Electrical engineering in general: Design and construction. Cable ducting and cable ducts

1 Purpose and scope

The document gives requirements for installation of outdoor cables and cable ducts along railway tracks. Moreover there are requirements to co-location of cables of different cables for different applications (functions).

Outdoor cable plant constitutes all physical cabling between technical installations along the railway track, included building entrance facilities in rooms for eletrotechnical facilities.

2 General requirements

This clause contains specific requirements for different facilities to cable installation along or crossing railway tracks.

Whenever installing cables along the railway tracks the owner of the railway infrastructure shall be addressed in advance. Prior to any digging a written application shall be provided and approval shall be obtained. The owner of the railway infrastructure shall evaluate the actual plans and will decide whether a geo-technical evaluation of the proposed cable path should be performed. Any possible requirements related to the ditch and the actual positions of it shall be specified as needed.

Cable installations shall in principle be in accordance with national rules [FEL], [FEF], [NEK EN 50122-1] and recommendations in [REN-blad: 9000 series].

All cable installations and all cable facilities shall be constructed to provide future extensions. For instance, there should be a spare capacity of minimum 30 % within a cable duct.

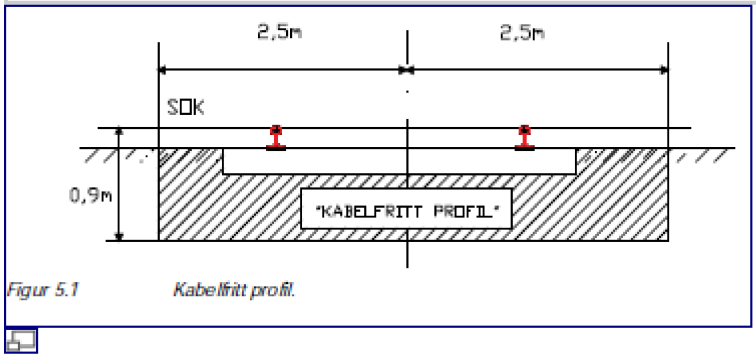
2.1 Cable free profile

a) A cable free profile apply for cables and cable protective devices and is fixed to 2,5 m to each side from the middle of the railway track and down to a debt of 0,9 m below the upper part of the rails (SOK), see Figur 1.

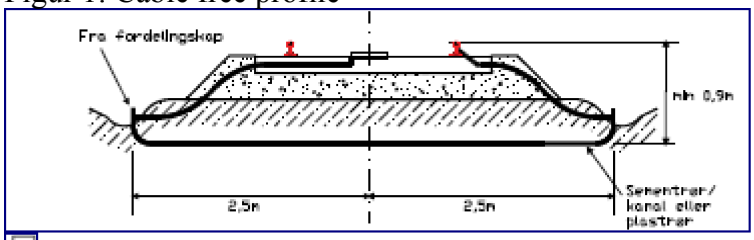
1. Cables feeding switch-point machines, heating elements, bonding connections, cross bonds etc. connected to nearby equipment within or in close proximity to the railway track must necessarily penetrate into the cable free profile, see Figur 2. Such cables should be installed with extended protection (plastic pipe, metallic pipe or similar).
2. Cables with solid protection (concrete or steel) may be positioned within the cable free profile if they are not damaged by machines processing the ballast, reconstructing the track and similar. The minimum distance should be at least 2,3 m from the middle of the track for a distance of less than 10 m, as far as the other side of the track satisfy the cable free profile.
3. Man holes may exceptional be positioned within the cable free profile if they are not damaged by machines processing the ballast, reconstructing the track and similar. The minimum distance should be at least 2,3 m from the middle of the track, as far as the other side of the track satisfy the cable free profile.
4. In tunnels and at bridges where the ballast is contained in a tray, the cable free profile is limited to the tray.

b) The requirements for the cable free profile is not relevant for tracks without ballast.

In some cases damage may be avoided when the track is moved away from cables and similar delicate matters when the track should be processed, and the track is later moved to the old position.



