



DELHI METRO RAIL CORPORATION LIMITED

***DMRC ELECTRICAL STANDARDS &
DESIGN WING (DESDW)***

**SPECIFICATION NO.
DMES-E/0001/ DMRC-E-E&M-CONDUIT-01**

**SPECIFICATIONS FOR SUPPLY & INSTALLATION
OF CONDUITS, ASSOCIATED FITTINGS &
ACCESSORIES**

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1. Detailed Description and Application in DMRC

Supply and Installation of Rigid GI Conduits, Associated Fittings and Accessories:

Conduit is a part of closed wiring system of circular or non- circular cross-section for conductors and/or cables in electrical installations allowing to draw them in and/or to replace them. However, in this document the word 'conduit' shall refer to circular cross-section only. Conduits shall be sufficiently closed- jointed so that the conductors can only be drawn in and not inserted laterally. The conduits shall be rigid GI type.

Conduit Fittings referred to in this document is a device designed to join or terminate one or more portions of a conduit installation which shall be of metal (GI) only.

Conduit Accessories are the parts other than fittings used in fixing steel/ GI conduits.

The specifications contained herein are applicable to Elevated/ Underground/ At Grade stations, Depots, Staff Quarters and office Complex etc.

2. Governing Specifications

The conduits, associated fittings and accessories shall satisfy the requirements given below and shall also comply with standards mentioned particularly in the table below unless otherwise stipulated in the specifications. The latest version of standards shall be applicable.

GI conduits for electrical wiring	IS: 9537 : Part I, 1980 IS: 9537: Part II, 1981
Accessories for rigid steel conduits	IS: 3837 : 1976
Conduit Fittings for Electrical Installations	IS: 14768 Part-1, 2000 IS: 14768 Part-2, 2003
Flexible Steel conduits for electrical wiring	IS: 3480 : 1966
Code of practice for electrical wiring installations	IS: 732 : 1989
National Electrical Code, 2011	
National Building Code, 2005	
Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2010	
3 pin plugs and socket outlets up to 250 volts	IS: 1293 : 2005
Switches for domestic and similar purposes	IS: 3854 : 1997
Boxes for the enclosure of electrical accessories	IS: 14772:2000
Code of practice for electrical installation fire safety of buildings	IS: 1646: 1997
Guide for safety procedure and practices in Electrical works	IS: 5216 : 1982
Specification for Hot-dip Zinc coating on mild steel tube and procedure for testing	IS: 4736 : 1986 IS: 6745 : 1972



Note: The latest edition of the standards shall be used. Wherever Indian Standards are not available, relevant latest British and/or IEC Standards shall be applicable.

2.1. Abbreviations

- IS- Indian Standard
- IEC- International Electrotechnical Commission
- ERW- Electric Resistance Welding
- GI- Galvanized Iron
- MS- Mild Steel
- NEC- National Electrical Code
- NBC- National Building Code

Note: The term 'Approved' in this specification means that the approval of the Engineer-in-Charge shall be taken.

3. Requirement

3.1. Rigid GI Conduits (IS: 9537, Part I & II)

These shall be galvanized iron with minimum wall thickness of 1.6mm up to 32mm diameter and 2.0mm for sizes above 32mm diameter, electric resistance welded (ERW), electric threaded type, with both ends screwed having perfectly circular tubing. Conduits shall show no appreciable unevenness and shall be free from burrs, fins and the like which may cause damage to cable insulation. These rough internal edges shall be removed by means of a proper reamer. Conduits shall be precision welded and shall be fabricated from tested steel strips of required thickness by electric resistance welding. Welds shall be smooth and consistently of high quality to ensure crack proof bending. The conduit shall be galvanized according to IS 4736-1986. All conduits used in this work shall be marked according to IS: 9537 Part-2 and also with ISI certification mark. Other requirements for the conduits shall be as per IS: 9537, Part-1 and Part-2.

3.2. Flexible Conduits (IS: 3480)

The usage shall be restricted to only those areas where it is not possible to use Rigid GI Conduits. All final connections especially to vibrating equipments shall be made through flexible conduits. Flexible steel conduits shall be as per latest edition of IS: 3480. Where flexible steel conduit is employed, the length shall not exceed 2.5 metres and shall be provided with an earth continuity conductor of copper size not less than 2.5mm².

