METHODS OF INTERNAL WIRING

B-1. CLEATED WIRING SYSTEM

B-1.1 General - This system shall not be employed for wiring on damp walls or ceiling.

B-1.2 Accessibility - All cleated wiring shall be run, as far as practicable, so as to be visible except in positions where they would be liable to mechanical injury and where they are less than 1.5 m above the floor, in which cases they shall be adequately protected.

B-1.3 Types of Cables - Vulcanized rubber insulated cables; plastic (PVC and polyethylene) insulated cables, braided or unbraided; and any other approved insulated cables shall be used without any further protection.

B-l.4 Cleats - All cleats shall consist of two parts, a base piece and a cap. A special pattern of cleat may be used, if necessary, where conductors pass round corners, so that there may be no risk of the conductors touching the wall owing to the sagging or stretching. Cleats shall be fixed at distances not greater than 60 cm apart and at regular intervals.

B-l.5 Where cleated wiring is laid along iron joist or any metal, spacing between such metal and porcelain cleats shall be inserted either with varnished wood fillet or varnished, wood clamp securely fixed as would be approved so as to prevent conductors coming in contact with such metal along which they are passing.

B-l.6 Fixing of Cleats

B-1.6.1 In ordinary cases, cleats shall be attached to plugs arranged in a suitable manner.

B-1.6.2 Where practicable the same method shall be adopted in the cases of stone walls, but when owing to irregular coursing or other reasons it is impracticable to fix the cleats in a regular and workman like manner, a wood batten shall be provided and fixed with not less than one plug per 1.25 m run. The batten shall be of seasoned teak or other suitable seasoned hardwood 2 cm thick
and 2.5 cm wider than the cleat used, it shall be chamfered on the edges, wrought all over and varnished with two coats of varnish conforming to IS : 347-1975* or painted as may be required.

B-l.7 Distance Between Wires - For voltages up to 250 volts, cleats shall be of such dimensions that in the case of branch loads, conductors shall not be less than 2.5 cm apart centre to centre and in the case of sub mains not less than 4 cm apart centre to ‘centre, provided that this shall not apply, if the cable used is twin-core. Care shall be taken in select&g size of cleats particularly for branch distribution wiring where two-way and three-way porcelain cleats are essential, and the difference in size shall be reasonable. Care shall also be taken that grooves of porcelain cleats do not compress the insulation nor be too wide for a very loose fit. Under no circumstances two wires shall be placed in one groove of porcelain cleats.

B-l.8 Cramming of Conductors

B-1.8.1 Where cleated conductors cross each other they shall be separated by an insulating bridging piece, which will rigidly maintain a distance of at least I.3 cm between the conductors except when the cable used is twin-core.

B-1.8.2 In open type wiring, joint cut-outs or fuse or fuse cut-outs shall not be inserted for any purpose, but where joints are required for connecting bifurcating wires, junction boxes of wooden or-other insulating material with porcelain connectors inside shall be used.

B-l.9 Protection Near Floor

B-1.9.1 No cleated wiring shall be left unprotected up to l-5m above floor level. When brought through the floor it shall be enclosed in conduit in the manner specified in B-2.9.

B-1.9.2 As far as possible, no open type of wiring shall run within floors, walls, partitions, ceilings, roof spaces or other concealed spaces in which they are not normally open to view; in such cases conductors shall be carried through steel conduit pipe with all screwed accessories, keeping mechanical continuity throughout the entire layout, and such pipe work shall be earthed and properly bushed on all open ends to prevent abrasion of cables.

B-1.9.3 At the time of laying and drawing of conductors, care shall be taken to keep the wires straight, tight and rigid without any twist.

B-1.9.4 All wooden fittings, such as boards, blocks, etc, shall be of well-seasoned teak wood or of suitable insulating material and shall be of double type, that is, separate base and top. The wooden boards shall be well varnished on all sides (both inside and outside) and may be mounted with suitable porcelain insulators behind the boards.

