SRI LANKA STANDARD 549 : 1982

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SPECIFICATION FOR DISTRIBUTION FUSE BOARDS FOR VOLTAGES NOT EXCEEDING 1000 V

BUREAU OF CEYLON STANDARDS

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SLS 549:1982

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This standard does not purport to include all the necessary provisions of a contract.

SRI LANKA STANDARD
SPECIFICATION FOR DISTRIBUTION FUSEBOARDS FOR VOLTAGES NOT EXCEEDING 1 000 V

FOREWORD

This Sri Lanka Standard was authorized for adoption and publication by the Council of the Bureau of Ceylon Standards on, 1982-01-28 after the draft, finalized by the Drafting Committee on Distribution Fuseboards, had been approved by the Electrical Engineering Divisional Committee.

The specification relates to indoor and outdoor enclosed distribution fuseboards with maximum rating of up to 200 A per outgoing circuit. Distribution fuseboards specifically designed for housing miniature air-break circuit breakers are not covered by this specification.

All standard values given in this specification are in SI units.

For the purpose of deciding whether a particular requirement of this specification is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with CS 102. The number of significant places to be retained in the rounded off value shall be the same as that of the specified value in this specification.

In the preparation of this specification, valuable assistance derived from the relevant publications of the British Standards Institution and the Indian Standards Institution is gratefully acknowledged.

1 SCOPE

1.1 This specification covers enclosed distribution fuseboards for voltages not exceeding 1 000 V between phases for use on a.c. only.

1.1.1 This specification applies only to distribution fuseboards incorporating re-wirable fuses not exceeding 100 A and HRC and diazed type fuses having a current rating not exceeding 200 A.

1.1.2 It does not cover distribution pillars or equipment such as switches, miniature circuit breakers and instruments.

2 REFERENCES

ISO 293 Plastics - Compression moulding test specimen of thermoplastic material

ISO 294 Plastics - Injection moulding test specimens of thermoplastic materials.

IEC 144 Degree of protection of enclosures for low-voltage switchgear and control gear

CS 102 Presentation of numerical values

CS 159 Code of practice for seasoning of timber

SLS 278 Standard test fingers and other accessibility test probes

SLS 352 Fuse carriers and fuse bases used in rewirable type electric fuses up to 660 volts

SLS 374 Standard atmospheric conditions for conditioning and testing

3 DEFINITIONS

For the purpose of this specification the following definitions shall apply:

3.1 distribution fuseboards : An enclosure containing bus bars, with fuses for the purpose of protecting, controlling or connecting more than one outgoing circuit fed from one or more incoming circuits.

3.2 fully shrouded fuseboard : A fuseboard in which all live parts are shrouded so that additional circuits may be wired and connected in safety whilst the existing circuits remain alive and on load.

3.3 non-fully shrouded fuseboard : A fuseboard which although allowing individual fuses to be renewed whilst the current carrying parts remain alive, does not allow additional circuits to be wired and connected in safety, whilst the existing circuits remain alive and on load.

3.4 pole of fuseboard : A bus bar and associated fuseways connected to a pole of a system of distribution.

3.5 neutral of a fuseboard : A bus bar and associated terminals connected to the neutral conductor of a system of distribution.

3.6 number of fuseways : The number of fuseways per pole, regardless of the number of incoming circuits.

3.7 ambient air temperature : The temperature, determined under prescribed conditions, of the air surrounding the enclosure(See Appendix A).

4 RATINGS

4.1 Rated voltage

Fuseboards shall be rated for 230 V or 400 V provided the voltage to earth does not exceed 250 V.

4.2 Rated current

Individual fuseways shall have one of the ratings given in Table 1.

TABLE 1 - Rated current of individual fuseways

Rated voltage between poles or pole and neutral	Rated current (A)
230 V a.c.	100, 60, 30, 20 and below
400 V a.c.	200,100, 60, 30, 20 and below

5 TYPES OF FUSEBOARDS

5.1 Designation

Fuseboards shall be of the following types:

a) Single pole and neutral (S P and N);

b) Double pole (D P);

c) Triple pole (T P); and

d) Triple pole and neutral (T P and N).

Fuseboards suitable for other systems of distribution may be accepted as meeting the requirements of this specification provided they comply with the requirements of all other clauses.

NOTE - No fusing shall be provided on the neutral.

5.2 Number of fuseways per pole

The preferred numbers and ratings of outgoing circuits per pole for each type of fuseboard shall be as given in Table 2 and Table 3.

TABLE 2 - Single pole and neutral and double pole fuseboards

Max. current rating (A)	20	30	60	100
No. of outgoing circuits	4	4	4	4
	6	6	6	6
	8	8	8	8
	10	10	10	-
	12	12	-	-

TABLE 3 - Triple pole and triple pole and neutral fuseboards

Max. current rating (A)	20	30	60	100	200
No. of outgoing circuits	-	-	-	-	2
	4	4	4	4	4
	6	6	6	6	6
	8	8	8	8	-
	10	10	10	-	-
	12	12	-	-	-

6 MARKING

6.1 Marking of fuseboard

The fuseboard shall be indelibly marked with the following particulars:

a) the rated voltage;

b) the rated current of outgoing fuseways;

c) degree of protection (See 8.1);

d) diversity factor (See Table 4); and

e) the manufacturer's name or distinguishing mark.

6.2 Circuit identification

Provision shall be made by means of a label or a card (which is preferably renewable and may be protected by transparent material) for recording the title, cable size and actual current rating of each outgoing circuit and in addition, the current rating of the cartridge fuse link or, when semi-enclosed fuses are used, the diameter and materials of the wire forming the fuse element. The position of the poles shall be indicated by colouring or other means. This may be incorporated in the outgoing circuit labels.

The label or card shall be fitted inside the door of the enclosure or on the insulating barrier if any, and may, if desired, be of printed paper. Where reversible door action is obtained by inverting the fuse-board, provision shall be made for inverting the label. Where the label or card is attached to the insulating barrier it shall be set out in such a way that the circuit indicated is directly in line with the related fuse. Where the label or card is not mounted directly in line with the relevant fuseway the circuit numbering means shall indicate by symbol and or diagram the relation to the fuseways, except that where no diagram is supplied, 5.1 (a) shall refer to the left hand fuse in each bank.

Provision shall be made for the recording of the size of the incoming cable(s)

7 SERVICE CONDITIONS

Where the standard conditions stated below apply, fuseboards to this specification are deemed capable of operating satisfactorily without further qualification. These standard conditions also apply for tests except for those otherwise specified in 9.

a) **ambient air temperature** : An ambient temperature having a peak value not exceeding 40 °C with an average value not exceeding 35 °C over 24 hour periods.

The lower limit of ambient temperature is 10 °C.

The relative humidity is 45 per cent to 85 per cent and in accordance with **SLS 374.**

b) **altitude** : An altitude not exceeding 200 metres above sea level.

c) **system voltage** : A voltage having a value not exceeding 110 per cent of the rated voltage of the equipment.

d) **current** : A total loading per pole on the fuseboard not exceeding the sum of the rated current of the fused circuits per pole multiplied by the appropriate diversity factor shown in Table **4.**

e) **frequency** : For a.c., a frequency of 50 Hz unless the fuselinks used are marked for some other frequency.

NOTE - Special consideration needs to be given during the design stage to equipment intended for use under particularly arduous conditions such as mounting out of doors without additional protection or where deposits of sea salt or abnormal deposits of industrial origin may occur.