3.3. GI Bends (IS: 14768)

Large right angle bends (as per IS: 14768 but more than 75mm radius) or non-right angle bends (as per IS: 14768) in conduits runs shall be made by means of conduits bending machines carefully so as not to cause any crack in the conduit. Small right angle bends in conduits runs can be made by standard conduit accessories



(solid/inspection bends/elbows). Facilities such as draw-in boxes must be provided so that cables are not drawn round more than two right-angle bends or their equivalent. The radius of bends must not be less than the standard normal bend. Bends in multi runs of conduits shall be parallel to each other and neat in appearance, maintaining the same distance as between straight runs of conduits.

3.4. Standard Fittings & Accessories IS: 3837 & IS: 14768, Part-1 and Part-2.

Heavy Protection Class Galvanized (IS 4736 & IS 6745) standard conduit fittings and accessories like standard/extra-deep circular boxes, looping in boxes, junction boxes, solid / inspection elbows, solid/inspection tees, couplers, nipples, saddles, check nuts, earth clips, bushes etc. shall be of superior quality and of approved makes. The covers screwed with approved quality screws shall be used that can withstand hard use or wear. Samples of all conduits fittings and accessories shall be got approved by Engineer-in-Charge before use. Conduit fittings and Accessories shall be as per IS: 3837 and IS: 14768, Part-1 and Part-2.

Conduit boxes and covers shall have a minimum degree of protection as follows:

Description	Against Corrosion	Enclosure	Surface or Concealed
Outside buildings	Heavy Protection both inside and outside	IP 54	Surface
Plant rooms and service ducts, Switch Rooms, Store Rooms, Ceiling Voids	Heavy Protection both inside and outside	IP 41	Surface
Below Ground	Heavy Protection both inside and outside	IP 44	-
All other locations	Heavy Protection both inside and outside	IP 41	Concealed

The contractor shall submit for approval the ‘Method Statement including Tests’ to ensure above degree of ingress protection. In case no testing facility is available, the contractor shall comply with this clause by submitting design and installation features.



3.5. Fabricated Fittings & Accessories

Wherever required, outlet/ junction boxes of required sizes shall be fabricated from 1.6mm thick MS sheets except ceiling fan outlet boxes which shall be fabricated from minimum 3mm thick sheets. The outlet boxes shall be galvanized and of approved quality, finish and manufacture. Suitable means of fixing connectors etc., if required, shall be provided in the boxes. A screwed brass stud shall be provided in all boxes as earthing terminal.

a) Outlet Boxes for Light Fittings

These shall be minimum 75mm x 75mm x 50mm deep and provided with required number of threaded collars for conduit entry. For ceiling mounted fluorescent fittings, the boxes shall be provided 300mm off center for a 1200mm fitting and 150mm off center for a 600mm fitting so that the wiring is taken directly to the down rod. 3mm thick Perspex/hylam sheet cover of matching color shall be provided.

b) Outlet Boxes for Ceiling Fans

Outlet boxes for ceiling fans shall be fabricated from minimum 3mm thick MS sheet steel and galvanized. The boxes shall be hexagonal in shape of minimum 100 mm depth and 60mm sides. Each box shall be provided with a recessed fan hook in the form of one 'u' shaped 15 mm dia rod welded to the box and securely tied to the top reinforcement of the concrete slab for a length of minimum 150 mm on either side. 3mm thick Perspex/hylam sheet cover of matching colour shall be provided.

3.6. Boxes for Modular Wiring Accessories

Boxes for housing modular wiring accessories (switches, switched socket outlets, telephone/computer / TV outlets, bell pushes, electronic fan regulators etc.) shall be fabricated from minimum 1.6mm thick MS sheets provided with rust inhibiting galvanization. The MS boxes shall be suitable for a grid plate being fixed over it for mounting wiring accessories leaving ample space at the back and on the sides for accommodating wiring conductors, MS boxes shall be provided with a brass earth terminal. The MS boxes shall have knockout holes for conduit entry which shall be secured in position by check nuts and provided with bushes.

In case the number of switches in one box is not tallying with that available in standard manufacturer range, the box accommodating the next higher number of switches shall be provided without any extra cost.