B-2. WOOD CASING WIRING SYSTEM

B-2.1 General - This system of wiring is suitable for low voltage installation where vulcanized rubber insulated cables, plastic insulated cables or other suitable insulated cables shall be used in the wiring work and carried within wood casing enclosure. Wood casing wiring system shall not be used in damp places or in ill-ventilated places, unless suitable precautions are taken.

B-2.2 Material and Pattern of Casing – All casing shall be of seasoned teak wood or any other approved hardwood, free from knots, shakes, saps, or other defects, all sides planed with smooth finish, and ail sides well varnished (both inside and outside) with pure shellac varnish. The casing shall have grooved body with beaded or plain moulded cover as desired.

B-2.3 Dimensions of Casing - The sizes of casing and capping for various sizes of 250V grade insulated cables in a groove shall be in accordance with those specified in Table 5.

B-2.4 Bunching of Circuits - Conductors, of opposite polarity or different phases shall not be bunched in one groove in wood casing.
NOTE - Length of conductors of the same polarity desired, and free joints, may be bunched, if so desired.

B-2.5 Attachment of Casing to Wall and Ceiling - All casing shall be fixed by means of suitable flat-head wood screws to plugs at an interval not exceeding 90 cm for sizes up to 64 mm casing and not exceeding 60 cm for sizes above 64 mm casing. Screw heads shall be countersunk within the dividing wall of the grooves (in the case of three-grooved casing, two screws shall be inserted on the two dividing walls in a workmanlike manner). All casing shall be spaced from the wall or ceiling by means of porcelain disc insulators not less than 6.5 mm thick. Casing shall be used only on dry walls and ceilings avoiding outside walls, as far as possible, and shall not be buried in walls or ceilings under plaster, nor fixed in proximity to gas, steam or water pipes or immediately below the latter. Casing under steel joists shall be secured by hoop-iron or by approved wood clamps, and spaced with disc insulators.

B-2.6 Attachment of Capping - All capping shall be attached to the casing (after all insulated wires are laid inside grooves) by round-head screws (rust resisting) fixed on edges and screwed to outer walls of the casing at an interval not exceeding 15 cm crosswise (that is, 30 cm between two successive screws on each side) for all sizes up to 64 mm casing and capping. For sizes above 64 mm similar additional round-head screws shall be fixed on the centre-wall (or alternative walls in cases of 3 grooves) at an interval of 45 cm.
NOTE - Care shall be taken in fixing screws on capping so that they do not pierce through the walls of casing and damage the insulation.

B-2.7 Joints in Casing and Capping – Casing and capping shall be run in lengths as long as possible. All joints shall be scarfed or cut diagonally in longitudinal section and shall be smoothed down by fitting to make joints a very close fit as far as possible. They shall be secured at joints with two or more screws as would be necessary. Joints in capping shall not overlap those in the casing.

B-2.8 Layout of Wood Casing Wiring – Layout of wood casing wiring shall be such as to avoid corners as far as possible and avoid crossing of conductors inside the casing. Where conductors have to cross corners, teak wood solid corner pieces of a radius not less than 7.5 cm and of the same width as that of casing with the same finish as that of capping shall be used,with grooves at the bottom for conductors. Where crossing of wires is unavoidable and a junction box is not used, a bridge piece of casing shall be fixed on the top of casing with neat finish and shall pass conductors avoiding crossing.

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* Specification for conduits for electrical installations.
† Specification for varnish, shellac for general purposes (first revision).