Figur 1: Cable free profile



Figur 2: Cable installation close to track

2.2 Return and feeder conductors

Return and feeder conductors shall always be laid tight together and as symmetric as possible (e.g. like a triangular), with the feeder conductors and any reinforcing feeders, such that the total electromagnetic field enclosing the conductors become as negligible as possible. The conductors should not be located close to other cables suffering from the emitted magnetic fields from the conductors – and most possible on the opposite side of the track with respect to other cables.

Return conductors positioned on the opposite side of the track will increase the distance to the exposed cables, and the EMC properties is a bit improved as the current in the rails are decremented. More reduction of the magnetic field is possible if the return conductor is positioned up in the masts close to the contact line system.

If the return and feeder conductors have to be laid in close proximity of other cables, the forward and return currents shall be arranged to be balanced out in order to minimize the electromagnetic fields around the conductors and hence gives rise to practically no disturbances and induced voltages.

For the design of feeder conductors and requirements for installations refer also to [546].

Return and feeder conductors out of use shall be short-circuited between the lead and the shield in both ends and shall be earthed in one of the ends.

Also refer to [FEF] and relevant REN-blad [REN-blad: 9000 series] for the installation of high voltage cables and distances to other cables.

2.2.1 Electrical testing of high voltage cables in new facilities

Testing shall be performed as soon as the cable and associated equipment is installed. The testing of existing and repaired facilities is not covered by this clause.

The testing shall be performed with a DC current with values given in Tabell 1. The voltage shall be applied for 15 minutes, and the cable and equipment shall sustain the test without any break-down.

The value of the test voltage must not be higher than 90 & of the peak value for the voltage of which the equipment shall be tested with. When it is not possible to disconnect breakers and other equipment during test, the procedure shall be negotiated between the parties.

If the manufacturer and the buyer agrees, AC current with the nominal frequency may be used as an alternative to DC testing.

1. Either test duration of 5 minutes with line voltage connected between lead and shield.
2. Or tested in 24 hours with the nominal system voltage for operation.

Tabell 1: Table for test voltage

Nominal voltage [kV]	7 / 12	14 / 24	21 / 36
Test voltage [kV]	25	50	76

2.3 Protection conductors

Protection conductors include earth conductors and bonding conductors directly connected to the railway return circuit, see [510], jording.

All protection conductors (earth conductors and bonding conductors) connected to the railway return circuit shall have a yellow/green insulation and consist of several copper leads (PN). Protection conductors in normal operation does hardly carry any current and shall be installed in such a manor that the risk for arcing to other equipment or cables, due to failure in the contact line system setting up current in the protection conductors, is eliminated.

Protection conductors shall be installed easily visible for inspection. Joints, branches and links shall be available. Protection conductors shall be installed in such a way that there is no harm to the environment.

For design of cross section area of the protection conductors refer to [510], jording.

2.4 Approved configurations of cables

Safety and vulnerability (refer to the principles in Vulnerability in chapter 4) decides which cables can be co-located in close proximity:

1. Cables with high voltage supply shall not be installed together with other cables.
2. Cables with transmission vital information shall not be installed together with cables that is or may become vulnerable for heath dissipation and autoignition.
3. Requirement for EMC may restrict the mix of installed cables.
4. Cables with (semi)conductive sheath (METF) or conductive sheath (TSLF) shall not be installed in ducts with lid and fed into buildings (risk for cable damage and dangerous voltages)
   METF or TSLF cables may be installed in ditches
   METF or TSLF cables may be installed in pipes or ducts consisting of pipes, but needs carefully installation due to dangerous voltages and arbitrary earth connection.

In ducting facilities or in ditches cables may be installed in the same ditch, in common pipe or in common compartment in ducting facilities as shown in Tabell 3.

