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CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANTS

JOINT USE OF TUNNELS BY PIPELINES AND TELECOMMUNICATION CABLES, AND THE STANDARDIZATION OF UNDERGROUND DUCT PLANS

ITU-T Recommendation L.11

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation L.11 was published in Volume IX of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression “Administration” is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation L.11

JOINT USE OF TUNNELS BY PIPELINES AND TELECOMMUNICATION CABLES, AND THE STANDARDIZATION OF UNDERGROUND DUCT PLANS

(Melbourne, 1988)

The CCITT,

considering

(a) that many countries are interested in the joint use of tunnels and are aware of the advantages, disadvantages and specific dangers they hold;

(b) that the rules governing this type of ducting vary significantly from country to country;

(c) that the importance of the joint use of tunnels increases with increasing density of population and shrinking open spaces, i.e. in large towns;

recommends

that Administrations, who in the future will be interested in this type of installation, follow the rules described in this Recommendation.

1 General considerations

Duct tunnels and trenches are constructions containing one or generally more ducts belonging to different networks. Tunnels which can be inspected (inspectable tunnels) include one or more gangways for initial assembly work and for subsequent control, maintenance and repair operations. A tunnel without standing room, but designed for crawling should have a clear internal height of at least 0.8 m. Duct gangways may not be entered.

The above principles apply to inspectable tunnels, and apply by analogy to tunnels with crawling room only.

Tunnels may contain ducts belonging to the following types of networks:

- collective antennas;
- telecommunications;
- electricity;
- gas;
- water;
- district heating;
- ducted transport (e.g. pneumatic tubes);
- drainage water.

2 Establishment of a routing plan

2.1 Structure

Tunnel routing must take into account the structure of networks and their levels of priority.

The transport ducts of different networks do not generally follow the same itinerary, since neither the production units (e.g., power plants, pumping stations or telephone exchanges) nor the transit points from transport to primary distribution coincide. On the other hand, in densely populated areas, primary and secondary distribution ducts often do follow the same itineraries, so that it is advisable to run tunnels under arteries containing primary and secondary distribution ducts.

2.2 Decision criteria

The following factors should be taken into account when opting between trenches and tunnels:

2.2.1 *Distribution security*

A high level of distribution security will depend on the following factors:

- durability of material and joints;
- rapid location of damage when it occurs, easy access and minimum repair times;
- low exposure to outside effects (e.g. damage caused by third parties or by earthquakes).

Ducts laid in tunnels generally offer high durability and a low risk of deterioration. They may be repaired rapidly.

2.2.2 *Third party risk, disturbances due to installation and repair work*

Account should be taken of disturbances caused by installation and repair work (rerouting of traffic, noise) and of the possible consequences of damages ducts (water and fire damage).

2.2.3 *Economic considerations*

Economic considerations should include not only the cost of constructing and maintaining tunnels, but also the savings which will arise in the future from avoiding the secondary effects of buried ducts. By secondary effects are meant the effects produced on local inhabitants, local activities, vehicle traffic and the environment in general by the installation, malfunction, repair and maintenance of ducts.

2.2.4 *Technical considerations*

Before either of the laying methods is chosen, the following factors should be considered:

- ducts, network, dimension (cross-section), power (capacity), material, protection against corrosion, number, distribution priority, duct routing, compatibility with other ducts, state of ducts, repairs, overhaul, replacement, reserves, extensions, emergency ducts, provisional installations connections to buildings;
- roadway, road width, pavement width, greenery strip, traffic density, surface water drainage, superstructure;
- subsoil, type of ground, groundwater level, existing ducts, existing underground constructions;
- schedules, beginning of works, duration of works (stages), start-up.

When a tunnel is planned, special attention should be paid to branch connections with buildings, which may be derived directly from the tunnel if the necessary openings have been provided. An alternative method is to bury secondary distribution ducts alongside the tunnel.