TABLE 5 SIEE OF WOOD CASING AND CAPPING, AND NUMBER OF CABLES THAT MAY BE DRAWN IN ONE GROOVE OF THE CASING
(Clam B-2.3)

Width of casing or capping(mm)	38	44	51	64	76	89	102
NO. of grooves	2	2	2	2	2	2	2
Width of grooves(mm)	6	6	9	13	16	16	19
Width of dividing fillet(mm)	12	12	13	18	24	35	38
Thickness of outer wall(mm)	7	10	10	10	10	11	13
Thickness of casing(mm)	16	16	19	19	25	32	32
Thickness of capping(mm)	6	6	10	10	10	13	13
Thickness of the back under the groove(mm)	6	6	6	10	10	10	13
Length(m)	2.5 to 3.0						

SIZE or CABLE		NUMBER OF CABLES TEAT YAY BE DRAWN IN ONE GROOVE						
Nominal Cross Sectional Area, mm	Number and Diameter (in mm) of Wires							
1	1/1.12*	2	2	3	3	9	12	12
1.5	1/1.40	1	1	2	2	8	12	12
2.5	1/1.80 3/1.60*	1	1	2	2	5	10	10
4	1/2.24 7/1.85*	—	—	2	2	5	8	9
6	1/2.80 7/1.06	—	—	1	1	4	6	6
10	1/3.55† 7/1.40	—	—	1 1	1 1	3 2	5 3	5 4
16	7/1.70	—	—	—	—	1	2	2
25	7/2.24	—	—	—	—	1	1	1
35	7/2.50	—	—	—	—	1	1	1
50	7/3.00† 19/1.80	—	—	—	—	1	1 1	1 1

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* For copper conductors only.
† For aluminium conductors only.

B-2.9 Passing Through Floors - Where conductors pass through floors, they shall be carried in an approved heavy gauge con&it properly bushed at both ends. The conduit shall be carried 1.5 m above floor level and 2.5 cm below ceiling level and neatly entered into the casing, which shall, if so required, be suitably protected at the floor level. The conduit pipe shall be securely earthed.

B-2.10 Casing Round Mouldings or Decorations - This shall be considered as special decoration work and carried out in consultation with the architect or the engineer-in-charge of construction work and with his approval.

B-2.11 Painting and Varnishing - All casing and capping shall be given, before erection, internally and on the back, two coats of varnish conforming to IS : 347;1975*. In addition all casing together with capping after erection shall be painted or varnished to the desired finish.

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* Specification for varnish, shellac for general purposes (first revision).

B-3. TOUGH RUBBER-SHEATHED OR PVC SHEATHED WIRING SYSTEM

B-3.1 General - Wiring with tough rubber sheathed cables is suitable for low voltage installations, and shall not be used in places exposed to sun and rain nor in damp places, unless wires are sheathed in protective covering against atmosphere and well protected to withstand dampness. Wiring with PVC-sheathed cables is suitable for medium voltage installation and may be installed directly under exposed conditions of sun and rain or damp places. This system of wiring is suitable in situations where acids and alkalis are likely to be present. Where attack from white ants (termite) is prevalent, anti-termite treatment shall be-given.

All sheathed cables on brick walls, stone or plaster walls and ceilings, steel joists, or any structural steel work shall be run on well-seasoned and varnished, straight teak wood battens finished not less than 10 mm thick and the width of which is such as to suit total width of cables laid on the batten. Prior to erection, these shall be painted with one coat of varnish or suitable paint matching with the surroundings. These battens shall be secured to the walls and ceilings by flat-head wood screws to wood plugs or other plugs at an interval not exceeding 75 cm; the flat-head wood screws shall be countersunk within wood batten and smoothed down with file.

B-3.2 Link Clips - Link clips shall conform to IS : 2412-1975*. Link clips shall be so arranged that one single clip shall not hold more than two twin-core TRS or PVC-sheathed cables up to l-5 mm above which a single clip shall hold a single twin-core cable. The clips shall be fixed on varnished wood battens with any rust resisting pins or screws and spaced at intervals of 10 cm in the case of horizontal runs and 15 cm in the case of vertical runs. For the wiring and runs of mains exposed to heat and rain, clips specially made for outdoor use from a durable metal, resistant to weather and atmospheric corrosion, shall be used.

B-3.3 Protection of TRS or PVC-Sheathed Wiring from Mechanical Damage

B-3.3.1 In cases where there are chances of any damage to the wirings, such wirings shall be covered with sheet metal protective covering, the base of which is made flush with the plaster or brickwork, as the case may be, or the wiring shall be drawn through a conduit complying with all requirements of conduit wiring system (see B-5).

