness of glass or 10 mm, whichever is smaller.

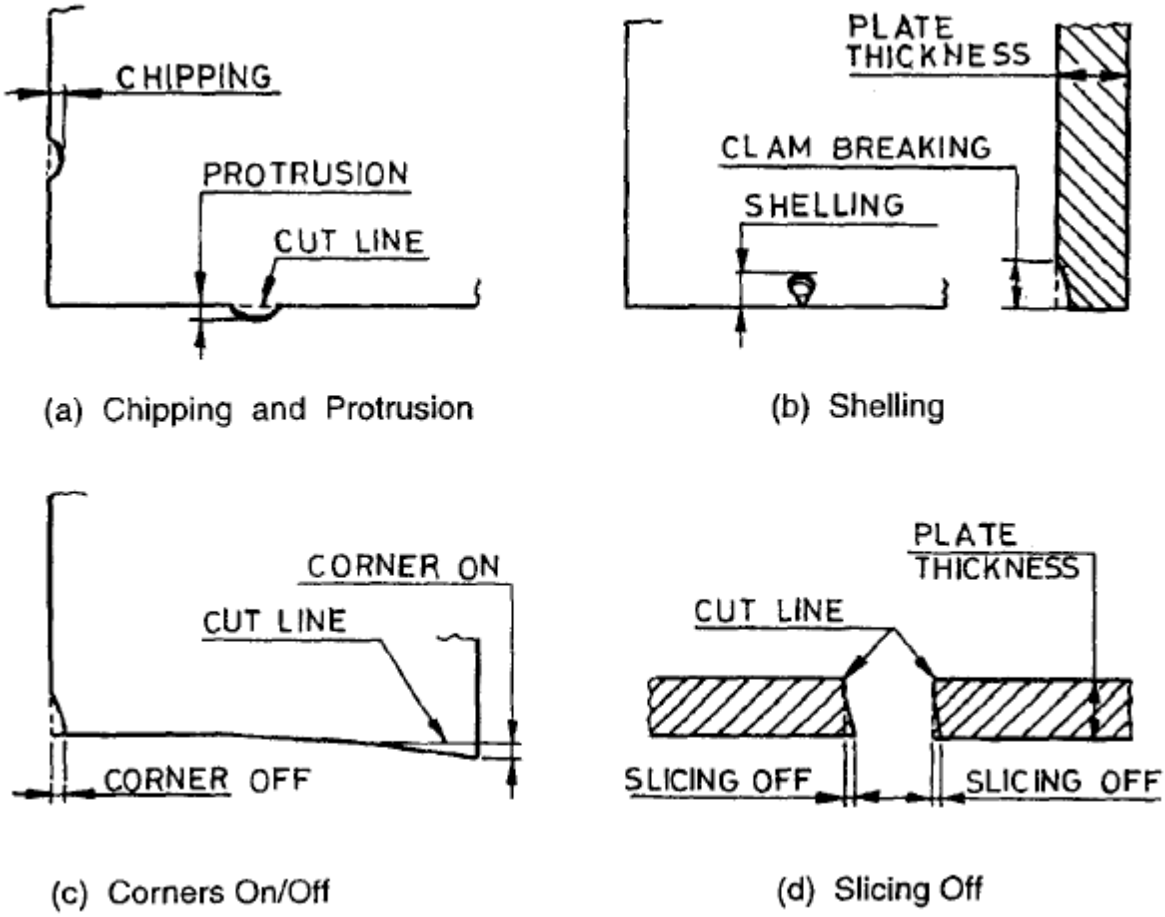

FIG. 2 DEFECTS ON CUT SIDE

5.2.10 *Optional Requirement: Bloom*

Material may be tested for bloom freedom as per the test method specified in **Annex F** of IS 14900 whenever required by the purchaser.

NOTE: This test is not applicable in case of dark tinted glass.

