

Reference : CC-ENGG-4540-001-199-PVE-W-001

Date : 04/01/2023

From : Subodh Pandit
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To : BHARAT HEAVY ELECTRICALS LTD
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Subject : EPC TTPP3 (2x660MW)

Please find enclosed following drawings/ documents for necessary action at your end.

Vendor Drg. No. : PE-DC-497-507-E004
Orgn. Drg. No. : 4540-001-199-PVE-W-001
Revision No. : 01
Drg. Title : CABLE ERECTION PHILOSOPHY
App. Category : CAT-I
Release Date : 04/01/2023



Scan to verify

Comments : Approved with minor comments

PROJECT: 2x660MW TALCHER PROJECT OWNER: NTPC LTD. Document No.: 4540-001-199-PVE-W-001 Document Title: CABLE ERECTION PHILOSOPHY				
SL. NO.	NTPC COMMENTS (DTD: 16.11.22)	BHEL REPLY (DTD: 12.12.22)	NTPC comments on BHEL reply dt 14.12.22	BHEL REPLY (DTD: 23.12.22)
1	Caluse No: 1.5 As it is EPC package all areas under the scope of BHEL, shall be covered in this document only. No additional document shall be added in MDL for review.	Noted. Relevant portion of equipment layout philosophy mentioned in this document shall be followed by other units . However this document is complete in all respects.		
2	Part of EPC. Shall be included Caluse No: 2.1 Stability of the clamped cable trays to be ensured.	Noted.	OK	Point closed
3	Caluse No: 2.2 The cable slits to be used for motor/equipment power/control supply shall be sand filled & covered with PCC after cabling.	Noted.	OK	Point closed
4	Caluse No: 2.4 The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm.	Noted.	OK	Point closed
5	Caluse No: 2.4 2.4 (a) The cable tray Support system is designed to withstand 1. weight of the cable trays 2. weight of the cables 3. Concentrated load of 75 Kg between every support span 4. Factor of safety of minimum 1.5 is considered	Noted and Shall be Indicated in the revised document.		
6	Caluse No: 2.8 Four legged structure shall be provided wherever there is change in elevation and change in direction	Same shall be in line with respective Mechanical / Civil Structural drawing.	OK	Point closed
7	Caluse No: 2.9 Minimum size of anchor fasteners shall be M 8 X 50 and material shall be stainless steel grade 316 or better.	Noted.	OK	Point closed
8	Caluse No: 2.13 C) Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route.	Noted and Shall be Indicated in the revised document.	OK	Point closed
9	Caluse No: 2.14 i. Pull-pits shall be filled with sand and provided with a PCC covering. li. 1.5m iii. PVC pipe not allowed.	i. Cable erection/ maintenance will be difficult if Pull-pits were filled with sand. However, as per requirement pull pit shall filled with sand after completion of cabling and PCC covering shall be provided. ii. 1.5 m from FGL shall be provided. iii. In duct banck PVC pipe with concrete encasing shall be provided.	OK i & ii agreed. iii. Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.	Point closed i. Point closed ii. Point closed iii. Noted; & point closed.
10	Caluse No: 3.2 BHEL to mention the arrangement of single core & multi core cables in trays & it shall comply to the drg 4540-001-299-PVE-U-003 (Design calculation of LV Cable selection Sizing) based on which derating factors has been considered.	Arrangement of single core & multi core cables in trays already mentioned in subsequent clauses of the document.	As mentioned in drg no- 4540-001-299-PVE-U-003 and as per derating factors considered; following details to be brought out:- (1) FOR AIR/RESTRICTED AIR CIRCULATIONS:- (For single core cable:- Max 3 nos trefoils per tray separated by 2 cable dia / For multi core cable-Max 9 nos cable per tray touching each other.) (2) For Ground- (For single core cable:- Max 3 nos trefoils in horizontal formation touching / For multi core cable-Max 3 nos cable touching each other.	Noted; & point closed.

