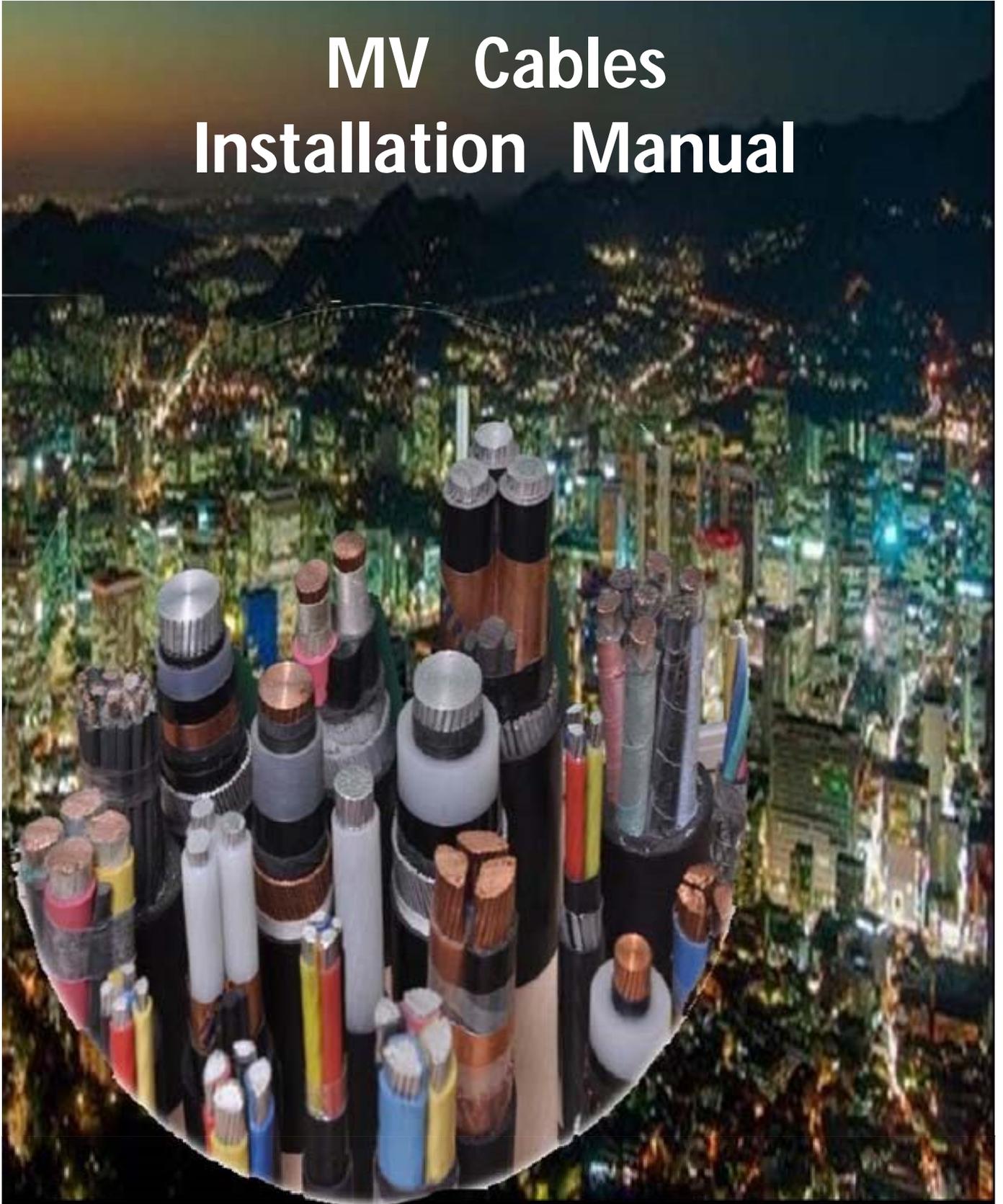




Universal Cables Limited, Satna (MP)
Contracts Division.