6 PACKAGING AND MARKING

6.1 Packaging

Glass shall, be packed in a suitable shock-absorbing manner which shall be as agreed between manufacturer and the purchaser.

6.2 Marking

6.2.1 Each package of tinted float glass shall be marked with the following information:

a) Name of the tint followed by Float Glass, For Ex: “Blue Float Glass”;

b) CIELAB colour values (L*,a*,b*,);

c) Indication of source of manufacture;

d) Nominal thickness in mm;

e) Nominal length and width in mm; and

f) No. of panes per package

6.2.2 Each piece of tinted float glass shall be legibly marked with the following details:

a) The words “Tinted Float Glass”,

b) Indication of source of manufacture, and

c) Thickness of glass.

6.2.3 *BIS Certification Marking*

Each glass may also be marked with the standard mark.

6.2.3.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made thereunder and as amended from time to time. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

7 SAMPLING

Representative samples shall be drawn in accordance with **Annex C** for lot testing.

ANNEX-A
(*Clause* **5.1.4**)

A-1 General

A test method is specified for the determination of colour delta (ΔE) value based on CIELAB L, a, b values and the use of any standard illuminant as specified in the table 6.

A-2 Apparatus

A-2.1 Colour meter capable to check L, a, b values in visible region (380 to 780 nm).

A-3 Procedure

A-3.1 Take samples of glass as per the instrument cavity from Left, Center & right.

A-3.2 Clean all the samples gently with tissue paper.

A-3.3 Standardize the instrument in Transmission mode by using black card & white tile or as per the instrument calibration system and do the same for reflectance mode.

A-3.4 Measure the white tile & green tile treating it as a sample and ensure its standard readings within $\pm$ 0.50 point.

A-3.5 Keep the sample in transmission compartment and measure the colour co-ordinates in transmittance mode.

A-3.6 Then keep the sample at reflection port with light trap and measure colour co-ordinates in reflection mode from both sides of the glass.

A-3.7 Pick up the average values of colour co-ordinates (X, Y, Z).

A-4 Calculation

A-4.1 Calculate the values of L, a, b using the equations 1, 2, and 3 respectively.

$$L = 100\sqrt{\frac{Y}{Y_n}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$a = K_a\left(\frac{X/X_n - Y/Y_n}{\sqrt{Y/Y_n}}\right) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$b = K_b\left(\frac{Y/Y_n - Z/Z_n}{\sqrt{Y/Y_n}}\right) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where

X, Y, and Z are the CIE tristimuluis values found in A-3.7.
X_n, Y_n, and Z_n are the tristimulus values for the illuminant.
Y_n is 100.00.
X_n and Z_n values are listed in the table 3.
K_a and K_b are chromaticity coefficients for the illuminant and are listed in the table 3.

Table 6 Standard Illuminant Properties

Sl No	Illuminant	X_n	Z_n	K_a	K_b
(1)	(2)	(3)	(4)	(5)	(6)
i.	A	109.83	35.55	185.20	38.40
ii.	C	98.04	118.11	175.00	70.00
iii.	D_{65}	95.02	108.82	172.30	67.20
iv.	F2	98.09	67.53	175.00	52.90
v.	TL 4	101.40	65.90	178.00	52.30
vi.	UL 3000	107.99	33.91	183.70	37.50
vii.	D_{50}	96.38	82.45	173.51	58.48
viii.	D_{60}	95.23	100.86	172.47	64.72
ix.	D_{75}	94.96	122.53	172.22	71.30

A-4.2 Calculate the values of ΔL, Δa, Δb using the equations 4, 5, and 6 respectively.

$\Delta L = L - L^*$ ……(4)

NOTE: + ΔL means sample is lighter
- ΔL means sample is darker

$\Delta a = a - a^*$ ……(5)

NOTE: + Δa means sample is redder
- Δa means sample is greener

$\Delta b = b - b^*$ ……(6)

NOTE: + Δb means sample is yellower
- Δb means sample is bluer

Where

L, a, and b are the determined values as calculated in A-4.1.
L*, a*, and b* are the values declared by the manufacturer.