Tabell 2: Approved installation of cables in common ditch, common pipe or common compartment in duct facilities

	Fibre optical cable, telecommunication cable [1]	**Signal cable [3]**	**Energy supply (≤ 1000 V)**	**Protection conductors**	**Return conductors**	**U >1000 V**

Fibre optical cable, telecommunication cable [1]	X [2]		X			
Signal cable [3]	X [2]		X			
Energy supply (≤ 1000 V)				X	X [4]	
Protection conductors				X [4]	X	X	X
Return conductors					X	X	X
U >1000 V					X	X	X

[1] A possible armouring in fibre optical cable shall be earthed in the ends and may be grounded at intermediate places.

[2] In complex facilities with many parallel signal cables in the same chamber of the duct, telecommunication cables should have a separate chamber – if possible.

[3] Signal cables are used in safety facilities etc. It is assumed that the conductors are protected with fuses with less breakout current than 10 A.

[4] Recommended position of bonding conductors are together with feeder and return conductors.

It is also assumed that cables that are installed together satisfy [FEL] and [NEK 400] which contains requirements for the level of insulation for different cables in the same line system.

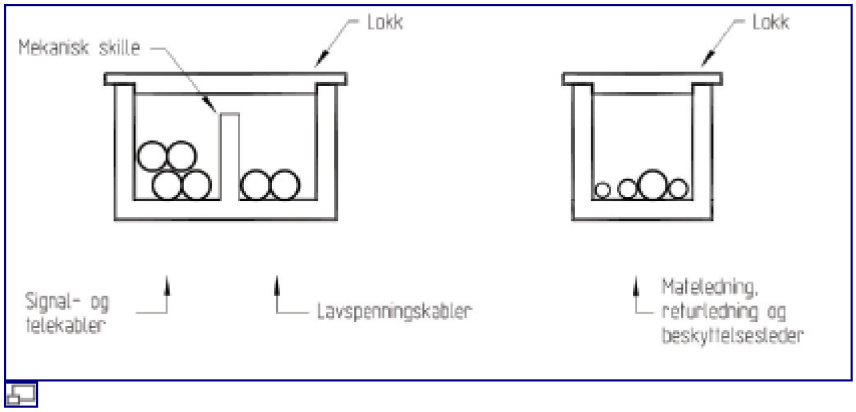
> Line system: Installation of cables and/or bars etc. and parts which protects and encapsulate cables, bars etc.. Pipes, ducts and similar are included [NEK 400]

If high voltage cables of different level of insulation are installed together they shall be separated from each other by a plate.

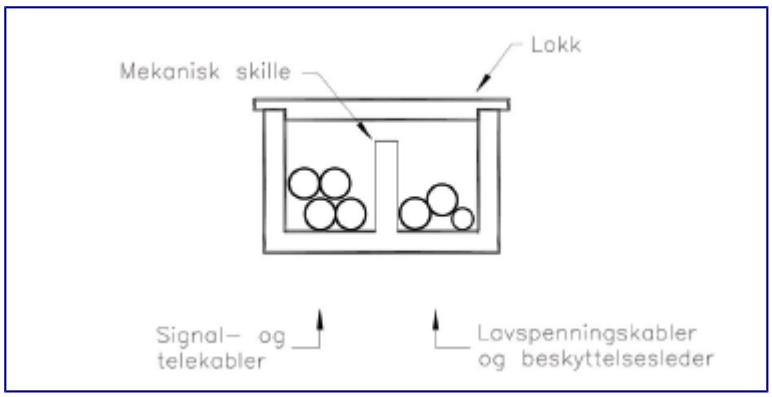
Where ducts with more chambers are used, the high voltage cables shall be positioned at the most far distance from the track.

Special evaluation of electrical interference, both electromagnetic or electrostatic, may become necessary for telecommunication circuits, data transfer and similar.

Figur 3 and Figur 4 depict examples of approve installations of cables in a cable duct with fixed mechanical separation between the different cables. It shall be a fixed mechanical separation between telecommunication cables and power cables when the distance between the different cables is less than 0,3 m.



Figur 3: Example 1. Approved configuration of cable duct with cables that fulfils the requirements of table 5.2. It is possible to make use of one duct with three compartments.



Figur 4: Example 2. Approved configuration of cable duct with cables that fulfils the requirements of table 5.2.
Horizontal separation (with sand and lid) of ducted cables shall be avoided.