MV Cable Installation Manual

MV Cables Installation Manual



MV Cable Installation Manual

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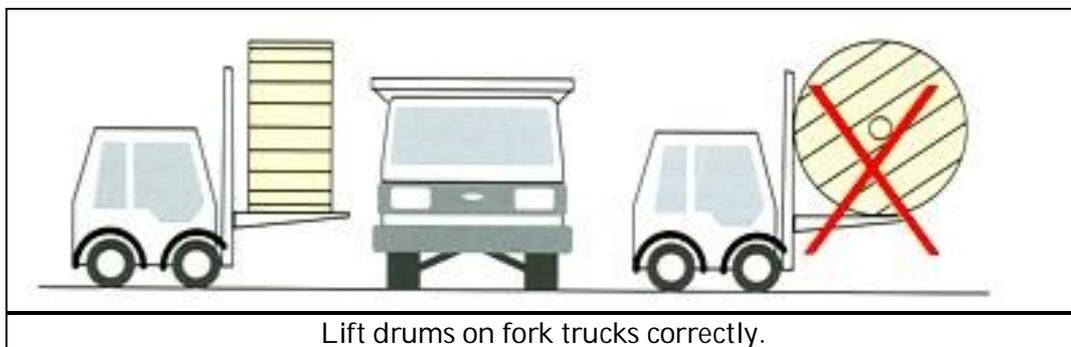
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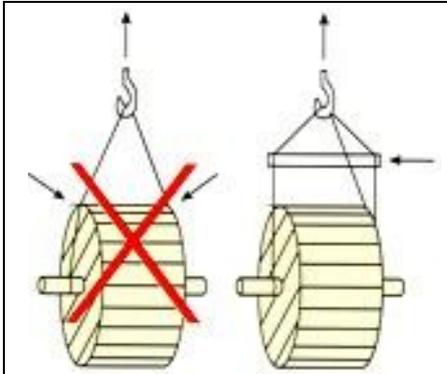
Transport, Storage & Handling of cable drum:

Even if cable and drum look very strong, there are certain rules to follow to avoid damage of the cable and an accompanying impairment of mechanical and electrical characteristics.

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- ④ For outdoor storage the ground must be even and clean. Stones or bumps in the ground should be removed or smoothed out. Damage to the wound goods/cable should be avoided at all costs.
- ④ Cables should be secured against accidental rolling away. Under no circumstances should the drum flange of neighboring cables touch any wound goods
- ④ Cable drums should always be stored and transported standing on both flanges. They should not be pushed along the ground standing on the flanges. It is possible that the strength of the cable drum would then no longer be guaranteed.
- ④ Observe the rolling direction. The arrow printed on the drum flange indicates the rolling direction so that the wound cables do not become loose.
- ④ Always uncoil the cable at a tangent, never over the flange, since the torsion thus resulting would damage the cable and laying would not be possible
- ④ Cable ends should be sealed pressure-tight and impermeable.
- ④ Unloading the drum should be by forklift or crane, rolling should be avoided.
- ④ If the above equipment are not available, rolling as per direction on special constructed ramps is allowed with a slope of 1/4 ($\alpha = 14$ degrees)
- ④ Drum should not be dropped on the ground under any circumstances even on soft material.
Drums should be kept in the up-right position.
Drums should be covered all the time.

④
④

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Lifting cable drums using crane.



Do not lay drums flat on their sides, use proper stops to prevent drums rolling.

Route finalization:

Before the cable laying work is undertaken, the route of the cable shall be decided by the Engineer-in-Charge considering the following.

1. While the shortest practicable route should be preferred, the cable route shall generally follow fixed developments such as roads, foot paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run merely to shorten the route length shall not be adopted.
2. Cable route shall be planned away from drains and near the property, especially in the case of LV/MV Cables, subject to any special local requirements that may have to be necessarily complied with.
3. As far as possible, the alignment of the cable route shall be decided after taking into consideration the present and likely future requirements of other services including cables enroute, possibility of widening of roads/lanes etc.
4. Corrosive soils, ground surrounding sewage effluent etc. shall be avoided for the routes.
5. Route of cables of different voltages.
6. Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid farther from the kerb line than HV cables.
7. Cables of different voltages, and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted such that this requirement cannot be met, LV/MV cables shall be laid above HV cables.
8. Where cables cross one another, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.
9. Way leave for the cable route shall be obtained as necessary, from the appropriate authorities, such as, Municipal authorities, Department of telecommunication, Gas Works, Railways, Civil Aviation authorities, Owners of properties etc. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

Pre-Installation Check List:**Code Review**

1. Review all applicable local, state, provincial, and national codes relating to cable installation.
2. Consult local inspection authority



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☞ Cable Inspection

1. Check for shipping damage before accepting shipment.
2. Record any damage on the way bill.
3. Confirm that the cable specified was received.
4. Verify that the cable end seals are intact.