11	Caluse No: 3.4 clamped at every one metre	Noted and Shall be Indicated in the revised document.	OK	Point closed
12	Caluse No: 3.8 low current carrying power cables (valve/ damper actuator power cables) may be laid along with control cables. In most such cases, the cable sizes shall be 2.5 sq mm; however, in a few cases higher sizes if required as per approved cable sizing calculations (due to voltage drop criterion) may be used.	Noted and shall be incorporated in the revised document.	OK	Point closed
13	Caluse No: 3.10 Subject to approval of site engineer.	Noted	OK	Point closed
14	Caluse No: 3.11 i. Subject to approval of site engineer ii. 300mm	i. Noted. ii. Due to space constraint 300mm is not possible. Same philosophy also being followed in other NTPC projects, executed by BHEL (e.g. Patratu).	OK ii. Generally gap between control cables & instrumentation cables if laid in same tray should be 300mm. However it may be reduced upto min 100mm, case to case basis where space constraint is there.	i. Point closed ii. Noted & point closed.
15	Caluse No: 3.13 GI pull wire of adequate size shall be laid in all conduits before installation. Caluse No: 3.19 i. Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes. Hume pipes shall be NP3 type as per IS 458 ii. In case of Duct banks, pull-pits shall be filled with sand and provided with a PCC covering.	Noted i. Duct bank provided shall be with PCC encashed, hence HDPE pipe is not required. iii. Refer our reply at 9(i) above.	OK	Point closed
16	Caluse No: 3.20 approval of Project Manager.	Noted	OK	Point closed
17	3.33 In fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc, fire retardant paint to be applied after installation cables.	All cables are FRLS, thus separate fire retardant paint is not envisaged.	In spite of FRLS cable, providing fire retardant paint on cables in fire prone area is technical requirement as per contract. BHEL to comply.	Noted & point closed. Fire retardant paint shall applied after installation on cables in topmost trays of Horizontal formation in fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc.
18	Caluse No: 4.1 i. joints for less than 250m run of cable shall not be provided. Extra length shall be provided for one LT and two HT joints at a later stage. ii. In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing. iii. 1) Details of cable drum lifting jack as per specifications to be included.	i. Noted and shall be incorporated in the revised document. ii. Noted. iii. Noted, however, Same shall be taken care by erection agency.	OK	Point closed

Redt

19	Caluse No: 4.11 Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections.	Lugs shall be of Copper for all Cables. Since terminals of all equipment are generally of Copper only.	Not acceptable. Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections.	Noted & Point closed
20	Caluse No: 4.12 However, no joints shall be allowed in trip circuits, protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Further, to avoid joints, the cable drum length shall be governed by clause no 4.00.04.02. SUB-SECTION-B-08 HT LT AND CONTROL CABLES, Section-VI, Part-B.	Noted	OK	Point closed
21	Caluse No: 6.2 Further details as per clause no 3.02.05 of SUB SECTION-B-10 (CABLING, EARTHING & LIGHTNING PROTECTION) for COAL HANDLING PLANT/FGD PLANT/ ESP AREA to be included in general cable erection philosophy.	Refer reply in sl. No. 1 above.	OK	Point closed



Revised with Date: 01/01/2015

2 X 660MW TALCHER TPP, STAGE III (EPC)

CABLE ERECTION PHILOSOPHY

BHEL DOC. NO. PE-DC-497-507-E004

NTPC DOC NO.: 4540-001-199-PVE-W-001

REVISION 1



BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA - 201301

U.P.

	2 X 660MW TALCHER TPP, STAGE III (EPC) CABLE ERECTION PHILOSOPHY	DOCUMENT NO. 4540-001-199-PVE-W-001
		Rev No: 01
		Date: 23.12.2022
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Reviewed by: [Signature]

1.0 **Scope**

- 1.1 This document is intended to cover the aspects of cable raceway design and installation, laying and termination of various types of cables for the project.
- 1.2 Design calculations for cable sizing and selection & design memorandum for fire sealing system are covered in a separate document.
- 1.3 Latest revisions of all drawings / documents shall be referred.
- 1.4 Reference standards/ documents.
 - i. IS: 1255 (Code of practice for installation and maintenance of power cables).
- 1.5 Exclusions: The following areas / systems are excluded from the scope of this Document.

Refer comments sheet point no. 1, cable erection philosophy shall also be applicable to the area marked in clause no. 1.5.

 - a. Switchyard.
 - b. Ash handling plant.
 - c. Coal handling plant.
 - d. ESP Integral cabling.
 - e. Steam generator integral cabling.
 - f. Turbine and generator integral cabling.
 - g. FGD system integral cabling.