In ditches the separating distance between telecommunication cables and low voltage cables shall be 0,3 m. With a fixed separation the distance may be reduced. A proper separation material may be bricks of plastic, separation stones, plastic plates installed in such a manor that the necessary distance between cables is maintained.

NEK EN 50174-3:2003 requires a fixed separation of minimum 100 mm. (the requirement for 100 mm is not relevant in pipes or in concrete ducts with fixed chambers.)

2.5 Pathways

2.5.1 Vulnerability

a) In order to avoid damage to cables the cables shall be installed with protection in the pathways.

1. Cables shall not be laid for itself on ground
2. Ducts made of composite material used in tunnels and on the ground exhibit less protection against heath during a fire than a duct with lid made of concrete. This is quite relevant for telecommunication cables with optical fibres used for GSM-R or other vital communication.

b) Telecommunication cables with vital fibre optical connections shall not be fed trough manholes or maintenance hole together with high voltage cables and return conductors.

1. With particular actions against fire low voltage cables may be installed in a manhole together with fibre optical cables.

c) High voltage cables (including return conductors) and other cables should not be installed in the same multi duct system (secondary damage from heat dissipation). High voltage cable and other cable should not be installed in the same pipe.

2.5.2 Cable ducts

The station area includes the distance from approach lighting A to approach lighting B.

a) In all station area cables shall be installed in cable ducts or in pipes. Cables outside the station area should be installed in ducts or in pipes with sufficient ring stiffness.

b) Ducts shall be installed as depicted in [520], kapittel 5.

c) The ducts should withstand the load of snow removal equipment that may be used in the area.

1. All ducts shall have solid lids that are likely to retain in position. The lids should be heavy or

secured in such a way that they are kept in position and can not be opened without the use of a tool.

Lids should sustain a load of minimum 5 tons from vehicles.

Cable ducts may have connections to manholes or maintenance holes. Manholes or maintenance holes may give access to pipes.

A work-saving method of installing fibre optic cable in a concrete duct is pushing in an appropriate sub-pipe in the duct and then blow the cable into the sub-pipe. This also provides protection against rodents.

2.5.3 Pipes

a) There may be one or more pipes surrounded by sand or casting or may consist of a duct profile with more chambers.

1. Pipes shall be installed at a debt of minimum 0,5 m without casting.
2. The installation debt may be reduced to less than 0,5 m, but in case this shall compensated with the use of pipes with less diameter and/or greater ring stiffness (SN>30) or casting.

b) When designing pipes at least 1/3 of the pipes should be spare for future use.

1. Pipes shall be installed without significant breaks or sharp turns.
2. The distance between manholes is recommended to be less than 50 m.
3. The pipes shall have an outer diameter of minimum 110 mm, and a wall thickness of minimum 2,5 mm.
4. the pipes shall consist of electrical non-conductive material, with an inner surface, either plain or corrugated, design with a low friction for cable pulling.

c) At crossing of railway, public road, station area or areas with heavy traffic (snow removal equipment etc.) the pipes shall have a wall thickness of minimum 3,2 mm. Pulling rope shall be pre-installed, also in pipes with cables.

d) In manholes and maintenance holes the pipes shall always be secured by lids to prevent intrusion of water, dirt and rodents.

The pulling of more cables into a used pipe over longer lengths can result in a risk of wedging. To prevent damage one of the following methods may be used:

- pull in a sub-pipe over the cables (This is lighter and less exposed for wedging)
- pull out the cables and pull in a number of sub-pipes for the cables
- pull out existing cables and pull in all old and new cables in one operation.

{{lærebokstoff|If possible do also secure the pipes containing cables to prevent intrusion. This must be carefully done to avoid any permanent plug in the pipe.