TABLE 4 - Diversity factors

No. of fuseways per pole	Maximum current rating (A)				
	200	100	60	30	20 and below
2	% 100	% 100	% 100	% 100	% 100
4	80	90	90	90	90
6	66	80	80	80	80
8	-	66	80	80	80
10	-	-	66	66	66
12	-	-	-	66	66

8 CONSTRUCTION

8.1 Type of enclosure

Distribution fuseboards shall have enclosures of degree of protection IP 30 in accordance with IEC publication 144. This type of enclosure is not necessarily air tight or dust tight in as much as provision for draining or breathing may be made where necessary.

Enclosures having requirements other than that mentioned above, for example : dust tight or for mounting out of doors, shall comply with the relevant requirement of IEC publication 144.

8.2 Construction of enclosure

8.2.1 *General*

Enclosures shall be so constructed as to ensure adequate strength and rigidity and shall be of metal, moulded or other insulating material having the appropriate characteristics as specified below:

For surface mounting means shall be provided to ensure that the distance between the back of the enclosure and the surface upon which it is mounted is not less than 3 mm except at the point of attachment.

When clearance holes or openings for cables or conduits are provided, they shall be blanked off by a common blanking plate or by individual plugs. When tapped holes are specified, blanking plugs shall be provided as agreed to between the manufacturer and the purchaser.

The means of attaching and fastening access doors or lids, whether hinged or otherwise, shall be such as to guard against commission or loss of any component part.

Where inversion of the fuseboard as a hole is not possible and the doors are not removable, provision shall be made for right hand or left hand hinging of the doors that is reversal of the door action.

When a distribution board is required to be supplied without a back or without one or more of the other enclosing surfaces (for example : sides), means shall be provided to enable the fuseboard to be fitted to a non-ignitable surface or to some other piece of apparatus in such a manner as to complete the enclosure. Individual doors shall be constructed to minimize flexibility and shall be provided with substantial hinges and fastening.

8.2.2 *Enclosures of metal*

The minimum thickness of metal used for the enclosure shall be as given in Table 5.

TABLE 5 - Minimum material thickness

Material	Min. thickness
	mm
Sheet metal	0.9
Cast metal	2.3
Die casting	1.5

Enclosures of ferrous material shall be protected against rusting. Compliance shall be checked by the test specified in **9.4**. Enclosures protected against rusting by hot dip galvanizing or similar processes are not covered by this specification. Where such protection is required it should be the subject of agreement between the manufacturer and the purchaser.

8.2.3 *Enclosures of moulded or other insulation materials other than timber*

The material used shall comply with the following requirements.

8.2.3.1 It shall be non-flammable at 250 ^{o}C when tested in accordance with the flammability test given in 9.5.

8.2.3.2 Its surface resistivity, after immersion in water, shall be not less than 1 000 M Ω when measured according to test given in 9.6.

8.2.3.3 It shall not soften when heated to a temperature of 85 ^{o}C and tested in accordance with the test given in 9.7.

Enclosures of moulded insulating material shall be at least 3.2 mm thick unless adequate strength can be provided by ribs or other suitably designed form, or by the use of a material of high inherent strength, for example : glass fibre reinforced plastics. Reduced sections intended for removal for wiring can be provided.

8.2.4 *Enclosures consisting of combination of metal with moulded or other insulating material other than timber*

The material shall comply with the relevant requirements of the clauses appropriate to those materials.

8.2.5 *Enclosure of timber*

8.2.5.1 These enclosures shall be of one of the species given in Appendix **E**. The timber used shall be well seasoned and free from knots, splits, sap and other defects which may affect the serviceability of the enclosure. The moisture content of the timber used shall not exceed 15 per cent when tested in accordance with Appendix **A** of **CS 159:1972**.

Glue used in the construction of enclosures made of timber shall be insoluble in water. The thickness of timber used in enclosures shall comply with Table 6.

8.2.5.2 The finished timber in the enclosures shall be non-flammable at 300 °C when tested accordance with the flammability test given in 9.5.

TABLE 6 - Minimum finished thickness of timber for enclosures for distribution fuseboards

Size of enclosures	Minimum thickness				
Overall dimension	Cut open enclosures		Frame door enclosures		
	Sides mm	Front and back mm	Sides mm	Door frames mm	Door panel mm
Up to and including 203	8	5	15	16	6
Over 203 and up to 305	8	5	15	15	6
Over 305 and up to 380	8	6	15	20	6
Over 380	10	6	16	20	6

8.3 Dimensions

The dimensions of fuseboards shall not exceed those listed in Table 8 appropriate to the current rating, type and number of fuseways.

NOTE - The table of dimensions, Table 7, refers to fuseboards intended for use with cables with copper conductors only.

8.4 Cable space

At any point in a fuseboard where cables have to pass between internal fittings and the rear of the enclosure, adequate wiring space shall be provided to all the cables to be installed easily. If it is necessary for the cables to be bent in order to attach them to their terminals the space available shall be such as to allow this to be achieved without subjecting the maximum size of cable, for which the terminal is designed, to a bend of internal radius less than four times the maximum dimension of the individual cable core over the insulation for diameters up to and including 25 mm add six times the maximum dimensions for diameters above 25 mm. The space available for cabling shall not in any case be less than that shown in Table 7. Fuseboards shall normally be designed to allow access to all outgoing connections from the front of the board.

TABLE 7 - Dimensions of fuseboards
(See Fig. 1, Fig. 2, Fig. 3, and Fig. 4)

No. of fuseways	Rating	Arrangement of poles	Dimensions					
			Max.					Min.
			A	B_1	B_2	C_1	C_2	D
	A		mm	mm	mm	mm	mm	mm
4	20	Single pole and neutral (S P and N)	460	310	360	230	260	33
6			460	410	460	230	260	33
8			460	460	510	230	260	33
10			460	540	590	230	260	33
12			460	590	640	230	260	33
4	30		540	390	440	260	280	40
6			540	440	490	260	280	40
8			540	510	560	260	280	40
10			540	590	640	260	280	40
12			540	690	740	260	280	40
4	60		610	420	470	280	310	44
6			610	540	590	280	310	44
8			610	650	700	280	310	44
10			610	770	820	280	310	44
4	100		610	560	610	340	360	57
6			610	670	720	340	360	57
8			610	810	810	340	360	57
4	20	Double pole(D P)	460	310	360	230	260	33
6			460	410	460	230	260	33
8			460	460	510	230	260	33
10			460	540	590	230	260	33
12			460	590	640	230	260	33
4	30		640	390	440	260	280	40
6			640	440	490	260	280	40
8			640	510	560	260	280	40
10			640	590	640	260	280	40
12			640	690	740	260	280	40
4	60		790	420	470	280	310	44
6			790	540	590	280	310	44
8			790	650	700	280	310	44
10			790	770	820	280	310	44
4	100		790	560	610	340	360	57
6			790	670	720	340	360	57
8			790	810	860	340	360	57

(Table 7 continued)