3.7. Wiring Capacity of Conduits

Conduits shall be of ample sectional area to facilitate simultaneous drawing of wires and permit future provision also. Total cross section of wires measured overall shall not



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normally be more than half the area of the conduit. Maximum number of wires which could be drawn in various sizes of conduits shall be as given in table below:

Nominal cross sectional area of conductor in sq.mm	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

Note:

(1) The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables as per DMRC's requirements.

(2) The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit, which deflect from the straight by an angle of more than 15 degrees.

(3) Conduit sizes are the nominal external diameters.

3.8. Modular Cover Plated Mounted Wiring Accessories

3.8.1. Switches

All 6 A and 16 A switches shall be of the modular enclosed type flush mounted 250 volt AC of the best quality and standard approved by Engineer-in- Charge. The housing of switches shall be made from high impact resistant and flame retarding plastic material. The switch controlling the light point shall be connected on to the phase wire of the circuit. The switch shall govern to 250 V grade as per IS 3854:1977 Amendment No. 6,



Aug 2011 and IS 1293 respectively. Brands namely Crabtree, MK Electric, CPL-obsession, MDS, Schneider, SSK, ABB shall be used.

3.8.2. Molded Cover Plates

Switches, receptacles and telephone system outlets in wall shall be provided with molded cover plates of shape, size and colour approved by the Engineer- in- Charge made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material, and secured to the box with counter sunk round head chromium plated brass screws. Where two or more switches are installed together, they shall be provided with one common switch cover plate as described above with notches to accommodate all switches either in one, two or three rows.

One and two gang switch cover plate, telephone outlet cover plate, 6 A and 16 A switched / unswitched plates, shall have the same shape and size. Three and four gang switch cover plates shall have the same shape and size. Six and eight gang switch cover plates shall have the same shape and size. Nine and twelve gang switch cover plates shall have the same shape and size. Wherever five switches, seven switches, ten switches and eleven switches are to be fixed the next higher sizes of gang switch cover plate to be used and openings shall be provided with blank-off covers at no extra cost.

3.8.3. Wall Socket Outlets

All 6/16 A wall sockets outlets unless otherwise mentioned on the drawings shall be switched, with round pins and fitted with automatic linear safety shutters to ensure safety from prying fingers. Unswitched 6/16 A wall socket outlets where called for in the drawings shall be of three pin type. The socket outlets shall be made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material. The switch and sockets shall be located in the same plate. The plates for 6A switched / unswitched plugs and telephone outlets shall be of the same size and shape. All the switched and unswitched outlets shall be of the best standard. The switch controlling the socket outlet shall be on the phase wire of the circuit. An earth wire shall be provided along the cables feeding socket outlets for electrical appliances. The earth wire shall be connected to the earthing terminal screw inside the box. The earth terminal of the socket shall be connected to the earth terminal provided inside the box.

3.9. Conduit Installation (IS: 732 and Relevant clauses of NEC, 2011)

3.9.1. System

The whole conduit system shall be installed to comply fully with relevant provision in Indian Standard Specifications, National Electrical Code, 2011. Conduits shall be laid either recessed in walls and ceilings or on surface on walls and ceilings or partly recessed and partly on surface, as required. Same rate shall apply for recessed and



surface conduiting in this contract. Steel wire of 1.6 mm² size to serve as a fish wire shall be left in all conduit runs to facilitate drawing of wires after completion of conduiting. No conduit shall be under mechanical stress. When crossing through expansion joints in building, the conduit sections across the joint shall be through approved quality metallic flexible conduits (as per IS 3480) of the same size as the rigid conduit. Allowance shall be made for running an earth wire of size not less than the largest conductor contained between each terminal fitted in the nearest conduit boxes on each side of the telescopic/flexible conduit joint.

3.9.2. Layout

Conduits layout and routes shall be submitted for Engineer-in-Charge's approval prior to execution. Allowance for adjustments due to site conditions shall be provided with no extra cost.

Conduit routes shall be chosen for easy, straight runs with a minimum of bends and crossing. Generally they shall follow the structure of building, running at right angles or in parallels to floors and ceiling. Conduit shall be kept within 300mm of floors and ceiling when running parallel to them.

Outlets boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduits runs do not exceed 12m or have more than two right angle bends.

Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw in wires.