B-3.3.2 Such protective covering shall in all cases be fitted on all down drops within 1.5m from the floor.

B-3.4 Bends in Wiring - The wiring shall not in any circumstances be bent so as to form a right angle but shall be rounded off at the corners to a radius not less than six times the overall diameter of the cable.

B-3.5 Passing Through Floors - All cables taken through floors shall be enclosed in an insulated heavy gauge steel conduit extending l-5m above the floor and flush with the ceiling below, or by

means of any other approved type of metallic covering. The ends of all conduits or pipes shall be neatly bushed with porcelain, wood or other approved material.

B-3.6 Passing Through Walls - The method to be adopted shall be according to good practice. There shall be one or more conduits of adequate size to carry the conductors. The conduits shall be neatly arranged so that the cables enter them straight without bending.

B-3.7 Buried Cables - The tough rubber sheathed cables shall not be buried directly in plaster; where so specified, they may be taken in teak wood channelling of ample capacity or cement chase or conduit buried in the wall.

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* Specification for link clips for electrical wiring (first revision).

B-3.8 Stripping of Outer Covering – While cutting and stripping of the outer covering of the cables, care shall be taken that the sharp edge of the cutting instrument does not touch the rubber or PVC sheathed insulation of conductors. The protective outer covering of the cables shall be stripped off near connecting terminals, and this protective covering shall be maintained up to the close proximity of connecting terminals as far as practicable. Care shall be taken to avoid hammering on link clips with any metal instruments, after the cables are laid. Where junction boxes are provided, they shall be made moisture-proof with an approved plastic compound.

B-3.9 Painting - If so required, the tough rubber-sheathed wiring shall, after erection, be painted with one coat of oil-less paint or distemper of suitable colour over a coat of oil-less primer, and the PVC-sheathed wiring shall be painted with a synthetic enamel paint of quick drying type.

B-4. METAL-SHEATHED WIRING SYSTEM

B-4.1 General - Metal-sheathed wiring system is suitable for IGW voltage installations, and shall not be used in situations where acids and alkalis are likely to be present. Metal-sheathed wiring may be used in places exposed to sun and rain provided no joint of any description is exposed; this system may be installed in damp places with approved protection against dampness coming in contact with open ends of cables.

B-4.2 Link Clips - Link clips shall conform to IS : 2412.1975* and shall be so arranged that one single clip shall not hold more than two twin-core metal-sheathed cables up to 1.5 mm, above which a single clip shall hold a single twin-core cable. The clips shall be fixed on varnished wood battens with brass pins or brass screws and placed at intervals of 10 cm in the case of horizontal runs and 15 cm in the case of vertical runs, For the wiring and runs of mains exposed to heat and rain, clips specially made for the outdoor use from a durable metal, resistant to weather and atmospheric corrosion, shall be used.

B-4.3 Attachment to Walls and Ceilings - All metal-sheathed cables on brick walls, stone walls or plastered walls and ceilings; steel joists or any structural steel work shall be run on well-seasoned and perfectly straight teak wood battens of not less than 10 mm finished thickness, which have been well varnished on four sides. The width of teak wood. battens shall be such as to suit the total width of cables laid on the batten. Prior to erection these shall be painted with one coat of varnish or suitable paint of colour to match with the surroundings These battens shall be secured to the walls and ceilings by flat-head wood cement chase or conduit buried in the wall.

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* Specification for link clips for electrical wiring (first revision).

† Specification for varnish, shellac, for general purposes (first revision).

screws to wood plugs or other approved plugs at an interval not exceeding 75 cm; the flat-head wood screws shall be countersunk within wood batten and smoothed down,with file.

B-4.4 Wiring on Rolled Steel Joists – Where wiring is ‘to be carried along the face of rolled steel joists, a batten shall first be laid on the joists and clipped to it as inconspicuously as possible. The wiring shall be fixed to the batten in the ordinary way.