2.0 **Cable Raceway System**

- 2.1 Cables shall generally be laid in galvanised MS cable trays in multi-tier arrangement. The trays shall in turn be supported on flexible cable tray support systems in TG Building, cable vaults, along structural members/ concrete surfaces inside plant buildings, cable trenches below switchboards/ MCCs in auxiliary plant buildings, and interconnecting pipe-cum-cable trestles. The trays shall be fixed to supports by means of bolting. Clamping of trays to the cantilever arms shall be resorted to where due to fabrication mismatches, there are misalignments between the respective locations of holes in trays and the cantilever arms. **Stability of cable trays shall be ensured.**
- 2.2 Cable trays shall be oriented horizontally in all areas, except in areas subject to coal dust or ash deposition (such as boiler platforms, raceways along C-row of Main Power House area, interconnecting overhead cable tray paths between boiler area and ESP area, etc.). Cable trays may be oriented vertically in other areas also if so required due to reasons such as space restriction, accessibility, plant aesthetics, operational clearances, etc. as per approved layout drawings. Branching of cables from main route shall be done through cable trench/slit/cable troughs. **The cable slits to be used for motor/ equipment power/ control supply shall be sand filled & covered with PCC after cabling.**

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- 2.3 Cable trays shall have standard width of 150mm, 300mm & 600mm and standard lengths of 2.5m. Minimum thickness of mild steel sheets used for fabrication of cable trays shall be 2mm. Minimum thickness of side coupler plate shall be 3 mm. Cable trays shall be ladder type for power and control cables, while perforated type cable trays shall be used for instrumentation cables. In corrosive areas where corrosive chemicals are likely to be handled, cable trays and supporting structure shall be epoxy painted.

- 2.4 *The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm* and cantilever arms shall be fabricated out of minimum 2.5mm thick rolled steel sheet conforming to IS 1079. Cantilever arms for various cable tray sizes shall be as follows:

S. No.	Cable Tray Width	Cantilever Arm size for overhead trays	Cantilever Arm size for trays in trench
1	150 mm	320 mm	320 mm
2	300 mm	320 mm	320 mm
3	600 mm	620 mm	750 mm

- 2.4 (a) *The cable tray Support system is designed to withstand:*

1. weight of the cable trays.

2. weight of the cables.

3. Concentrated load of 75 Kg between every support span.

4. Factor of safety of minimum 1.5 is considered.

- 2.5 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, tees, crosses, etc.) accessories (like side coupler plates, etc.) and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable trays, fittings and accessories shall be fabricated out of rolled mild steel sheets free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

- 2.6 Suitable cable tray accessories such as horizontal and vertical bends, crosses, tees, reducers etc. shall be used in conjunction with straight runs of cable trays wherever required as per approved layout drawings to ensure a continuous and break-free tray support system for cables.

Cable tray accessories shall be factory fabricated for use at site as per approved drawing titled "TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES", (drawing no. 4540-001-215-PVE-B-045). For specific site requirements (e.g. irregular angle bends such as 30°/60° bends, etc) as per layout conditions, tray accessories shall be fabricated at site from the straight length of respective sizes as required. They shall

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be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

- 2.7 The flexible cable tray support system shall comprise of galvanised MS single channel (C1: having provision of supporting cable trays on one side) or double channel (C2: having provision of supporting cable trays on both sides) members as main supports, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs etc.
- 2.8 The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied. Running lengths of single / double channels shall be cut to required lengths for installation. Any cutting or welding of galvanised surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
- 2.9 Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval max of 2000 mm. vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 2000 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Spacing between cable trays shall normally be kept 300mm for cable laying convenience and effective heat dissipation. For installation of cable tray and support system, brackets/clamps/insert plates using anchor fastener shall be fixed. **Minimum size of anchor fasteners shall be M8 X 50 and material shall be stainless steel grade 316 or better.**
- 2.10 All cable way sections shall have identification, designations as per cable way layout drawings and painted/ stencilled at each end of cable way and where there is branch connection to another cable way. Minimum height of letter shall not be less than 75mm. For long lengths of cable trays, the identification shall be painted at every 10m. Risers shall additionally be painted / stencilled with identification numbers at every floor.
- 2.11 The cable trays and supports system shall be type tested, of approved makes, and conforming to their respective approved drawings. Cable tray support shall be designed for loading as per technical specifications.
- 2.12 Cable trays shall be grounded as per the provisions of the approved grounding document for the project.
- 2.13 Directly buried cables
 - a) Cable trenches shall be constructed for directly buried cables. Construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, supply and installation of brick or concrete protective covers, back filling and compacting, supply and installation of route markers and