2.5.4 Manholes

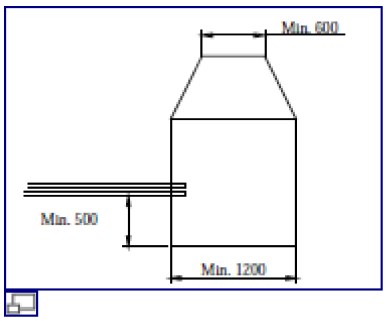
a) Manholes and associated pipes shall be installed such that water is not collected, but will be drained out.

1. The entrance of pipes in the manhole shall be sealed by a solid material (e.g. concrete – not build foam – should be used).
2. Use of a water pump shall be assessed if the manhole is positioned more or less under normal groundwater level.

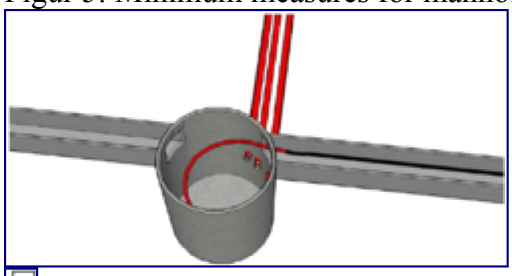
b) It should be 0,5 m from the bottom of the manhole up to the lowest pipe.

c) The minimum inner diameter in the manhole should be 1,2 m, but the diameter can be reduced to 0,6 m at the top, see Figur 5.

1. If the requirements for bend radius for the cables needs an even greater diameter a manhole with a greater inner diameter shall be selected.
2. High voltage cables shall be contained in a separate manhole together with associated return conductors and protection conductors, see Figur 6.
3. Exceptionally low voltage cables may be positioned in a manhole containing high voltage cables, however, the cables shall be the necessary marks (signs) and the high voltage cables shall have insulated outer sheaths and protected in a sleeve.



Figur 5: Minimum measures for manhole. All measures in mm.


Figur 6: Separate manhole with high voltage cables.

2.5.5 Maintenance hole

Maintenance hole may be shallow and rectangular.

a) Maintenance holes and associated pipes shall be installed such that water is not collected, but will be drained out.

1. The entrance of pipes in the manhole shall be sealed by a solid material (e.g. concrete – not build foam – should be used).

b) It should be 0,25 m from the bottom of the maintenance hole up to the lowest pipe. See Pipes for requirements to the installation of pipes.

c) Maintenance holes shall have lid with sufficient strength to withstand vehicles for snowplows and light construction machinery.

1. If (telecommunication) cables that is vulnerable for interruption is installed, the maintenance hole shall have a secured lower lid with a lock.

Vulnerability requirements: A secured lid with lock is relevant where there is a joint box in the maintenance hole, but is otherwise of less relevance if the cable is just routed through the maintenance hole to a duct with an unsecured lid.

d) Maintenance holes is applicable on platforms and shall usually be applied for other cables than return conductors and feeder conductors. If a high voltage cable is routed through a maintenance hole it should rather run from one wall to the opposite – in other words without any significant

change in direction.

2.5.6 Alternative hight below pipes in manholes and maintenance holes

a) If problems arise to have the necessary hight from the bottom and up to the lower pipes (50 cm for manholes and 25 cm for maintenance holes) this distance may be reduced to 5 cm as long as:

1. The manhole/maintenance hole is equipped with drainage
2. The manhole/maintenance hole has a solid bottom
3. There is sufficient sealing between the wall and bottom to block out any fine soil and debris.

b) When a maintenance hole is installed to connect existing pipes placed directly on platform elements, the area around the pipes shall be cleaned, the in-lets to the maintenance hole shall be secured and drainage shall be prepared. If a pipe is punctuated, this shall be done in a manner that prevent damage on cables and prevent ingress of water and debris in existing pipes.

2.5.7 Cables in duct

a) Cables shall be installed at a debt of minimum 0,5 m.

1. The cables may be installed at a debt of 0,3 m if they are protected by plastic pipes, plastic sheets or similar materials proven according to existing requirements.
2. For high voltage cables requirements in [FEF] apply.
3. For co-location with telecommunication cables the requirements in [NEK EN 50174-3] apply.

b) As a minimum there shall be installed warning tapes with relevant text (OBS: ”Kabeltype”) above cables in all cable ducts.