No. of fuseways	Rating	Arrangement of poles	Dimensions					
			Max.					Min.
			A	B_1	B_2	C_1	C_2	D
	A		mm	mm	mm	mm	mm	mm
4	20	Triple pole (T P)	670	310	360	230	260	33
6			670	410	460	230	260	33
8			670	460	510	230	260	33
10			670	540	590	230	260	33
12			670	590	640	230	260	33
4	30		790	390	440	260	280	40
6			790	440	490	260	280	40
8			790	510	560	260	280	40
10			790	590	640	260	280	40
12			790	690	740	260	280	40
4	60		970	420	470	280	310	44
6			970	540	590	280	310	44
8			970	650	700	280	310	44
10			970	770	820	280	310	44
4	100		1070	560	610	340	360	57
6			1070	670	720	340	360	57
8			1070	810	860	340	360	57
2	200		1630	580	630	390	410	100
4			1630	740	790	390	410	100
6			1630	920	1010	390	410	100
4	20	Triple pole and neutral (T P & N)	670	310	360	230	260	33
6			670	410	460	230	260	33
8			670	460	510	230	260	33
10			670	540	590	230	260	33
12			670	590	640	230	260	33
4	30		920	390	440	260	280	40
6			920	440	490	260	280	40
8			920	510	560	260	280	40
10			920	590	640	260	280	40
12			920	690	740	260	280	40
4	60		970	420	470	280	310	44
6			970	540	590	280	310	44
8			970	650	700	280	310	44
10			970	770	820	280	310	44
4	100		1220	560	610	340	360	57
6			1220	670	720	340	360	57
8			1220	810	860	340	360	57
2	200		1630	580	630	390	410	100
4			1630	740	790	390	410	100
6			1630	920	1010	390	410	100

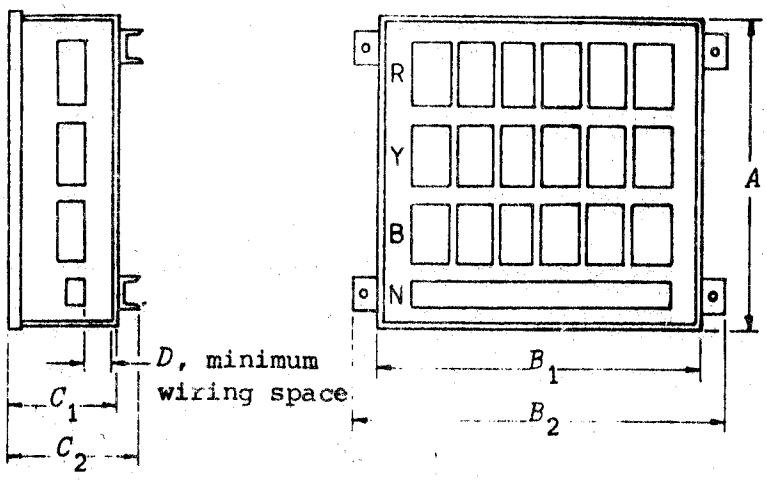


FIGURE 1 - Limiting dimensions of fuseboards (indoor type)

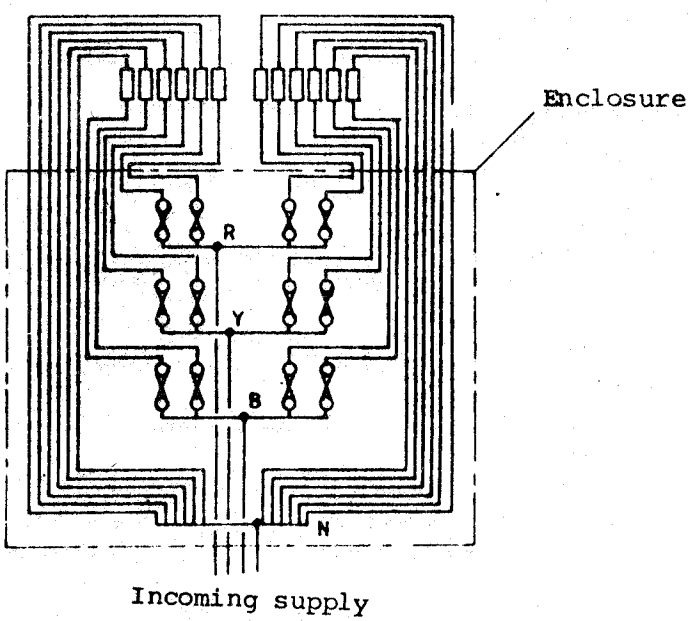


FIGURE 2 - Diagram of connections for T P and N distribution fuseboard rated up to and including 30 A

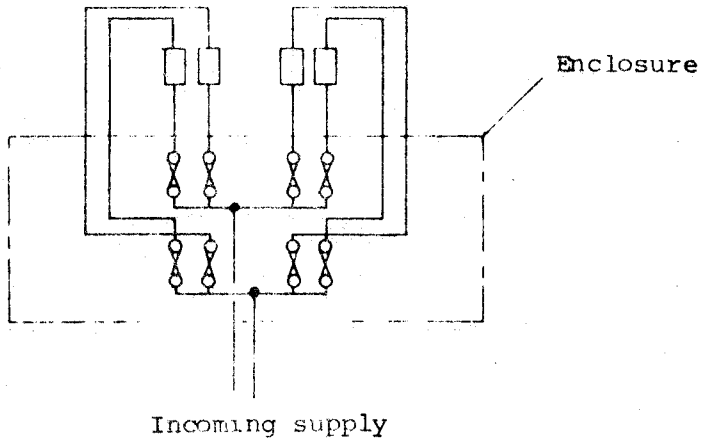


FIGURE 3 - Diagram of connections for D P distribution fuseboard

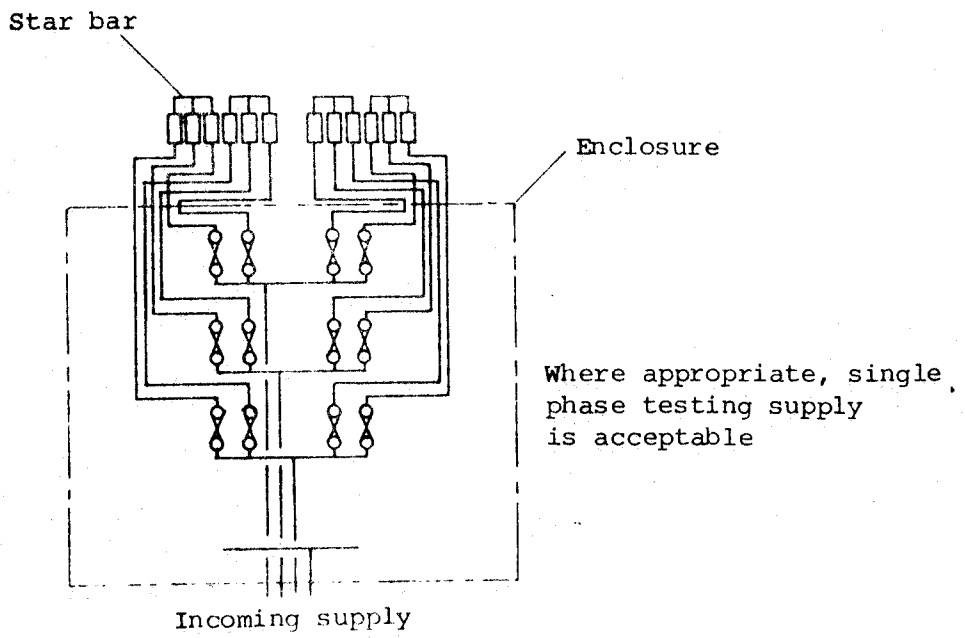


FIGURE 4 - Diagram of connections for T P and T P and N distribution fuseboard rated in excess of 30 A.

8.5 Cable terminals

The incoming cable terminals shall be suitable for the attachment of cables of at least the size shown in Table 8.