☞ Cable Handling

1. Remove nails and staples from reel flanges.
2. Calculate and comply with recommended bending radii.
3. Use swivels, and avoid overruns when unreeling by utilizing a reel brake or back tension.

☞ Cable Storage

1. Provide firm support for reels.
2. Protect cable from mechanical damage and from liquid spills.
3. Check cable end seals periodically.
4. Advise all jointers, installers and handlers of all special instructions.

Methods of laying:

The cables shall be laid direct in ground, pipe, closed or open ducts, cable trays or on surface of wall etc. The method(s) of laying required shall be specified by customer schedule of work.

☞ Laying direct in ground:

This method shall be adopted where the cable route is through open ground, along roads/lanes, etc. and where no frequent excavations are likely to be encountered and where re-excavation is easily possible without affecting other services.

☞ Trenching

1. The width of the trench shall first be determined on the following basis. The minimum width of the trench for laying a single cable shall be 600mm.
2. Where more than one cable is to be laid in the same trench in horizontal formation, the width of the trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified by customer.
3. There shall be a clearance of at least 15cm between axis of the end cables and the sides of the trench.

☞ Depth of trench

1. The depth of the trench shall be determined on the following basis. The desired minimum depth of laying from ground surface to the top of cable is 1.05m for 33KV Cables.
2. Minimum clearance required for Power Cable to control cable is 200mm and 300 mm for communication and gas pipe lines.