1. Above high voltage cables there shall also be a mechanical protection.

c) There is also reference to [REN-blad 9000] for dimensions of duct, materials used for cover, distances between cables etc..

2.6 Cables in tunnels

All cables to be installed in tunnels shall be halogen free. This also applies for single conductors as parallel earth wire, protection conductor (PE), phase conductors and return conductors. In addition all cables should be self-extinguishing. The cable bundles in tunnels shall be self-extinguishing – either the cables may be self-extinguishing or the other methods shall be applied, such as protection by concrete ducts with concrete lids.

In tunnels cable ducts shall be established. The ducts shall be in concrete or an other material with good fire protection for the cables installed. Cable ducts in tunnels shall also be installed in such a way that they may serve as an escape route in an emergency situation. For security requirements in tunnels see also [540], kapittel 12.

For particular security installations within tunnels, such as local communications and emergency lightning, the use of fire safe cable or fire safe cable installation which shall provide electrical functions until the tunnel has been evacuated. These cables should be installed in places in the tunnel profile where the expected heath from a fire is moderate. Also fibre optical should be protected against the heat of a possible fire.

Feeder conductors for high voltage and return conductors should be installed on wall or roof in similar way as in free, see [540], chapter 12. If this is not possible the return conductor may be installed in cable ducts, preferably on the opposite side of other metallic cables (telecommunication and/or signal cables), see also details in Return and feeder conductors and Approved configurations

of cables.

2.6.1 Cable trays, pipes and sub-pipes in tunnels

Cable trays, pipes and sub-pipes exposed within the tunnel profile in case of fire, shall be free from halogens.

Materials – in general, if there is some volume of it – shall be free of halogens.

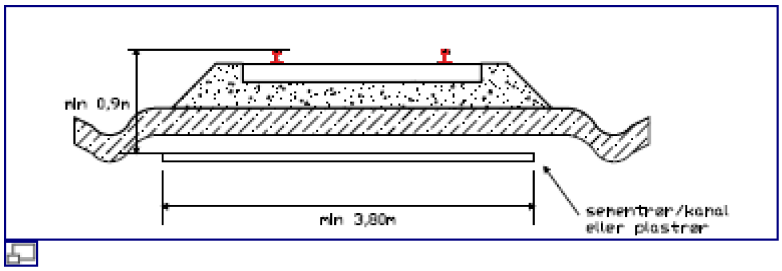
In tunnels pipes made of PVC may be encased in concrete (totally enclosed). (No harm for toxic gases during a possible evacuation.)

2.7 Crossings of tracks

All crossings of tracks with cables shall be done outside the cable free profile. Such crossings should be done at 90 degrees to the track and shall be approved by the owner of the facility.

At the crossings suitable protection materials as pipes and ducts shall be used (see Figur 7) thus prevent digging in the track whenever cables shall be installed or withdrawn. By crossing more tracks (e.g. station areas etc.) manholes should be used to ease the installation where necessary.

By establishing crossing in main tracks and tracks with dense traffic there should be installed minimum 8 solid pipes of 110 mm diameter and connecting manholes on both sides of the tracks.



Figur 7: Cable installation, point of crossing

Pipes to be installed to penetrate an existing track, should if possible be drilled through the ballast bed at the prescribed debt to avoid digging close to or in the track.

Pipes for crossing of tracks shall be minimum 110 mm in diameter and shall be approved according to [REN-blad 9000]. See also clause Pipes.

All pipe paths shall be installed to avoid collection of water inside.

2.8 Provisional facilities

Provisional installed cables, or cables to be temporarily moved due to constructional work, e.g. digging, ballast changing or similar, may be laid on the ground but shall be adequately protected against damage and dropping contact wire. Provisional facilities shall in every case be approved by the owner of the facility and the time duration shall be agreed.

OBSERVE: Cables for safety facility shall not be in used when moved. These cables shall be tested against failure after each movement and prior to the operational use.

In addition requirements in [FEF] apply for high voltage cables.