TABLE 8 - Incoming conductor sizes

No. of ways	Incoming conductor sizes				
	Maximum current rating (A)				
	200	100	60	30	20 and below
	mm^2	mm^2	mm^2	mm^2	mm^2
2	240	-	-	-	-
4	500	240	120	35	25
6	630	300	185	70	35
8	-	400	240	95	50
10	-	-	240	95	50
12	-	-	-	120	70

All cable terminals shall be so arranged that it is impossible to cause them to come into contact with one another, or with the enclosure, by the movement of the cables after correct installation. Terminals for cables having conductors up to and including 50 mm^2 nominal cross-sectional area, shall be of the pinch screw, pressure clamp, stud or screw type. For cables having conductors of cross-sectional area greater than 50 mm^2, the terminals shall be of the pressure clamp, stud or screw type.

Fixed connections shall be such that the necessary contact pressure is maintained under the conditions of service and operation. Terminals shall be such that they cannot turn or be displaced when the connecting screws are tightened and such that the conductors cannot be displaced. The parts gripping the conductors shall have a shape such that they cannot damage the conductors. Terminals shall be so arranged that they are readily accessible (after removal of screws, if any) under the intended conditions of installation.

8.6 Neutral bus bars and connections

The current carrying capacity of the neutral bus bar(s) shall be not less than that of the phase bus bar(s). Neutral bus bar(s) shall be insulated from earth, and be rigidly mounted in an accessible position. The neutral bus bar(s) of all S P and N and T P and N distribution boards having fuse rating not exceeding 100 A shall have one outgoing terminal for each fuse. For 200 A, T P and N distribution boards the neutral bus bar(s) may have one out going terminal for each three phase circuits.

8.7 Provision for earthing

Fuseboards shall be fitted with an earthing and/or earth continuity terminal or terminals suitable for internal or external connection irrespective of any means of earthing provided for attaching armouring or other metallic covering of a cable connected to the fuseboard. If the earthing terminal has a stem or bolt to receive a cable socket it shall not be smaller in size than M6 for fuseboards designed for incoming cable(s) up to and including 100 A, and not less than M10 for fuseboards designed for incoming cable(s) above 100 A.

The earthing terminal, if single stem type, shall be at least 25 mm long and shall be provided with brass washers. When the earthing terminal is of steel, it shall be plated for protection against corrosion; earthing studs shall be provided with brass nuts. Earthing screws or bolts shall be hexagonal headed if likely to be inaccessible to a screw-driver. Non-current carrying parts likely to become live in the event of the insulation or any portion of the fuseboard becoming defective shall be in secure contact with the earthing terminal.

A multi-terminal earthing bar having the same number of terminals as the neutral bar shall be provided in every fuseboard with moulded insulating enclosure. In every metal cased fuseboard there shall be sufficient space for fitting a multi-terminal earthing bar having the same number of terminals as the neutral bar if required to be so fitted.

Provision shall be made to ensure that good electrical contact is achieved between a metallic enclosure and the earthing terminal.

8.8 Shielding and prevention of danger

8.8.1 *Shielding of fully shrouded fuseboards*

When the door(s) of the enclosure are open, means shall be provided to prevent accidental contact with live parts, whilst the fuse carriers are fitted into their bases. In addition, it shall not be possible to touch with the flexible test finger complying with the requirements of **SLS 278** either fixed contact in the fuse based when the fuse carrier is removed from the fuse base. The design of the fuseboard shall be such that all live parts are shrouded so that additional circuits may be wired and connected in safety, whilst the existing circuits remain alive and on lead.

8.8.2 *Shielding of non fully shrouded fuseboards*

When the doors of the enclosure are open means shall be provided to prevent accidental contact with live parts, whilst any fuse carriers etc. are fitted into their fuse bases and whilst any insulation barriers etc. are correctly fitted.

8.9 Temperature rise limits

The temperature rise of any cable terminal of a fuseboard shall not exceed 70 ^{o}C when tested in accordance with **9.2**. The temperature rise of any cartridge fuse-link contacts shall not exceed 80 ^{o}C when tested in accordance with 9.2 . The enclosure shall be complete during the test.

8.10 Fuses

Fuseboards to this specification shall be designed to accomodate fuses conforming to **SLS 352** in respect of rewirable fuses.

9 TESTS

All tests on fuseboards shall be type tests. Records of type tests shall be accepted as evidence of compliance of fuseboards with the requirements of this specification, and the manufacturer shall hold available such records, together with full details drawings of the apparatus tested and details of any alterations that have been made subsequent to the type tests. The fuseboards for the type tests shall be identical in all detail likely to affect performance with these to be used in service.

9.1 High voltage test

The high voltage test shall be performed on a fuseboard in clean new condition. If tested with the door or doors open, it shall be established that there is adequate clearance between live parts and earth when the door or doors are closed.

The test voltage shall be 2 000 V r.m.s. for fuseboards rated at 230 V and 2 500 V r.m.s. for fuseboards rated at 400 V. The voltage shall have a frequency between the limits of 45 Hz to 65 Hz and shall be applied and maintained for one minute as follows:

a) between poles;

b) between poles and neutral (when fitted) ; and

c) between current carrying and non-current carrying metal parts.

It is not necessary for the full test voltage to be switched on instantly but the voltage shall be increased as rapidly as in consistent with its value being indicated by the measuring instrument. The best voltage may be rapidly diminished before switching off.

During the test, one pole of the test transformer shall be connected to earth, and to non-current carrying metal parts of the fuseboard.

9.2 Temperature rise test

9.2.1 *Condition of test*

The temperature rise test shall be performed on a fuseboard in clean new condition mounted in surroundings free from draught. The results obtained shall comply with the requirements of 8.9. The temperature rise test shall be performed on that size of fuseboard in each current rating where under the conditions of diversified loading described in (e) of 7, the maximum value of power loss per unit area of the total heat dissipating surface of the enclosure is achieved. For the purposes of this calculation, the power loss is the sum of the rated power loss as declared by the fuse manufacturer of all the fuse links in the fuseboard multiplied by the appropriate diversity factor.

The test shall be regarded as proving the performance of all fuseboards of the same rating and basic design having different numbers of fused ways.

For the test, all insulation barriers, shields, etc. shall be in position. The fuseboard shall have fitted in every fuseway, a fuse link or element of maximum current rating for which it is designed. The test shall be performed using an alternating current supply having a frequency within the range 45 Hz to 65 Hz.

Fuseboards having partial enclosure shall have the enclosure completed during this test.

For fuseboards with mixed sizes of fuses, utilizing the enclosures of standard boards, the diversity factor, D, shall be established as follows:

$$D = \frac{P}{S}$$

where,

P = power loss of standard fuseboard; and

S = sum of the rated power losses of all the fuselinks in the mixed circuit fuseboard. Where the value of D so calculated equals, or exceeds, unity, the diversity factor shall be taken as 100 per cent. The performance of mixed circuit fuseboards complying with the foregoing formula may be verified by temperature rise tests on the appropriate standard fuseboards. For tests on mixed circuit fuseboards having no standard arrangement as reference, a diversity factor of 66 per cent shall be assumed for all fuseways within them.

9.2.2 *Connection for test*

For the purposes of the test the incoming cables shall be PVC insulated of the size shown in Table 7 appropriate to the current rating and number of fused ways. The size of incoming cable for mixed circuit fuseboards shall be selected from Table 8 and shall be that appropriate for the total current determined from the information in 9.2.1 . The total current fed into mixed circuit fuseboards shall be so shared between all ways to ensure that each way carries 66 per cent of its rated current.

The outgoing cables connected to the fuseboard for test shall be PVC insulated, and shall be in compliance with Table 9 of this specification.