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joint markers. Laying of cables and providing protective covering shall be as per IS: 1255 and "INSTALLATION DETAILS OF CABLE TRAYS SUPPORT (drawing no. 4540-001-215-PVE-C-046).

- b) RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint". The marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

c) Directly buried cables, if essential, shall not have concentration of more than 4 cables in one route.

- 2.14 For outside cable trench to inside cable trench connection, pipe sleeves in walls as under will be provided for each cable tray for transiting the cables from one side to the other above the finished floor level

- a) For each 600mm wide tray: 3 nos. 200 diameter PVC pipes.
b) For each 300mm wide tray: 2 nos. 200 diameter PVC pipes.
c) For each 150mm wide tray: 1 no. 200mm diameter PVC pipes.

The trays shall be stopped approximately 200mm short of the wall on both sides and cables passed through the pipe sleeves as above, the pipe sleeves being aligned horizontally with the respective cable trays. This method is adopted for smooth passage of cables and effective sealing of cable openings. All openings shall be sealed with fire sealing compound.

For cable entry to pump house / building, outside cable trays running on walls / structure shall enter by means of wall opening. Alternatively, cable pull pit shall be provided outside and shall connect to cable trench inside by means of pipe sleeves as indicated above. *Pull-pits shall be filled with sand and provided with a PCC covering.* The cable entry and exit from switchgear room/pump houses/building shall be taken from *1.5 mtr.* (minimum) above FFL to avoid water ingress in cable trenches.

FGL

Where cables cross roads/ rail tracks, the cables shall be laid in 'hume pipe' / *Duct banks with High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.*

- 2.15 Local cabling in various auxiliary plants or pump houses from the main tray runs to equipment terminal boxes shall be through notches in floor, which will be filled up with sand and then provided with lean concrete covering matching with the floor after completion of cable laying.
- 2.16 Cable troughs shall be used for branching out few cables from main cable route. These shall be U-shaped, fabricated of mil steel sheets of thickness 2 mm and shall

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be hot dip galvanized. Troughs shall be standard width of 50mm & 75 mm with depth of 25 mm.

3.0 General Philosophy of Cable Installation

- 3.1 Cable runs shall be uniformly spaced, properly supported and protected. All bends in runs shall be as per specification and made with due consideration to avoid sharp bending and kinking of cable. The bending radius of various types of cables shall not be less than those specified by cable manufacturers or that specified in IS: 1255 Table 5.
- 3.2 For the purpose of cable laying, the cables are categorised as under:
- HT: Power cables of 33kV/ 11kV / 3.3kV grade
 - LT: Power cables of 415kV grade, catering to loads at 415V AC/ 230V AC/ 220V DC / 24V DC
 - Control: Control cables of 1.1KV grade generally carrying control signals at 220V DC / 110V AC.
 - Instrumentation: (Also called screened control cables): Screened cables of cross-section 1.5sqmm or lower generally carrying very low voltage very low current signals.

The arrangement of single core & multi core cables shall be as mentioned in drg no-4540-001-299-PVE-U-003 and as per derating factors considered. Further, refer following details as indicated below:-

(1) FOR AIR/RESTRICTED AIR CIRCULATIONS: - (For single core cable:- Maximum 3 nos. trefoils per tray separated by 2 cable dia / For multi core cable:- Maximum 9 nos. cable per tray touching each other.)

(2) For Ground CALCULATIONS:- (For single core cable:- Maximum 3 nos. trefoils in horizontal formation touching / For multi core cable:- Maximum 3 nos. cable touching each other.)

- 3.3 All cables shall be provided with identification tags indicating the cable numbers in accordance with the cable circuit schedule. Cable tags shall be fixed at terminal ends, at tray intersection / bend and at each side of floor/ wall/ duct crossings etc and at every 20m in cable trench/tray or buried run. Cable tray routing points shall be located where they are readily visible and not concealed by equipment, fire proofing or other materials.