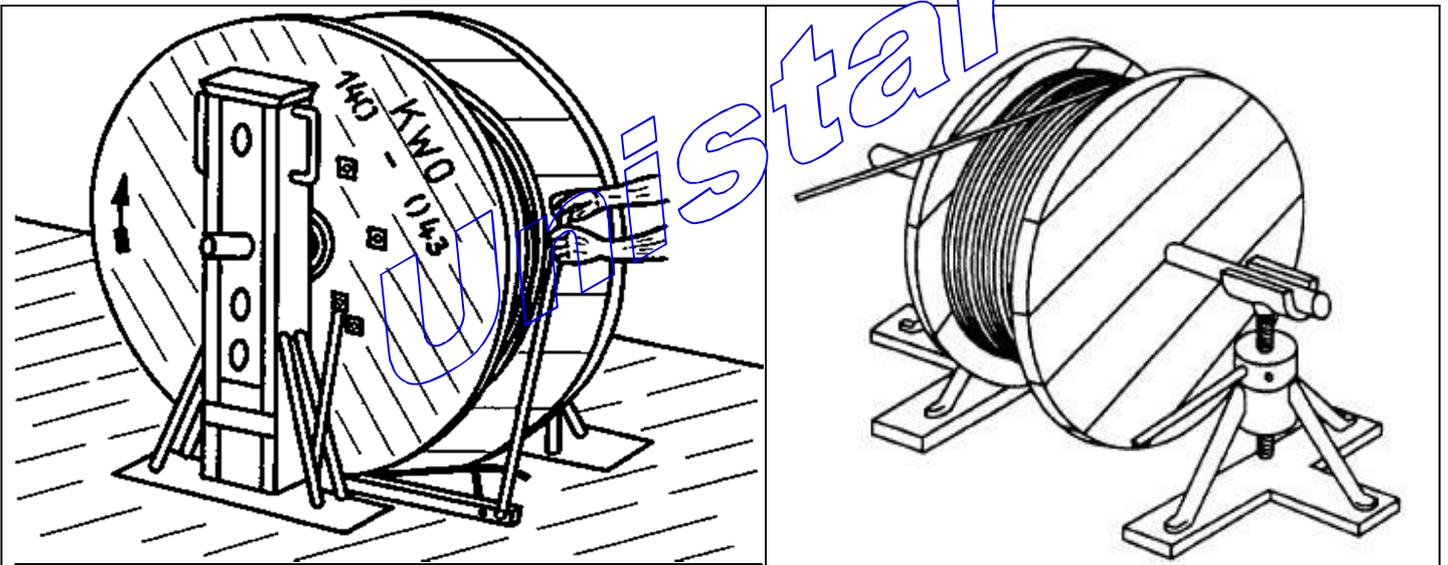
☞ Excavation of trenches

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1. The trenches shall be excavated in reasonably straight lines. Wherever there is a change in the direction, a suitable curvature shall be adopted complying with the requirements.
2. Where gradients and changes in depth are unavoidable, these shall be gradual.
3. The bottom of the trench shall be level and free from stones, brick bats etc.
4. Excavation should be done by suitable means-manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.
5. Precautions should be taken not to damage any existing cable(s), pipes or any other such installations in the route during excavation. Wherever tricked, tiles or protective covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Engineer-in-Charge.
6. Existing property, if any, exposed during trenching shall be temporarily supported adequately as directed by the Engineer-in-Charge. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled.
7. If there is any danger of a trench collapsing or endangering adjacent structures, the sides may be left in place when back filling the trench.
8. Excavation through lawns shall be done in consultation with the Department concerned.

⌚ Sand Bedding

1. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 75mm in depth, before laying the cables therein.
2. The sand bed shall cover full width of the Trench.

⌚ Laying of cable in trench**⌚ Setting up Drum Prior to Pulling:**

1. Drum flange bolts should be inspected and tightened as they may get loosened during drum transportation and frequent handling.

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2. Drums should be normally mounted so that the cable is pulled from the top of the drum and for very heavy cables it may be necessary to use a ramp to support the cable during passage into the trench.
3. The cable drum shall be properly mounted on jacks at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure, and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.
4. Always observe the correct direction of roll indicated by the "roll this way" arrow on the drum flange. Position the drum so that the pull from the drum to the trench is as straight as possible, in any case, the lead in angle of the cable to the trench shall not be greater than 30°.
5. A lead in roller shall always be used to guide the cable into the trench.
6. When pulling a cable into a duct the drum shall be positioned above the duct so that the cable leaves the drum and enters the duct in a smooth curve.
7. The drum shall be rotated by hand during the installation to ensure that the cable does not become tight between the drum and the duct mouth.
8. Check that the jacks and spindle are adequate for the size and weight of the cable drum, the gross weight of the cable drum will be marked on one flange.

⌚ Removing battens & lagging

1. Battens or other drum protection (wooden planks) should be removed carefully to ensure that any nails or tools do not damage the cable.
2. Care should be taken when removing any metal strapping used to secure lagging, this strapping may be under considerable tension and can spring with some force when cut.
3. Ensure that no nails are left protruding from the drum flanges as these may result in injury when moving or handling the drum.
4. Ensure correct Disposal of any excess materials.

⌚ Checking cable details and sealing cap integrity

The end of the cable should be freed and inspected to ensure that:

1. The cable is of the correct size and type.
2. The cable sealing cap is intact and undamaged.
3. On a new drum the length marking on the outer sheath agrees with the details marked on the Cable drum

⌚ Cable Pulling

1. It is recommended to dig a trial hole in the cable route which shall indicate the position of other services and a smooth bend can be provided to reduce the pulling load on the cable.
2. Cable should be inspected before laying to ensure that it is damage free.
3. The cables should always be pulled off the top of the drum.
4. The cable should preferably be drawn to its final position in a continuous manner. During stops, it will settle between rollers and may cause high strain on machines during re-starting.
5. Rollers shall be placed in the trench to prevent the cable from dragging on the trench bottom or in mud. The roller spacing required to achieve this will depend on the cable type being installed and the pulling tension along the route.