TABLE 9 - Outgoing cables for temperature rise test

Maximum current rating of fuseway	Nominal cross-sectional area of conductors	Number and nominal diameter of wires	Radial thickness of insulation	Overall diameter
A	mm^2	mm	mm	mm
20	2.5	1/1.78	0.8	3.5
30	6	7/1.78	0.8	4.9
60	16	7/1.70	1.0	7.3
100	35	19/1.53	1.2	10.3
200	95	19/2.52	1.6	16.1

All incoming and outgoing cables shall be not less than one metre long and each group of cables per circuit shall be bunched together for as much of their length as is practicable. All doors and covers shall be closed and cable entries not used during the test shall be blanked off to prevent inadmissible ventilation.

The total current fed into the fuseboard shall be equal to the sum of the ratings of all the outgoing fuseways per pole multiplied by the appropriate diversity factor shown in Table 4 with a tolerance of ± 3 per cent. Care should be taken to ensure that the current in the way which is likely to be hottest is not less than the average current.

For tests on fuseboards containing neutral and of ratings up to and including 30 A the equipment shall be set up for test generally as shown in Fig. 2. For tests on fuseboards containing neutrals and rated above 30 A the equipment shall be set up for test generally as shown in Fig. 4. For tests on fuseboards without neutrals the equipment shall be set up for test generally as shown in Fig. 3.

The temperature rise of the cable terminals and of the top contacts of cartridge fuse and links where fitted shall be measured by means of thermocouples attached by low melting point alloy or by some equally effective means of attachment. It is sufficient to measure those cable terminals, and contacts where fitted, which by their position are likely to have the highest temperature rise. The test shall be made at an ambient air temperature of between + 10 ^{o}C and + 30 ^{o}C. The temperature rise shall be measured after sufficient time has elapsed for the temperature to become steady. For the purposes of this test the temperature is deemed to have become steady when the variation does not exceed 1 ^{o}C.

The ambient air temperature shall be measured by devices protected against draughts and heat radiation, at about the mid height of the fuseboard under test and at a distance of 1 metre to 2 metres from the fuseboard. No correction to the measured temperature rise is required if the ambient temperature during the test is different from the ambient temperature to be expected in service. (See Appendix A).

9.3 Effectiveness of shielding

The test shall be made using a standard flexible test finger complying with the requirements specified in SLS 278, connected by an incandescent lamp to one pole of a supply of at least 40 V, the other pole of the supply being connected to the parts intended to be live in normal service, electrically connected together for the duration of the test. The rated voltage of the lamp shall be equal to that of the source. The protection shall be deemed satisfactory if the lamp does not light when an attempt is made to touch the bare live parts or partially shrouded or insulated parts, with the test finger placed in every possible and pushed without undue force.

9.4 Test for rust protection

The test shall be made on a representative sample of the material used for the enclosure. The test may be carried out either on a sample cut from a complete enclosure or on a sample of metal identical in all respects to the metal used for the enclosure and given an identical protective finish.

The sample shall be first cleaned with a piece of wadding soaked in benzene* and then dried. Then it shall be totally immersed in a solution. Prepared as detailed in Appendix **B**, the solution and the sample being maintained at a temperature of 20 ± 1 °C. After the test, the sample shall show no more than two blue coloured spots on any area of 100 mm^2 and no spot shall have dimension larger than 1.5 mm. Traces of rust on sharp edges and screw threads and any yellowish film-removable by rubbing should be ignored.

9.5 Test for flammability

The flammability test shall be carried out in accordance with Appendix **C**. (See 8.2.3.1 and 8.2.5.2).

9.6 Test for surface resistivity

The surface resistivity test shall be carried out in accordance with Appendix **F**. (See 8.2.3.2).

9.7 Test for softening point

The softening point test shall be carried out in accordance with Appendix **D** (See 8.2.3.3).

APPENDIX A

A.1 MEASUREMENT OF AMBIENT TEMPERATURE

Measure the temperature of the surrounding air by means of at least two thermometers so placed as to take account of the maximum and minimum ambient temperature at any one time, and adopt the mean reading. Immerse each thermometer in oil contained in, and sufficient to fill, a bottle having a capacity of about 250 ml and locate in a position free from draughts and the effects of heat radiation.

Because of the toxic effects of benzene, toluene or xylene may be used.

APPENDIX B

B.1 SOLUTION FOR USE IN TEST FOR RUST PROTECTION

Prepare a solution of 7.5 grams of potassium ferricyanide ($K_3Fe(CN)_6$) and 2.5 grams of ammonium persulphate ($(NH_4)_2S_2O_8$) in a litre of water. Add a quantity of about 1 g of a suitable wetting agent, for instance a sodium salt of an alkylnaphthaline sulphonic acid, to each litre of this solution.

APPENDIX C

FLAMMABILITY TEST

C.1 PREPARATION OF SAMPLES

C.1.1 Selection

The size of specimen will depend largely on circumstances but may conveniently be 50 mm long, 12.5 mm wide and of thickness equal to the thickness of the material, provided it is not more than 12.5 mm thick, in which case the specimen should be cut down to 12.5 mm thickness.

C.1.2 Conditioning

The specimen shall be conditioned for a period of not less than 24 hours in a controlled atmosphere of temperature of 27 ± 2 °C at relative humidity of 65 per cent ± 5 per cent before the test is carried out (See C.1.3). Each specimen shall be tested within three minutes after its removal from the controlled atmosphere.

C.1.3 Method for achieving standard relative humidity

C.1.3.1 A convenient method of achieving an atmosphere of relative humidity of 65 per cent at a temperature of 27 ± 2 °C is by the use of saturated solution of sodium chloride and sodium nitrate, exposed to the atmosphere in an enclosed chamber where it is desired to have the required humidity.

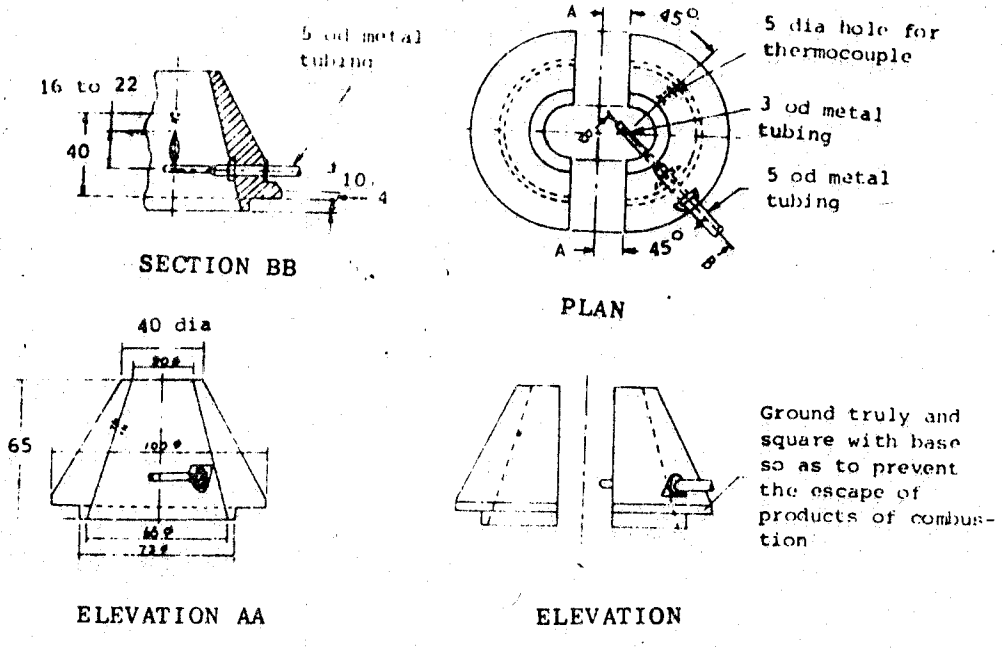
C.1.3.2 The saturated solution is prepared by boiling in water a mixture of 4 parts by weight of sodium chloride and 9 parts by weight of sodium nitrate. The solution is then cooled and more of the solid mixture is added than what may be taken into solution.