Cable tag shall be of 2 mm thick aluminium with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, cable tags can be made of nylon, cable marking ties with cable number heat stamped on the cable tags.

- 3.4 Single core cables for a. c. three phase circuits, when laid on trays, shall be in trefoil formation (each trefoil with RYB phases formation), with distance of four times the diameter of cable between trefoil centrelines. The trefoil formation shall be duly secured to the cable tray by means of trefoil clamps of nonmagnetic material, *clamped at every 1000mm interval*. All multicore cables shall be laid touching formation.

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- 3.5 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables as defined in clause 3.2 above. In horizontal tray stacks, H.T. cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays.

- 3.6 1100 V grade multi-core power cables carrying continuous current when laid on trays shall be placed in single layer, touching and clamped by means of cable ties/clamps.

The cable clamps/ties required to clamp multicore cables shall be of SS-316 material, 12mm wide, polyester coated ladder lock type. The clamps/ties shall have self-locking arrangement & shall have sufficient strength. The cable clamps/ties shall be supplied in finished individual pieces of suitable length to meet the site requirements.

Cables of sizes indicated below, shall be clamped individually.

- a) Single core cables: 500 sq mm or higher (when not laid in trefoil formation- e.g. dc circuits)/ neutral cables)
 - b) Multi-core cables : 95 sq mm or higher
- 3.7 Control and instrumentation cables shall be laid in multi layers, but not exceeding three layers in any section. Special purpose cables (e.g. IPB, WAN etc.) shall be laid as per system manufacturer/ supplier recommendations with due regard to segregation of routes for redundant circuits.
- 3.8 While power, control and instrumentation cables shall generally be laid in separate trays.
- 3.9 Cables shall be placed on trays on the basis of their types and functions as under for horizontal formations:
- a) HT cables: in the top tier(s).
 - b) LT power cables: in the tray(s) below the HT cable trays.
 - c) Control cables: in the tray(s) next below to the LT power cable tray(s).
 - d) Instrumentation cables (screened control cables): in the bottom most perforated tray(s).

HT Power, LT Power and LT Control/Instrumentation cables shall be separated from each other by at least 300mm.

- 3.10 For vertical formations, the outermost tray shall be considered as the topmost tray and the order indicated in clause 3.9 shall be followed. In rare cases, where there is no clear distinction of bottom/ top trays, the order convenient for linking the horizontal and vertical formations avoiding criss-crossing, or exit of cables shall be followed **subject to approval of site engineer.**

Typical examples of tray numbering are given in sheet **8 of 11.** **9 of 12**

- 3.11 Wherever it is not possible to accommodate cables as per the criteria indicated in the clauses 3.9 & 3.10 (due to layout constraints) for very short field runs, control cables

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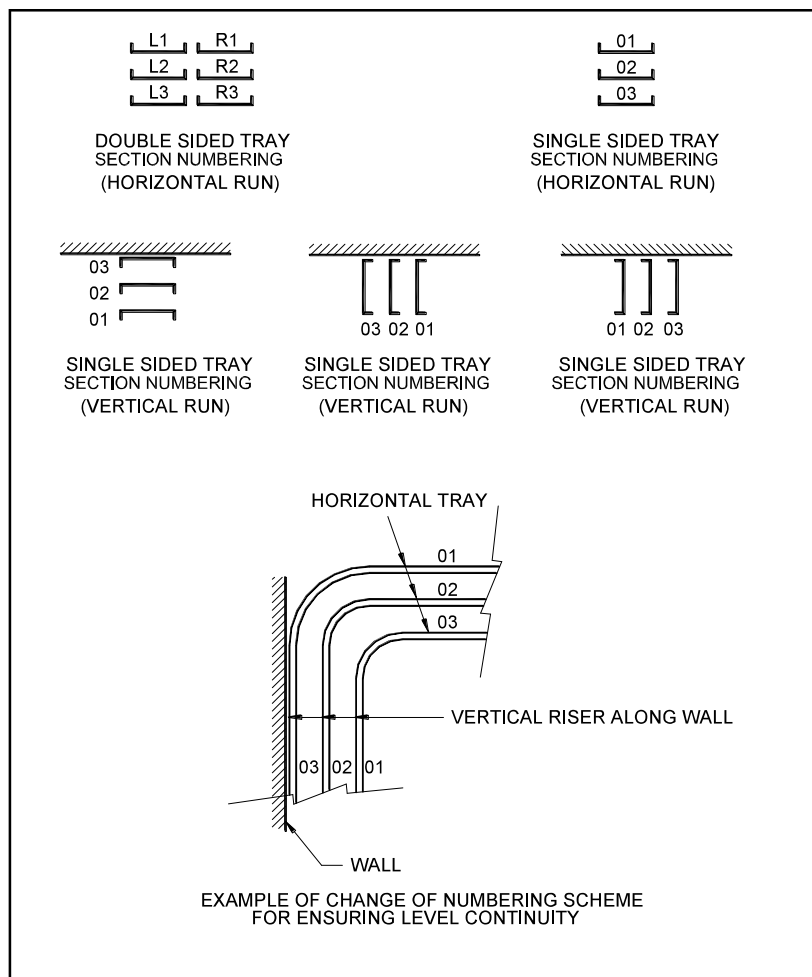