3.9.3. Joints and Terminations

Conduit threads shall be thoroughly cleaned and the conduits tightly screwed. The conduit system shall be watertight after installation. The contractor shall submit for approval the 'Method Statement including Tests' to ensure the above requirement.

Conduits shall be connected using couplers or via boxes. With a coupler, the ends of the conduit shall be butted close together and the running coupler is screwed tightly on and tightened by a locknut.

Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.

Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.



In all joints and terminations, conduits threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be treated as given in Section 4(b) of this specification.

3.9.4. Bends (IS: 14768-2)

Conduits shall be bend cold with an approved type of bending block or bending machine, without altering the dimensions of their sections. The approval for the bending block or bending machine proposed to be used at site shall be taken from the Engineer-in-Charge.

All conduits bends shall be such as to permit compliance to the requirements for bends in the IS regulations.

Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes shall to be used for connecting conduits.

3.9.5. Recessed Conduiting

Conduits recessed in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embed the entire run of conduits and ceiling outlet boxes with a cover of minimum 12mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 metre. No reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building. Spacing between concealed conduits entering the draw-in boxes shall not be less than 25mm to allow concrete aggregate to pass and set between conduits.

Conduits recessed in brick work shall be laid in chases to be cut by electrical contractor in brick work before plastering. The chases shall be cut by a chase cutting electric machine. The chases shall be of sufficient width (minimum 10mm spacing between adjacent conduit) to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster (minimum 6mm) over conduits. The conduits shall be secured in the chase by means of heavy duty pressed steel clamps screwed to MS flat strip saddles at intervals of maximum 600 mm. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering. Galvanized chicken wire mesh of 0.6mm thick with 10 to 15mm aperture shall be provided for the full length and width of the chase in the plaster to prevent cracking.

Junction boxes intended for facilitating drawing of wires in conduiting system shall be located in accessible locations to permit redrawing of wires in future. Open ends of conduits laid in slabs and walls shall be suitably plugged before pouring concrete/plastering to prevent ingress of water / debris in to the conduits.



Entire recessed conduit work in concrete member and in brick work shall be carried out in close coordination with progress of civil works. Conduits in concrete member shall be laid before casting and conduits in brick work shall be laid before plastering. If it becomes necessary to embed conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimizing this cutting, conduits of lesser diameter than 25mm and outlet boxes of lesser depth than 50mm could be used by the contractor for such extensions only after obtaining specific approval from Engineer-in-Charge. For embedding conduits in finished and plastered brick work, the chase would have to be made in the finished brick work. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish.

Cutting chases in finished concrete or finished plastered brick work for recessing conduits and outlet boxes etc. shall be done by the Contractors without any extra cost.

In the concealed GI conduit system, all boxes for accessories & draw/junction boxes shall be installed such that outer rim is flush with the finished surface of the wall. Sockets near skirting level shall be fed from the floor above rather than the floor below, because in the latter case it would be difficult to avoid traps in the conduit

Where surface mounted distribution boards are used with a sunk conduit, a flush adaptable box shall be fitted in the wall behind the distribution board and to take the flush conduits directly into it. Holes can be drilled in the back of the distribution board and bushed. Spare holes should be provided for future conduits. Distribution boards must be bonded to the adaptable boxes and unused holes should be sealed.

3.9.6. Surface Conduiting

Wherever so desired, conduit shall be laid in surface over finished concrete and/or plastered brickwork. Suitable spacer saddles of approved make and finish shall be fixed to the finished structural surface along the conduit route at intervals not exceeding 600mm (except from fitting where 300mm). Fixing of standard bends or elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with a long radius which will permit easy drawing-in of conductors. Holes in concrete or brick work for fixing the saddles shall be made neatly by electric drills using masonry drill bits. Conduits shall be fixed on the saddles by means of good quality GI clamps meant to withstand hard use and wear screwed to the saddles by counter sunk screws. Neat appearance and good workmanship of surface conduiting work is of particular importance. The entire conduit work shall be in absolute line and plumb. Conduits above false ceiling shall be fixed on suitable hangers supported from structural ceiling.



All surface conduits shall be run in a vertical or horizontal direction. Diagonal runs shall not be permitted.