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6. The rollers along the route should be checked and adjusted to line up with the taut bond and a final check should be made to ensure that other services which may be rubbed or abraded by the cable during installation are suitably protected.
7. The cable shall be pulled over on rollers in the trench steadily and uniformly without jerks and strain. The entire cable length shall as far as possible be laid off in one stretch.
8. When pulling cables beside existing cables, special care should be taken to avoid damage to the existing cables.
9. Precautions should be taken such as clearing all excavated material from the trench edges, using vertical timbers etc., so that no stones or sharp objects shall fall onto the cable.
10. Minimum permissible bending radius shall be as per Table -I and Table -2.
11. Maximum pulling tension should be as per Table -3.
12. Side wall pressure at the bend should not be exceeded.
13. Remember always that cables is a high commodity value and it is very sensitive to damage and must be handled with necessary care.
14. Possibility of braking the drum anytime should be prepared as in sudden stoppage of cable pulling. Continuation of drum rotation can cause sharp bending of the cable.
15. During pulling the inner end of the cable might be projected more and more, then it is necessary to interrupt the cable pulling from time to time in such cases for re-securing the said end.
16. After the cable has been so uncoiled, it shall be lifted slightly over the rollers beginning from one and by helpers standing about 10m apart and drawn straight. The cable shall then be lifted off the rollers and laid in a reasonably straight line.
17. When pulling the cable inside conduit/pipe the inner diameter of the pipe shall be min. 1.5 times the cable diameter.
18. When pulling a cable into a duct the drum shall be positioned above the duct so that the cable leaves the drum and enters the duct in a smooth curve. The drum shall be rotated by hand during the installation to ensure that the cable does not become tight between the drum and the duct mouth.
19. It is preferable to use pipe with funnel shape, cable should not rest at the sharp edges of the pipe, special care should be taken such that stones and other objects are not dragged with the cable inside the pipe.
20. Pipe should be cleaned before pulling operation.
21. Special lubricant can be used to minimize the cable friction with the pipe wall.
22. When cables of different voltages are laid together it is preferable that the higher voltage to be laid down, then the lower voltage and then lower voltage. High voltage cables should be separated by a covering slab from the other cables.
23. For direct buried installations, rollers at a distance of around 1-2 meters are to be used based on cable weight, in any case cable should not touch the ground, It is recommended to use motorized rollers at the distance of 20 M to 30 M with proper monitoring. These are beside the normal cable rollers specially near bending points so that the cable pulling force shall be distributed evenly over the complete length of the cable. This kind of pulling is recommended when there are many bends in the cable route.
24. For cable pulling, cable stocking can be used for Steel Wire armoured cables while for non-armoured cables and Steel Tape armoured cables pulling head is preferred. Special care shall be taken to seal the cable head avoiding water penetration during pulling.
25. It is not advisable to use cable pulling stocking when the ambient temperature is around 45°C or more and under direct sunlight as the outer jacket might soften and get damaged.
26. It is recommended to use pulling head when the cable is pulled inside pipes or conduits as slipping of stocking might occur inside the pipe or conduit.
27. While pulling, continuous monitoring of the tensile force should be maintained.
28. At the bend, cable shall be guided by rollers. Direct touch with trench wall shall be completely avoided.

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29. Immediately after cutting, the cable ends must be suitably sealed so that there is no ingress of moisture.
30. It is recommended to inspect the cable after laying to ensure that the cable has not been damaged.
31. Cable after laying should not be straightened but left with slight meandering to allow longitudinal expansion and contraction during thermal cycling.
32. When the ground water table is high it is advisable to use special cable construction with longitudinal and radial watertight characteristics.

☞ For Single Core Cables:

1. Single core cables should not be installed individually in protective steel ducts; instead all three should be laid together in one single duct.
2. When the cables are laid in flat formation, spacing between three cables should not be less than cable diameter and each should be secured by Non-Magnetic, Non-Corrosive Clamps.

☞ Laying Completion:

1. When installation is complete, all cut cable ends must be sealed by capping in accordance with approved procedures. All unused cable must be capped before returning to stores.
2. The loose end of the cable remaining on the drum shall be rewound tightly onto the drum by means of a length of rope tied around the cable end and secured to the drum.
3. After securing the cable end, lower the drum jacks keeping the drum level. Remove, clean and store the spindle and drum jacks.