2.8.1 Provisional installation of cables conducting current for the contact line system

Prior to provisional installation of feeder conductors or return conductors there shall be an

assessment of the risk of high magnetic fields and the most prosperous solution shall be documented for the temporary facility.

2.9 Cable installation on bridges and other conductive constructions

Cable installations on bridges and other conductive constructions shall be done avoiding unintentional conductive contact between metallic parts of the cable with the metallic construction.

2.10 Telecommunication cables in contact line masts

Metallic telecommuication cables should not be routed in close proximity to contact line masts and associated conductive parts.

If it is difficult to have sufficient distance (0,5 m) the cables should be protected by plastic pipes, plastic sheets or similar materials proven according to existing requirements.

2.11 Building entrance facility for cables

Buildings with electric equipment along tracks are categorized according to complexity.

- Buildings at stations with large and important plants of telecommunication, signal and/or remote control facilities (e.g. central stations, connecting stations) shall be equipped with all-halogen free and flame retardant cabling.
- Local cables internal to Buildings with electrical installations at minor stations shall be free of halogens. Terminated external cables should have outer sheath free of halogens. (In minor technical rooms where the volume of electronic equipment is rather low – and will remain rather low – PVC-insulated cables may be terminated if supported by an investment analyses showing great savings. A better technical solution is to change to halogen free cable at the outer perimeter of the building.

All cable paths into and out of buildings – with a possible reservation of metal free fibre optical cable – shall enter in a common building entrance facility according to “soneteorien” as depicted in [510], Generelle tekniske krav, and shall be earthed at the earthing system of the building, see [510], jording. The building entrance facility (also relevant for kiosks and containers) shall have fire barriers. All internal cabling in buildings shall be installed in such a way that the mechanical properties and fire barriers do not deteriorate, [FEL], [NEK 400].

Building entrance facilities and technical objects in the outside plant shall be secured against rodents, humidity and dust.

Other specific requirements to building entrance facility may be found in other parts of “Teknisk regelverk”, see the different parts Hovedside.

2.12 Cables within overhead contact line zone (see chapter 6)

If cables may be exposed to a dropped contact wire the should be contained within a protecting pipe, either metallic or plastic. The pipe shall have the same mechanical strength as required for the crossing of tracks, see Pipes. If the pipe is metallic, it shall be bonded to the return circuit of the contact line system, see [510], jording.

2.13 Marking, labelling

Cables and protecting pipes shall be installed and marked in such a way that they easily may be identified during inspection, testing, repair and reconstruction.

The markings shall be clear and made on a durable material and should be done with embossed text on the cable sheath, pipe and/or marking plates.

In addition there are special requirements for marking of cables in [5XX], [FEL] and [FEF].

Marking shall as a minimum be made at:

- entrance in cabinets/distributors/buildings
- branching points, joints, at direction changes
- manholes
- each contact line mast (in normal, may be limited in station area – depending on distances)
- at crossings of tracks (to be marked in manholes on each side of the crossing)

Earthing conductors are usually identified by the insulation in colours of yellow and green. At places with many terminated earth conductors on the same bar, they shall be marked (identified). Earth conductors to earth electrode shall be marked. The marking shall be made with the colour code specified in Felles elektro/Prosjektering og bygging/Kabellegging og kabelkanaler#Marking, labelling that is most relevant.

Examples of marking of earth conductors on a station area is depicted in Vedlegg 5.a (.pdf).

2.13.1 Colours of markings

Colours may be used in addition to other cable markings to identify cables belonging to a particular category. If used, the following colour codes according to Tabell 3 shall be implemented:

Tabell 3: Colour markings

Category	colour code
High voltage and return circuit	Red
Low voltage	Blue
Signal	Green
Telecommunications	Yellow
other, not related to any specific category	White

2.14 Jointing and termination of cables

There are examples of damage to cable facilities resulting in big risk for the railway traffic (Statens havarikommisjon for transport, rapport 2008/2 (Jernbanehendelse)).