C.1.3.3 The saturated solution shall be so exposed that maximum surface is in contact with the air in the chamber, for example: by covering the floor of the chamber with a tray containing the saturated solution. To ensure that the solution remains saturated, an excess of the solid salt shall be contained in the liquid. It is important that the solid remains covered by the solution and that the surface of the liquid is free from any crust of film of grease, dirt, etc.

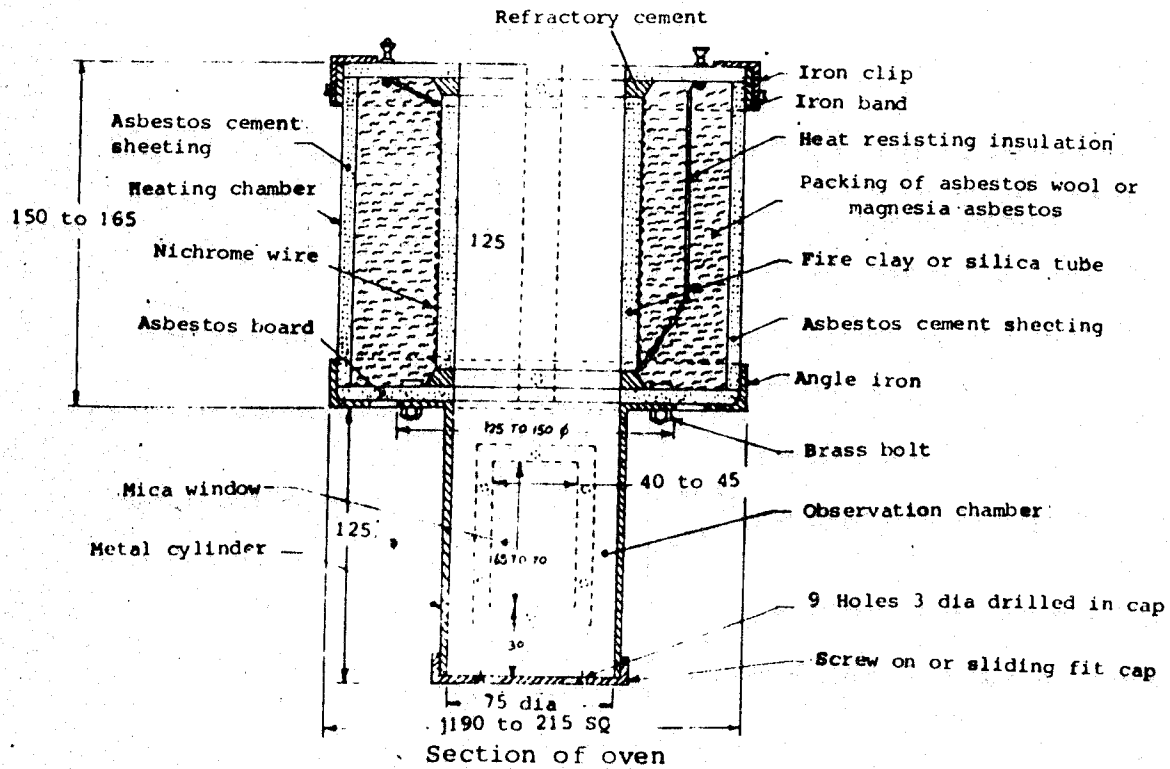
C.1.3.4 To ensure uniform conditions throughout the chamber, a fan should circulate air over the surface of the saturated solution and around the specimens. Care should be taken to allow free access of the conditioning atmosphere to all specimens.

C. 2 APPARATUS

C.2.1 The specimen shall be tested in the heating tube of an apparatus of the general type shown in Fig. 5 and Fig. 6 the pilot flame being located 22 mm above the upper end of the specimen. The relative position of specimen, thermocouple and pilot flame in the apparatus for flammability test are shown in Fig. 7.



DETAILS OF CONICAL COVER
(To be of refractory material)



(All dimensions in millimetres)

FIGURE 5 - Details of apparatus for flammability test

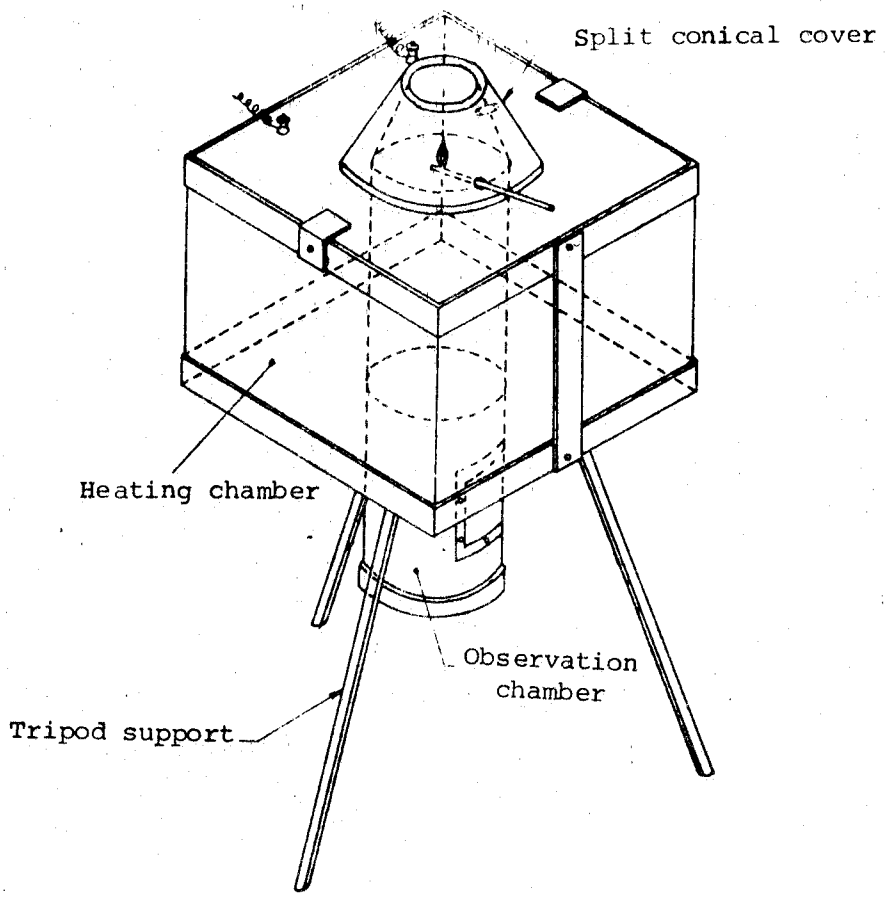


FIGURE 6 - Assembly of apparatus for flammability test

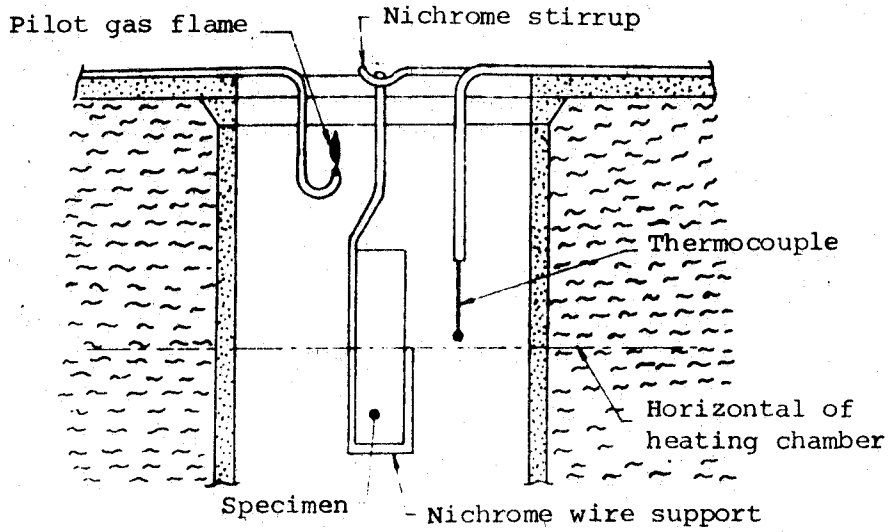


FIGURE 7 - Relative position of specimen, thermocouple and pilot flame in flammability test apparatus (Fig.5 and Fig.6)