☞ Cable Sealing:

1. All cut ends of cables, including cable left on the drum, shall be sealed immediately and not left exposed to the atmosphere. This applies whether the cables are cut at stores, in the yard or on site.
2. All end caps, including factory fitted end caps, shall be examined after laying and any cap found to be damaged shall be removed and the cable resealed immediately.

☞ Sand covering

1. Cables laid in trenches shall have a covering of dry sand of not less than 200cm above the base cushion of sand before the protective cover is laid.

☞ Extra loop cable

1. At the time of original installation, approximately 3m of surplus cable shall be left on each termination end of the cable and on each side of the underground joints. The surplus cable shall be left in the form of a loop.
2. Where there are long runs of cables such loose cable may be left at suitable intervals as specified by the Engineer-in-Charge.

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☞ Mechanical protection over the covering

1. Mechanical protection to cables shall be laid over the covering in accordance with (2) and (3) below to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.
2. Unless otherwise specified, the cables shall be protected by second class brick of nominal size 22cmX11.4cmX7 cm or locally available size, placed on top of the sand (or, soil as the case may be). The bricks shall be placed breadth-wise for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5cm over the sides of the end cables.
3. Where bricks are not easily available, or are comparatively costly, there is no objection to use locally available material such as tiles or slates or stone/cement concrete slabs. Where such an alternative is acceptable, the same shall be approved by Engineer-In-Charge.
4. Protective covering as per (b) and (c) above need not be provided only for MV cables, in exceptional cases where there is normally no possibility of subsequent excavation. Such cases shall be particularly specified in the Tender specifications.
5. The protective covering as per (b) and (c) above shall, however invariably be provided in the case of HV cables.

☞ Back Filling

1. The trenches shall be then back-filled with excavated earth, free from stones or other sharp ended debris and shall be rammed and watered.
2. The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required.
3. After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and –re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer-in-Charge.
4. Where road beams or lawns have been cut out of necessity or kerb stones displaced, the same shall be repaired and made good, except for turfing /asphalting, to the satisfaction of the Engineer-in-Charge and all the surplus earth or rock shall be removed to places as specified.

☞ Laying in Pipes:

1. In locations such as road crossing, entry in to buildings, paved areas etc. cables shall be laid in pipes or closed ducts. Metallic pipe shall be used as protection pipe for cables fixed on poles of overhead lines. 2. The size of the pipe shall not be less than 1.5 times diameter of a single cable
3. Pipes shall be continuous and clear of debris or concrete before cables are drawn. Sharp edges if any, at ends shall be smoothed to prevent damage to cable sheathing.
4. These pipes shall be laid directly in ground without any special bed which shall be laid over 75 mm thick Plain cement concrete 1:3:6 bed. No sand cushioning or tiles need be used in such situations.

☞ Laying on Cable Tray:

1. This method may be adopted in places like indoor substations, air-conditioning plant rooms, generator rooms etc. or where long horizontal runs of cables are required within the building and where it is not convenient to carry the cable in open ducts. This method is preferred where heavy sized cables or a

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number of cables are required to be laid. The cable trays may be either of perforated sheet type or of ladder type. 2. Cables laid on cable trays shall be clamped on to the tray at suitable intervals.

☞ Route Marker:

1. Route markers shall be provided along the runs of cables at locations approved by the Engineer-in-Charge and generally at intervals not exceeding 100m. Markers shall also be provided to identify change in the direction of the cable route and at locations of underground joints.

☞ Cable identification tag:

1. Whenever more than one cable is laid/run side by side, marker tags as approved, inscribed with cable identification details shall be permanently attached to all the cables in the manholes/pull pits/joint pits/entry points in buildings/open ducts etc. These shall also be attached to cables laid direct in ground at specified intervals, before the trenches are backfilled.

☞ Jointing:

1. Before laying a cable, proper locations for the proposed cable joints, if any, shall be decided, so that when the cable is actually laid, the joints are made in the most suitable places. As far as possible, water logged locations, carriage ways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks etc. shall be avoided for locating the cable joints.
2. Joint pits shall be of sufficient dimensions as to allow easy and comfortable working. The sides of the pit shall be well protected from loose earth falling into it. It shall also be covered by a tarpaulin to prevent dust and other foreign matter being blown on the exposed joints and jointing materials.
3. Sufficient ventilation shall be provided during jointing operation in order to disperse fumes given out by fluxing.