In this and other reports from SHT corrosion was detected that resulted in electrical hazards and following traffic events. The corrosion was due to intrusion of water in a cable joint. The water had entered close to the inner sheath of the cable or through the sealing mass of the joint. Hence the following recommendations for signalling facilities and telecommunication cables applies:

- use of cables filled with Vaseline
- use of water-proof materials for jointing leads and crimp material
- hermetic wrapping of the joint with self-vulcanizing tapes and crimp sheet.

a) Cable and associated material shall exhibit properties that is well suited and grant proper performance in the actual environment.

b) Joints and terminations shall be performed by skilled persons.

See Vedlegg b Skjøting og terminering av kabel.

2.15 Installing and pulling cables in outdoor environment

Suitable environment for pulling cables is in the range of 0 °C to 20 °C without too strong sun shine. If the weather is particular cold or hot, the cable drums should rest in house free of direct sunshine and with the temperature in the range of 15 °C to 25 °C for one or two days: Cables with sheath of polyethylene (known by brands as METF, METI, FEBI, MEBI, EEBI etc. and fibre optical cables) may be installed as long as the temperature in the cable is above -5 °C to -10 °C – even if the temperature in the air is well below -10 °C.

Other cables with PVC is somewhat stiff, and should not be installed in temperatures below 0 °C.

Cables that is pulled out within or by the pathway shall be comforted by rollers or suitable glands to protect the cable sheath from damage. Cables pulled out from cars shall be adequate protected from damage from the ground and other obstacles.

The cable drum shall be guided during the installation to avoid uncontrolled unwinding and to avoid kinks to the cable.

Vedlegg b Skjøting og terminering av kabel gives more information and guidance.

2.16 Cable facility that is taken out of use

Cables out of use represent more cost as the space is occupied, and the presence of the cable results in more actions for the maintenance. Cable of suitable quality may be re-used after removal. Otherwise the cable shall be sent to an appropriate disposal.

a) Disconnected cables shall be well isolated and marked “ute av bruk” (out of use). In any case no cable ends shall emanate from the ground. The cable shall stilled be registered with the status “ute av bruk”.

b) As long as the cable is installed in the pathway system it shall be treated as if it was still in use, and it shall be registered in the archives of the owner of the facility.

c) Cables out of use with no prospect of being used, shall be removed from the facility. After removal the registered information in the archives about the cables shall de removed.

3 Documentation

3.1 Common register of cables and pathways

There shall be one common plan (drawing) “Felles kabelplan og føringsveier” for coordination of the electrical fields. ”Felles kabelplan og føringsveier” should be in the same format as ”Tverrfaglig jordingsplan” see [510], jording. See also [501], chapter 2 for requirements to documentation.

”Felles kabelplan og føringsveier” shall depict how the cable installations are situated in relation to the track, the type and sizes for pathways and the cables installed in the facility.

The minimum requirements for documentation are:

- Cable path
- type of pathway
- position of cables

- cable types

  > Cable types and identity shall be stated in accordance with requirements given in Teknisk regelverk for the different subjects [5XX].

- Cable identity
- Cable joints (position and type)

The pathway shall be identified with distance from the track and other fixed markings (foundations, buildings and similar) in maps. The distance from tracks is preferred but distance from other fixed markings may be used where feasible. All crossings of tracks shall be drawn and identified with kilo-metrical values.

The pathway shall identify:

Ditch; dimensions
Duct; dimensions, number of chambers, materials

Pipes; dimensions, number of pipes,

Drawings giving cross-sections shall be worked out where there is a split or a significant change of direction and the position:

- more than one buried cable
- more than one buried pipe
- more than one duct or
- where there is a duct with more chambers.

All high voltage cables shall be unambiguously marked in the drawings of cross-sections. For other cables in pipes or ducts the pathway (numbered pipe, chamber of duct) shall be specified.

Pathways for cables/pipes/ducts shall also be identified by GPS coordinates (Euref 89) at the time when they are visible.

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4 Annexes

Vedlegg a (.pdf) Merking av jording, eksempel

Vedlegg b Skjøting og terminering av kabel