C.2.2 A support for the specimen shall be provided in the heating tube which may suitably consist of a light stirrup of nichrome wire, supported by a length of nichrome wire passing over the pilot tube. The support shall be such that the specimen is fixed centrally in the heating tube, with its largest dimension vertical.

C.2.3 The apparatus shall be heated by passing a suitably regulated electric current through a nichrome resistance wire surrounding the heating tube.

C.2.4 *Measurement of temperature of tube*

The temperature of the tube shall be taken as shown by a thermocouple situated at the level of the centre of the specimen and equidistant from the inner surface of the heating tube and the specimen. The wires of which the thermocouple is made shall be in between 0.405 mm and 1.25 mm and shall be bare for a length of 25 mm from the junction.

C.3 TEST FOR FLAMMABILITY

C.3.1 The temperature of the tube shall be raised to 300 °C and the specimen shall then be readjusted to 300 °C within a period of three minutes. This temperature shall be maintained for five minutes from the time of insertion of the specimen. During this period, a conical cover at the top shall limit the opening to approximately 6.5 cm^2 while the air intake orifice at the bottom shall be opened approximately 0.65 cm^2. At the end of five minutes, the specimen shall be removed from the tube. The material shall not be deemed non-flammable if at any time during the test, the specimen flames or give off flammable vapours in sufficient quantities to ignite at the pilot flame.

APPENDIX D

DETERMINATION OF SOFTENING POINT OF THERMOPLASTIC MOULDING MATERIAL (BENDING TEST)

(See 9.7)

D.1 FORM OF TEST SPECIMEN

The specimen shall be of the form and dimensions shown in Fig. 8. The specimen shall be moulded to shape under the conditions specified in the relevant ISO Standard for the material or may be machined to shape from sheet moulded under these conditions.

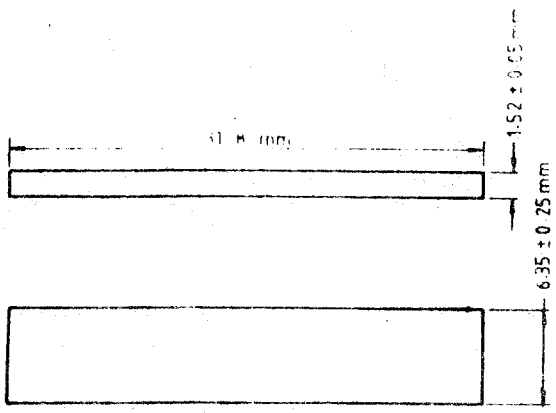


FIGURE 8

NOTE - ISO 293 and ISO 194 lay down the general principles to be followed when moulding test specimens of thermoplastic material.

D.2 NUMBER OF TEST SPECIMENS

Two specimens shall be used.

D.3 PROCEDURE

The specimen shall be mounted horizontally in a clamp as shown in Fig. 9 so that the plane of its upper surface is leveled with the zero graduation of the quadrant and 25.4 mm of it is free form of a cantilever. A looped thread with a brass weight of mass 20 g shall be attached as shown in Fig. 10, the weight being supported temperarily so that no load is applied to the specimen.

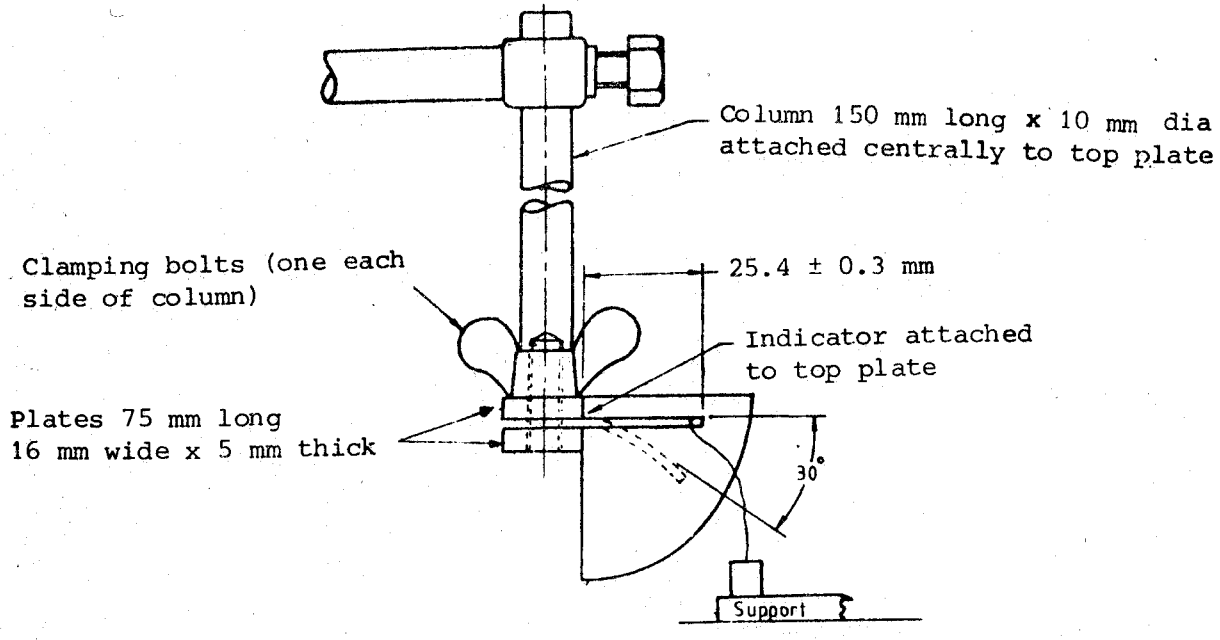


FIGURE 9 - Arrangement of specimen and apparatus

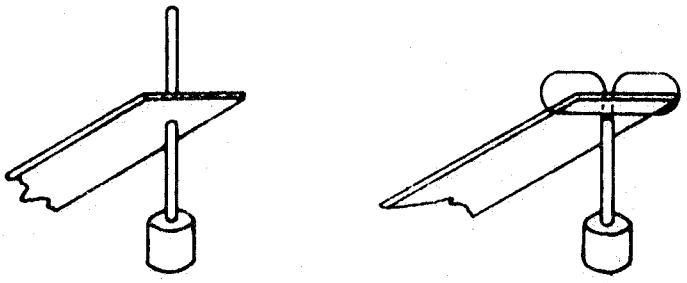


FIGURE 10 - Method of attaching load to specimen

The assembly shall then be immersed in a bath of the appropriate liquid for the material (See foot note under D.4) which is at a temperature 25 °C to 30 °C below the expected softening point (See 8.2.3.3) of the material under test. The load shall then be applied to the specimen and the temperature bath shall be raised at the rate of 1.0 ± 0.2 °C per min. The liquid shall be adequately stirred during the period of test.