Testing & Commissioning:

1. All new Cables should be tested for Insulation resistance test before jointing.
2. After completion of jointing work, Insulation Resistance test, Conductor Resistance Test, Capacitance Test, DC High Voltage test should be done.

ANNEXURE:**Consideration for cable Current Rating:**

When laying cables special attention should be given to:

1. Cable spacing.
2. Any other cable passing by, in parallel or crossing as this might affect considerably the cable rating.
3. Any other heat source which might be near the cable as this shall have the same effect as point no. 2.
4. Drying effect of soil on the value of soil thermal resistivity and side effects on current rating.



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5. Avoid connecting the armour and sheath at both ends for single core cables as this shall reduce the current rating of the cables considerably but special attention should be given to induced voltage in both normal operation and short circuit.
6. The deeper the cables are laid lower is the ampacity of cables.
7. If cables are passing through pipes for more than 6 meters then the pipe de-rating factor should be considered.
8. Avoid pulling single core cable inside steel pipe or any other magnetic material as this shall cause high losses and cable overheating.
9. Soil thermal resistivity of the actual ground at different places of the trench shall be measured to ensure that the value is matching the one used for current rating computation. **TABLE I - Installation Bending Radius for Low Voltage Cables**

Type of Cable	Multiplying Factor	
	Installation bending radius	
	During Installation	Fixed Installation
Single core (Un-armoured, Armoured) Multi-core (Un-armoured and Steel Wire Armoured)	12	8
Multi-core (Steel Tape Armoured)	15	8

TABLE II - Installation Bending Radius for Medium Voltage Cables

Cable outermost sheath or covering	Factor to be multiplied by Overall diameter of cable	
	During Installation	Fixed Installation
PVC	15	10
HDPE	20	15
Lead Sheathed (Un-Armoured)	18	12
Lead Sheathed Armoured	15	10

TABLE III - Installation Bending Radius for High Voltage Cables

Factor to be multiplied by Overall diameter of cable	
During Installation	Fixed Installation
20	20



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TABLE IV - Permissible pulling force in the laying of LV, MV and HV cables

Means of pulling	Type of Cable	Formula	Factor
With pulling head attached to the conductors	All types of cables	$P = s \cdot A$	$s = 50 \text{ N/mm}^2$ Copper Conductor $s = 30 \text{ N/mm}^2$ Alum. Conductor
With pulling stocking	Un-armoured Cables*	$P = s \cdot A$	$s = 50 \text{ N/mm}^2$ Copper Conductor $s = 30 \text{ N/mm}^2$ Alum. Conductor
	Armoured Cables	$P = k \cdot d^2$	$k = 9 \text{ N/mm}^2$
	Lead Sheath Cables	$P = k \cdot d^2$	$k = 3 \text{ N/mm}^2$

When pulling 3 single core cables simultaneously with a common pulling stocking. the same maximum pulling force applies, whereas the pulling force 3 laid-up single core cables is 3 times that of a single core and for 3 non-laid-up single core cables is 2 times that of a single core.

** Not applicable for high voltage cables

P = Pull in N

A = Total cross sectional area in mm^2 of all conductors (but not screen or concentric conductor) d

= Outside diameter of the cable in mm

s = Permissible tensile stress of conductor in N/mm^2 k

= Empirically derived factor in N/mm^2

TABLE V - Permissible Radial Load Values



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Permissible radial loads for pulling through plastic pipes

Non-Armoured Cables	10000 N/m
Cables with Single Armour	15000 N/m

Maximum permissible loads on rollers fitted on bends

Non-Armoured Cables	1500 N/m
Cables with Single Armour	2500 N/m

When using roller chain (5 rollers/m)

Non-Armoured Cables	7500 N/m
Cables with Single Armour	12500 N/m

When only 3 rollers/m are fitted

Non-Armoured Cables	4500 N/m
Cables with Single Armour	7500 N/m

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