

	General installation instructions for MV power cables Cables with rated voltages of 3.6/6 kV, 6/6 kV, 6/10 kV, 12/20 kV and 18/30 kV, with XLPE or PVC insulation and a PE or PVC sheath	No.: 11.IN281
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- When selecting the type of cable, factors such as the cable route, method of installation and operating conditions must be taken into account.
- Cables should be installed exclusively by authorised and experienced specialists. The process of unwinding and laying cables must be carried out in a manner that does not adversely affect their properties. Particular attention should be paid to the following aspects:

a) Factors affecting the operating conditions of the cables:

- the number of cables and their arrangement (e.g. triangular or flat layout),
- ambient temperature and temperature differences,
- cable density,
- interaction between cables,
- mechanical stresses, such as compression, tension, shear or vibration,
- protection of cables against UV radiation,
- thermal properties of the ground (e.g. thermal resistance) and others.

b) Leakage or stray currents, which may lead to corrosion of materials,

c) Ground movements, vibrations and shocks,

d) Methods of unwinding and pulling cables, which must be adapted to the type of cable sheathing to prevent mechanical damage, whilst taking into account its load-bearing capacity,

e) Protection of cables against the harmful effects of chemicals in the environment.

3. Cables without metal armour must be adequately protected against mechanical damage once they have been installed.

4. Installation in a conduit or duct:

The internal diameter of pipes or cable ducts should be at least 1.5 times the diameter of the cable.

Single-core cables in three-phase networks, laid in steel pipes or on steel structures, should be routed through the same pipe or structure. To protect the pipes from mechanical shocks, it is recommended to use a bed of sand.

The minimum bending radius of the cables must be taken into account during installation.

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In the case of electrical systems with multiple cables per phase, it is essential to ensure an even distribution of current amongst the cables of the same phase to prevent individual cables from becoming overloaded.

5. Fire protection:

During installation, the relevant fire safety regulations must be observed. Cables should be laid in such a way as to limit the spread of fire and minimise its effects. The type of fire protection used must be adapted to the specific characteristics of the protection system in the installation. Cables made from halogen-containing materials, such as PVC, may emit toxic smoke and harmful fumes if exposed to fire.

6. Minimum installation temperature for cables:

Cables with PVC insulation and sheathing may be laid and installed at a temperature of at least 0°C, both for the cable itself and the surrounding environment. If the cable temperature is below this value, it must be warmed to the required minimum (e.g. by storing the cables in a heated room). Warming may take between one and two days.

7. Cable pulling force:

Suitable equipment must be used to pull cables into ducts or trenches, ensuring that the force is distributed evenly across the cable conductors. The maximum pulling force depends on the equipment used and the cable construction, and this value should be monitored throughout the entire process.

- When using **a pulling head**, where the force acts directly on the cable conductors, the maximum force is calculated using the formula:

$P = n \times S \times \sigma$ [N], gdzie:

n – number of conductors,

S – cross-sectional area of the conductors [mm²],

σ – permissible stress of 50 N/mm² for copper and 30 N/mm² for aluminium.

- If the force is transmitted via *a frictional connection between the grip and the cable conductor* (e.g. in the case of thermoplastic cables without a metallic sheath), the same maximum values may be applied as for the pulling head.

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- When the pulling force of the grip acts on the cable sheath (e.g. when using a cable stocking), the maximum force is calculated using the formula:

$$P = 3 \times D^2 \text{ [N]},$$

where: D – cable diameter [mm].

- For 3 **cables twisted together**, the total pulling force should not exceed three times the maximum value for a single cable. In the case of three cables laid in parallel, the total force must not exceed twice the permissible value for a single cable. Particular care must be taken at sharp bends in the route.

The maximum pulling forces must not be exceeded, and the force should be applied using a swivel clamp that prevents the cable from twisting about its own axis.

8. Long cable runs:

For long cable runs with heavy copper cables, the pulling forces must be calculated separately for each section. The installation plan should be drawn up in detail, taking into account the location of the cable drum, winches or pushers, as well as the number and type of guide rollers required.

9. Laying cables in the ground:

When laying cables directly in the ground, guide rollers should be positioned every 3–4 metres, as well as at bends in the route.

10. Types of cable installation:

Cables may be laid in the ground, pulled through pipes or ducts, or installed on walls and ceilings using cable racks or cable trays.

11. Preparing the cable route:

The cable route should be adapted to the chosen installation method, with an appropriate number of cable reels. Attention must be paid to the minimum cable bending radii. The pulling force should be constantly monitored and must not exceed the permissible values. The walls of the cable trench must be compact and smooth to prevent damage to the cable from stones or gravel.

12. Cable bending radius:

The minimum bending radii depend on the type of cable:

- 15 times the cable diameter – for armoured single-core or three-core cables,
- 12 times the cable diameter – for 3-core cables.

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13. Reduction of the bending radius:

The bending radius may be halved provided that all of the following conditions are met simultaneously:

- a) the bending is a one-off operation,
- b) the work is carried out by experienced staff,
- c) the cable has a temperature of at least 30°C or has been heated to this temperature,
- d) templates or shaped rollers are used for bending.

14. Change of cable direction:

When changing the direction of cable laying, the cable reels should ensure a radius greater than the minimum bending radius.

15. Protection at duct inlets:

At duct inlets where there are sharp bends, special support rollers or bell-shaped duct ends must be used to prevent damage to the cable's outer sheath. The edges of the ducts must be protected so that they do not cause scratches, tears or deformation of the cable sheath.

16. Protection against moisture:

Care must be taken during installation not to damage the cable sheaths. The protective caps at the cable ends should only be removed immediately before connection or fitting of the connector. Once removed, the cable ends must not be exposed to moisture.

17. Cable fixing:

Single-core cables may be installed individually or in bundles, which may be treated as a multi-core cable.

When installing single-core cables individually, it is recommended to use fasteners made of plastic or non-magnetic materials. Steel clamps may only be used in situations where they do not form a closed magnetic circuit around the cable.

Clamps should be secured with sufficient force to avoid damaging the cables, whilst taking their thermal expansion into account.

Maximum horizontal distance between clamps:

20 times the diameter of the cable or cable bundle, but not more than 80 cm. The same distance should be maintained between support points in cable trays.

Maximum vertical distance between clamps: 1.5 m.

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18. Post-installation testing of cables:

Once the cables have been laid in routes and cable trays, and before backfilling the trenches, the following tests must be carried out:

- checking the continuity of the conductors,
- measurement of insulation resistance,
- voltage test.

19. Environment:

- > The incineration of waste cables must comply with applicable national regulations.
- > Cables may be damaged by contact with corrosive substances or solvents, including petroleum vapours.
- > Standard cable sheaths do not protect against damage caused by rodents, termites and other pests.
- > Live cables may have high surface temperatures and should therefore be protected against accidental contact where necessary.

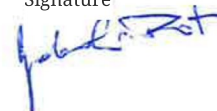
Detailed guidelines on cable installation can be found in the standard: SEP No. N SEP-E 004:2022-08.

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