3.9.7. Fixing of Conduit Fittings and Accessories

For concealed conduiting work, the fittings and accessories shall be completely embedded in walls/ceilings leaving top surface flush with finished wall/ceiling surface in a workman like manner.

Loop earthing wire shall be connected to a screwed earth stud inside outlet boxes to make an effective contact with the metal body.

3.9.8. Painting and Colour Coding of Conduits

Surface conduits shall be provided with 20 mm wide and 100 mm long color coding strips as below.

USE	COLOUR CODE
Low Voltage	Grey
Telephone	Black
Earthing System	Green
Security Conduit	Blue
Fire Alarm Conduit	Red
Control System Lighting	Purple

3.9.9. Protection of Conduit

To safeguard against filling up with mortar / plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs, which shall be replaced by sheet/plate covers as required. All screwed and socketed joints shall be made fully water tight with white lead paste.

3.9.10. Cleaning of Conduit Runs

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables. All conduit shall be swabbed through before wiring is commenced and cables shall not be drawn into any section of the system until all conduits and draw boxes for that particular section are fixed in position.



The contractor shall submit for approval the 'Method Statement including Tests' to ensure the above requirements of cleaning of conduit runs.

3.9.11. Loop Earthing

Loop earthing shall be provided by means of insulated stranded copper conductor wires of sizes as per bill of quantities laid along with wiring inside conduits for all wiring outlets and sub mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc.

4. Additional Requirements

- a) All conduits shall be electrically and mechanically continuous and substantially water tight after installation.
- b) Where an exposed galvanized surface has been cut or otherwise damaged, it shall be repaired by application of a zinc rich epoxy primer with a generous overlap on the existing sound metal coating. Exposed threads and connections shall be similarly treated. The epoxy primer shall be used strictly in accordance with the manufacturer's instructions.
- c) The use of inspection elbows and tees shall be avoided, as there is insufficient room for drawing in cables and, in addition the installation presents a shoddy appearance. Round boxes in accordance with relevant Indian Standards may be used. For conduits up to 25 mm diameter, the small circular boxes should be used. Circular boxes are not suitable for conduits larger than 32 mm, and for these larger sizes rectangular boxes should be used to suit the size of cables to be installed.
- d) All circular boxes shall be provided with long spouts, internally threaded, incorporating a shoulder for the proper butting of the conduit and a tapped 5mm hole in the base to accept a solid brass earth terminal.
- e) An indelible display shall identify the cables laid along with the conduits at each conduit junction/ termination etc. for identification during any future handling.
- f) The contractor shall submit 'Method Statement' for Installation, Testing and Commissioning of the conduit system as per the requirements of this specification. The 'Method Statement' shall also cover the aspect of quality and safety during Installation, Testing and Commissioning of the system.

5. Safety

The conduit system shall follow the relevant clauses of Central Electricity Authority (Measures relating to Safety and Electricity Supply) Regulations, 2010, National Building Code, 2005 and National Electrical Code, 2011 for the safety precautions to be adopted. In addition to this, following conditions should be adhered to:



- a) All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150mm away from gas pipe. Where proximity to these pipes is unavoidable, they shall be effectually segregated e.g. using rubber or other insulating material to prevent appreciable voltage difference at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to that same voltage requirement as lighting and power circuits.
- b) The materials used in the conduit system shall be fire retardant, shall not emit toxic gases and smoke on exposure to fire. The materials shall be easy to dismantle and replace in case of rearrangement and also withstand vibration due to rail operation and seismic tremor.
- c) No timber or inflammable material shall be used for any supports.
- d) No sharp edges or portion shall be present which may cause injury during handling or installation.

6. Energy Efficiency- NA

7. Maintenance and Life

This is an installation not requiring any maintenance with a long life. The contractor shall take suitable measures during manufacturing and installation of the product to achieve long life.

8. Special Condition- NA

9. Inspection, Testing & Dispatch

9.1. Inspection & Testing

All tests to be conducted as per relevant IS. In case of any contradiction with the relevant IS and this specification, this specification shall prevail.

9.2. Packaging and Sealing

The contractor shall ensure to the satisfaction of the Engineer-in- Charge that the material is properly packaged with inspection seal before dispatch. The contractor shall ensure satisfactory dispatch of material so as not to damage the packing condition and inspection seal.