may be laid in the same tray with the instrumentation cables with *clear gap generally of 300mm. However it may be reduced upto min 100mm, case to case basis where space constraint is there.* separator may be provided between the two types of cables, *subject to approval of site engineer.*

- 3.12 All cables associated with the unit shall be segregated from cables of other units. Interplant cables of station auxiliaries shall be laid in such a way that not more than half of the drives are lost in case of single incident of fire. Power and Control cables for ac drives and corresponding ac or dc drives shall be laid in segregated routes. Cable route for one set of auxiliaries of same unit shall be segregated from the other set. Segregation means physical isolation to prevent fire jumping or minimum one hour fire rating. Cables of unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. In switchyard, control cables of each bay shall be laid on separate racks / trays.
- 3.13 To facilitate pulling of cables in GI conduits, powdered soft stone, plastic soap or other dry inert lubricant may be used where required. However, any material harmful to the cable sheaths shall not be used. *GI pull wire of adequate size shall be laid in all conduits before installation.*
- 3.14 No single core cable shall pass through a GI conduit/ pipe or duct singly except DC single core cables. AC single core cables shall pass through GI conduit/ pipe in trefoil formation only, or through PVC pipes. Conduit/pipe occupancy shall not exceed 40% of the conduit/pipe cross-section area. Pipes / conduits if used in corrosive areas shall have anti-corrosive coating both inside & outside. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof. Different voltage grade shall be laid in separate conduits.
- 3.15 Wherever specific cable routes are not shown in cable schedules, cables may be laid through the shortest route as per the above criteria, as directed by site Engineer.

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- 3.16 Power and control cables shall be secured fixed to trays/support with self-locking type clamps/ties. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.
- 3.17 For Cable unloading, pulling etc following guidelines shall be followed in general:
- Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and

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not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

- b) While laying cable, ground rollers shall be used at every 2 meter interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables. If any particular cable is damaged, the same shall be repaired or changed to the satisfaction of Project Manager.
- 3.18 Cables shall be laid on cable trays strictly in line with cable schedule.
- 3.19 For road/rail crossings, buried RCC hume pipes (at a depth of minimum 1000mm) shall be used. Alternatively, *duct banks of high density PE pipes encased in PCC as per specification requirement can be used.*
- 3.20 If required the necessary modification in cable tray layout shall be made at site to suite condition i.e. to avoid fouling of cable trays with beam, columns, steel structure, pipes etc. with prior *approval of Project Manager* i.e. to avoid fouling of cable trays with beam, columns, steel structure, pipes etc. with prior required in cable trays installation a pre-fabricated type of accessories in line with technical specification requirement shall be used.
- 3.21 Recommended tightening torque shall be used for dowels and bolts.
- 3.22 Where there is a considerable risk of steam, hot oil or mechanical damage cable routes shall be protected by barriers or enclosures.
- 3.23 *Fire retardant paint shall applied after installation on cables in topmost tray of Horizontal formation in fire prone areas, like Boiler, TG, fuel oil area and any other strategic location etc.*
- 4.0 **Cable Termination & Jointing**
- 4.1 Termination and jointing of cables shall conform to the requirements of IS: 1255 and shall be carried out as per the recommendations of termination and jointing kit supplier. Cable terminations at various electrical and electronic equipment terminals shall be done as per approved scheme/ interconnection diagrams. *In each cable run some extra length shall be kept at suitable point to enable one LT/two HT straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.*
- 4.2 Termination and jointing of HT cables shall be done with pre – moulded type, taped type & heat shrinkable type termination/ jointing kits of proven design & type tested as per IS: 13573(for above 3.3kV) and IS: 13573 /VDE0278 (for 3.3kV). The kit shall be complete with tinned copper solderless crimping type cable lugs & ferrule as per DIN standard.