A-4.3 Calculate the value of Colour Delta **(**ΔE) using the equation 7.

$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$ ……(7)

ANNEX-B
(*Clause* **5.1.5**)

DETERMINATION OF COLOUR BAND

B-1 Procedure

B-1.1 Cut the sample of complete running width (Net) in minimum 300 mm length from float line, put the sample in normal inspection light with white back ground. Observe the glass from 3 meters distance and no colour band shall be visible in glass.

ANNEX C
(*Clause* **7**)

SAMPLING OF FLOAT TINTED GLASS

C-1 SCALE OF SAMPLING

C-1.1 Lot - In a single consignment, glass of the same quality, tint and nominal thickness and belonging to the same batch of manufacture shall constitute a lot.

C-l.2 Samples shall be tested separately from each lot for ascertaining conformity of float tinted glass to the requirements of this specification.

C-l.3 The number of tinted float glass sheets to be sampled from a lot for this purpose shall depend on lot size and shall be in accordance with co1 1 and 3 of Table 7. If the sheets are packed in boxes or cartons, at least 20 percent of them, subject to minimum of 2 boxes shall be selected at random and opened for taking out the samples. Approximately equal number of sheets shall be selected from the middle and both the ends of each selected box or carton to give the required sample size. In order to ensure randomness of selection of float glass from the lot, procedures given in IS 4905, may be adopted.

Table 7 Scale of Sampling and Criteria for Conformity
(*Clause* **7, C-1.3**)

Lot	**For distribution of visual faults, optical faults and colour characteristics**						**Nominal thickness and dimensional tolerance**	
	Stage	Sample size	Combined size	C_1	C_2	C_3	Sample size	C_4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	First	8	8	0	2	2	4	0

< 500 tonnes	Second	10	18					
≥ 500, upto 1,500 tonnes	First	14	14	0	2	2	5	1
	Second	16	30					
≥ 1 500, upto 2,500 tonnes	First	20	20	1	3	4	8	1
	Second	20	40					
≥ 2 500 tonnes	First	22	22	1	3	5	10	1
	Second	25	47					

C-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

C-2.1 UV test to identify tin side of float glass

Samples selected in **C-l.3** shall be examined for the requirement of UV test as specified at 5.2.1. The sample size for this test shall be as per co1 8 of Table 7. Reject the lot if any one of the samples fails.

C-2.2 Distribution of Visual Faults, Optical Faults and Colour Characteristics

Samples selected in **C-l.3** shall be examined for the requirements of visual faults, optical faults and Colour Characteristics in two stages as shown in co1 2 of Table 7. A glass sample failing to satisfy any of these requirements shall be considered as defective. If the number of defective pieces found in the sample in the first stage is less than or equal to the corresponding number given in co1 5 of Table 7, the lot shall be accepted. If it is equal to or greater than the corresponding number given in co1 6 of Table 7, the lot shall be rejected without any further testing.

C-2.2.1 If the number of defective sheets found in the sample in the first stage lies between C_1 and C_2, a second such sample of the size prescribed in co1 3 of Table 7 shall be taken and examined. The lot shall be considered as conforming to these requirements if the combined number of defectives in the first and second stage is less than the corresponding number C_3, given in co1 7 of Table 7; otherwise the lot shall be rejected.

C-2.3 Nominal Thickness and Dimensional Tolerance

The lot, which has satisfied the requirements given in **C-2.2**, shall be examined for these requirements. The sample sheets required for testing these characteristics shall be selected from those examined under **C-2.2** and found satisfactory. The sample size for these tests shall be as given in co1 8 of Table 7. The lot shall be considered to have met these requirements, if the number

of defective sheets found in the sample is less than or equal to the corresponding number C_4, given in co1 9 of Table 7.