The temperature of the bath shall be noted when the upper edge of the free end of the specimen coincides with the 30° graduation on the quadrant. This temperature shall be recorded as the softening point of the test specimen.

The softening point of the material under test shall be reported as the arithmatic mean of the softening points of the test specimens.

D.4 REPORT

The report shall state:

a) The softening point of the material;

b) The individual test results;

c) The moulding conditions; and

d) The conditioning, if any, of the test specimens.

NOTE - Liquid paraffin is suitable for testing cellulose acetate moulding materials and glycerol for testing polystyrene, toughened polystyrene and rigid polyvinyl chloride. Other media of suitable boiling point may be used provided that it is established that they will not affect the material under test.

APPENDIX E

RECOMMENDED SPECIES OF TIMBER FOR ENCLOSURES OF DISTRIBUTION FUSEBOARDS

Common name	Botanical name
Mahogany	*Swietenia macrophylla*
PALU	*Manilkara hexandra*
Satin	*Chloroxylon swietenia*
Teak	*Tectona grandis*
HALMILLA	*Berrya cordifolia*

APPENDIX F

METHOD OF MEASUREMENT OF SURFACE RESISTIVITY

(see 8.2.3.2)

F.1 INTRODUCTION

This method is for measuring the electrical resistance across the surface of material as determined from the current flowing when a voltage is applied to electrodes on the surface of the material.

F.2 FORM OF TEST SPECIMEN AND CONDITIONS FOR MEASUREMENT

The specimen shall be 3.20 ± 0.40 mm thick. Before the measurement is made the specimen shall be immersed for 24 ± 0.5 h in distilled or deionized water at 25.0 ± 0.5 °C and then taken from the water and surface moisture removed with filter paper or blotting paper or a clean absorbent cloth.

The surface resistivity shall be measured at 20 ± 5 °C within 10 min to 15 min from the time of removal from the water. The relative humidity of the laboratory atmosphere at the time of test shall not exceed 75 per cent.

F.3 NUMBER OF TEST SPECIMENS

Two specimens shall be used.

F.4 ELECTRODES

The electrodes shall be of mercury or of sprayed or evaporated metal (see Note 1) or of graphite (see Note 2), and shall be coaxial with one another. The electrodes shall be applied to the specimen in the positions shown in **Fig. 11**. When mercury electrodes are used, the apparatus shown in **Fig. 12** is suitable.

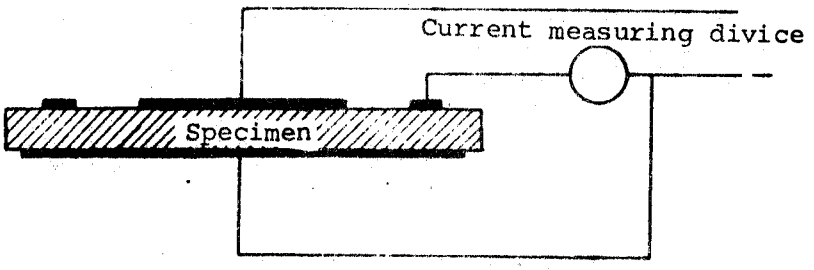
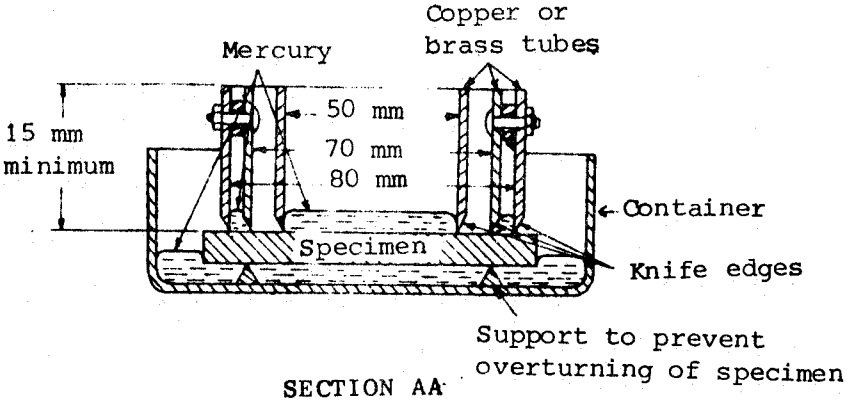


FIGURE 11



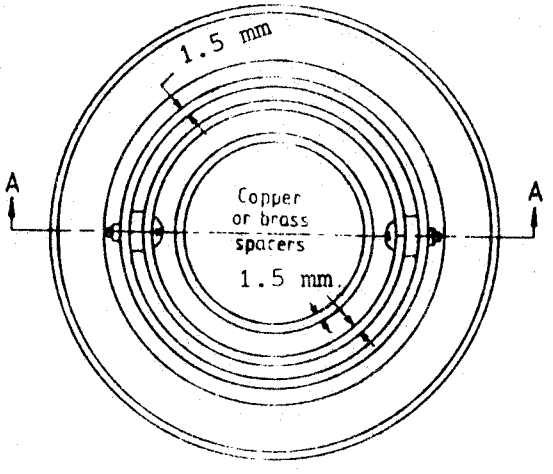


FIGURE 12 - Details of mercury electrodes

Graphite electrodes shall be prepared from a colloidial suspension of graphite in water.

The diameter of the electrodes shall be as follows:

Upper inner electrode	50 mm to 150 mm
Lower electrode	Not less than 30 mm greater than that of upper inner electrode
Upper outer electrode (inner diameter)	20 mm greater than that of upper inner electrode
Upper outer electrode (Outer diameter)	30 mm greater than that of upper inner electrode

F.5 PROCEDURE

A diagram of a suitable electrical circuit is shown in **Fig. 12** (see Note 3 and Note 4).

The surface resistance between the electrodes shall be measured, at the temperature specified in F.2 after electrification for one minute at a potential difference of 500 ± 50 V d.c. The surface resistivity shall be expressed as $\log_{10}$ ohms and shall be calculated as follows:

$$\text{Surface resistivity } \log_{10} \text{ ohms}) = \log_{10} \frac{2\pi R_s}{\log_e \frac{D}{d}}$$

where,

R_s = surface resistance in ohms

D = inner diameter of upper outer electrode in mm

d = diameter of upper inner electrode in mm

For the apparatus illustrated in **Fig. 12** .

$$\text{Surface resistivity } (\log_{10} \text{ohms}) = \log_{10} 18.7\ R_s$$

The surface resistivity of the material under test expressed in $\log_{10}$ ohms shall be reported as the arithmetic mean of the results calculated as above.

F.6 REPORT

The report shall state:

a) The surface resistivity of the material in $\log_{10}$ ohms;

b) The individual test results;

c) The moulding conditions;

d) The conditioning, if any, of the test specimens; and

e) The type of electrodes used.

NOTES

1 In selecting electrodes it should be borne in mind that materials which absorb water readily may be affected by the application of nonporous electrodes if it should be necessary that these are applied before the test specimen is subjected to conditioning in a humid atmosphere prior to test.

2 The electrical properties of materials which absorb water readily may be affected by aqueous suspensions of graphite.

3 A sensitive galvanometer can be used to measure, with sufficient accuracy, resistances up to 1 x 10^{12} ohms at 500 volts.

4 The input impedance of any measuring instrument should be very much lower than either the resistance to be measured or the resistance between the upper outer electrode and the lower electrode.

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