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- 4.3 When the equipment are supplied with undrilled gland plates for cable/ conduit entry into the equipment, all drilling & cutting on the gland plate and any minor modification work required to complete the job shall be carried out at site as per cable glanding requirement. A plan showing the holes for cable entry in the gland plate shall be developed at site in consultation with site engineer for drilling holes (gas cutting is not allowed). Types of glands to be used are as under.

- i. Material: Nickel-Chromium plated brass, heavy duty conforming to BS:6121
- ii. II. Type: Double compression

All cable entry points shall be sealed & made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

- 4.4 Termination of cables shall be done as per termination drawings & interconnection diagrams furnished. Shorting & looping of cores/ wires at terminals and between the panels if required shall be carried out as per approved scheme.
- 4.5 All cable entries in the equipment shall be sealed by cable glands supplied with the equipment. Any discrepancy in cable glands/ lugs with respect to cable size shall be brought to the notice of site engineer.
- 4.6 Adequate length of cables shall be pulled inside the switchboards, control panels, terminal boxes etc. so as to permit neat termination/ dressing of each core/ conductor.
- 4.7 Power cable terminations shall be carried out in specified manner to avoid strain on the terminals.
- 4.8 Control cable cores entering switchboard or control panels shall be neatly bunched and strapped with cable clamps & ties and suitably supported to keep them in position at the terminal block. All spare cores shall be neatly dressed and suitably grounded / insulated with blank ferrules.
- 4.9 Screened control cables of small cross-sectional area, (0.5 sq mm) shall be terminated by means of cage clamp termination system.
- 4.10 Individual cores of control cables shall have ferrules for identification. Ferrule numbers shall be provided as per the control schemes and other related documents.
- 4.11 *Cable lugs/ferrules shall be solderless crimping type suitable for power and control cables as per the DIN 46239. Aluminium solderless crimping lugs/ ferrules shall be used for Aluminium cables and Copper lugs/ferrules shall be used for Copper cables. Bimetallic washers or bimetallic type lugs shall be used for bimetallic connections.*
- 4.12 Cable joint(s) shall normally be made at an appropriate point (s) in the straight run of cables only when the length of the run is more than the standard drum length supplied by the cable manufacturer, or when a joint is necessitated due to site constraints. In such cases, when jointing is unavoidable, the same shall be made by means of specified cable-jointing kit. Prior approval of Engineer shall be taken for deciding location of joint. *However, no joints shall be allowed in trip circuits,*

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protection circuits and CT/PT circuits. Also joints in critical equipment in main plant area shall not be permitted. Further, to avoid joints, the cable drum length shall be governed by clause no 4.00.04.02, SUB-SECTION-B-08 HT LT AND CONTROL CABLES, Section-VI, Part-B.

- 4.13 Junction boxes may be used, wherever required, for jointing/ marshalling of control and instrumentation cables.

5.0 Trefoil Clamp

The cable trefoil clamps shall be used for clamping of MV & LV single core cables to be routed in trefoil formation using trefoil clamps Trefoil clamps for single core cables shall be pressure die cast aluminium or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc.

6.0 Grounding of Cabling System

6.1 Armour grounding:

- Armour of the HT cables and LT single core cables shall be grounded only at one end of cable preferably the source end.
- Armour of other cables shall be grounded at both ends of cable.

6.2 Screen Grounding:

- Screen of multi-core cables shall be grounded at both ends.
- Screen of single-core power cables shall be grounded at one end.
- Screen of electronic grounding system cables shall be grounded as per the Control System panel manufacturer recommendation.