B 4.5 Protection of Wiring from Mechanical Damage

B-4.5.1 In cases where there are chances of any damage to the wiring, such wiring shall be covered with sheet metal protective covering, the base of which is made flush with the plaster of brickwork, as the case may be, or the wiring shall be drawn through a steel conduit pipe by complying with all requirements of conduit system of wiring (see B-5).

B-4.5.2 The protective covering shall in all cases be carried right through the entire length of such doubtful positions.

B-4.6 Joints - Where joint-box system is specified, joints shall be made by means of connectors, insulated with porcelain, or other approved material and enclosed in joint-boxes. The joint-boxes shall be so constructed as to prevent insects from entering them, and to allow the white washing of the walls without water having access to the connectors. All cables shall be bonded through,
or across these boxes. Bonding connections shall be so arranged as not to come in contact with plaster.

B-4.7 Stripping of Insulation and Outer Covering

B-4.7.1 When rubber or PVC insulation has to be stripped for joints, the metal sheathing shall be nicked only, not cut, and the insulation between the metal sheath and the conductors shall be of rubber or ,PVC sheath only. All tape shall be stripped off. Where paper-insulated metal-sheathed cable is used, all openings in the same shall be efficiently sealed.

B-4.7.2 While cutting and stripping of the outer covering of the cables, care shall be taken that the sharp edge of cutting instrument does not touch the rubber or PVC insulation of conductors. While connecting conductors to the connecting terminals of accessories, care shall be taken to remove cotton tape covering from the top of rubber insulation of cable. The cotton tape covering shall always remain inside lead covering of cables.

B-4.8 Passing Through Floors - All cables taken through floors shall be enclosed in an insulated steel conduit extending 1.5 m above the floors and flush with the ceiling below, or protected by means of any other approved type of metallic covering. The ends of all conduits or pipes shall be neatly bushed with porcelain, wood or other approved material.

B-4.9 Passing Through Walls - The method to be adopted shall be in accordance with good practice. There shall be one or more conduits of adequate size to carry the conductors. The conduit(s) shall be neatly arranged so that the cables enter them straight without bending.

B-4.10 Burried Cables - Metal sheathed cables shall in no case be hurried directly in the plaster or under any masonry work.

B-4.11 Earthing - Precautions shall be taken to ensure that all lead sheathing including portable appliance with exposed metal parts, together with all joint-boxes and other similar receptacles are efficiently earthed and made electrically continuous throughout their lengths by means of soldered joints or approved suitable clamps or, alternatively with earth continuity conductors (each bonded

cables) specially manufactured for the purpose. The earthing (shall extend to all main switches, distribution boards, etc, in compliance with Indian Electricity Rules, 1956, as well as manufacturers' design and instructions in connection with earthing of all insulated micro gap main switches or similar fittings.

B-4.12 Resistance - The electrical resistance of the metal sheathing together with the resistance of the earthing lead, measured from the connection with the earth electrode to any other position in the completed installation shall not exceed one ohm.

B-4.13 Painting - Where required, all metal sheathed wiring or its protective covering when such is fitted, shall be neatly painted after erection with two coats of any suitable paint.

B-5. CONDUIT WIRING SYSTEM

B-5.1 Surface Conduit Wiring System with Rigid Steel Conduits

B-5.1.1 *Type and Size of Conduit* - All conduit pipes shall be conforming to IS : 1653-1972*, finished with galvanized or stove enamelled surface, All conduit accessories shall be of threaded type and under no circumstances pin grip type or clamp type accessories be used. No steel conduit less than 16 mm in diameter shall be used. The number of insulated conductors that can be drawn into rigid steel conduit are given in Table 6.

B-5.1.2 *Bunching of Cables* - Unless otherwise specified, insulated conductors of ac supply and dc supply shall be bunched in separate conduits. For lighting and small power outlet circuits phase segregation in separate conduits is recommended.

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* Specification for .rigid steel conduits for electrical wiring (second revision).