3 **Recommendations applicable to tunnels**

3.1 *Phases*

The following sequence of phases should be considered:

- construction phase;
- operational phase.

3.2 *General recommendations*

In both the construction and the operational phases, the following requirements should be observed:

- *Introduction of duct components in the tunnel*

It should be possible to introduce any components either through normal access points or through special openings.

- *Cable pulling*

Cables in tunnels should be placed in appropriate technical containers, in order to facilitate their installation, repositioning or removal.

- *Construction aids*

For construction work, especially in the case of heavy tubing, securing devices should be provided at appropriate locations.

- *Movement of duct components in tunnel*

The necessary facilities should be provided for the transport of duct components inside a tunnel.

- *Reserve facility for network extension*

Since networks are likely to be extended on the future, appropriate reserve space should be set aside in the tunnel cross-section plan.

- *Clear space around ducts*

Enough clear space should be allowed between a tunnel wall and ducts, as well as between ducts in proportion to their diameter (to facilitate maintenance, repair and branching).

- *Ambient temperature*

High temperatures may occur in tunnels containing heat-emitting ducts. Care should be taken to maintain physiologically acceptable environmental conditions in order to avoid any impairment to health during work or inspections. For telecommunication cables, see § 3.3.2.

- *Corrosion of ducts, fixtures and equipment accessories*

The working life of fixtures and equipment accessories should be as long as that of the ducts. High levels of humidity may produce condensation and cause non-rustproof metals to corrode. The appearance of corrosion should be considered in the light of Recommendation L.1. Metal components (pillars, racks or supports) should preferably be made of hot galvanized steel. In some cases, cathodic protection may be applied.

- *Vibrations*

Some ducts may be sensitive to vibrations. In some cases, vehicle traffic may produce vibrations which are propagated inside the tunnels.

3.3 *Comments on distribution networks*

3.3.1 *Collective antennas*

Extra space has to be provided in places to house amplifying equipment. Apart from that, collective antenna cables have no special requirements.

3.3.2 *Telecommunication cables*

The following requirements should be taken into account:

- *Distances from power lines*

Minimum distances from main ducts should be applied (see § 5).

- *Protection against thermal load*

Since telecommunications cables are vulnerable to thermal load, thermal conditions in tunnels must be taken into account. This applies especially for optical cables.

- *Protection against corrosion and lightning*

Telecommunication cables should generally be protected by metal sheaths or shields. This protection may be applied, but the use of joint earth electrodes is either not required or not permissible.

- *Protection against electrical interference*

Normally no special measures need be taken, although cable constructions with a high screening factor or overvoltage relays may be used in some cases.

- *Protection against mechanical forces*

Metal shields may be used to protect cables against mechanical effects such as vibrations or impacts. In the case of lead sheaths, vibration-resistant alloys should be used.

- *Protection against outside effects*

Plastic-covered cables may be protected against rodents with fibreglass or aramid-fibre shielding.

Contractable cable joints may provide protection against earthquakes.

- *Bends*

Since cable curvature is limited, layout plans must take account of permitted curvature radii.

- *Specialized work*

Since work has to be done relatively frequently on telecommunication installations, particularly on sleeves, sufficient working space should be provided (e.g. alcoves or chambers).

3.3.3 Power cables

The following requirements should be taken into account:

- *Bends*

The same rules apply, by analogy, as for telecommunication cables.

- *Ambient temperature*

The load capacity of electrical cables depends, among other parameters, on ambient temperature, which should be determined in each case to achieve the ideal balance between tunnel cooling and cable load capacity.

3.3.4 Gas

Tunnels containing gas ducts should be ventilated (naturally or artificially). Dilation sleeves should be leakproof and located in separate chambers.

3.3.5 Water

The choice of tunnel layout or cross-section should take account of the dimensions of special water duct components. Water ducts may require special precautions against climatic effects to avoid overheating or freezing. Ducts with a nominal diameter of 150 mm may give rise to special problems, in which case the following factors should be taken into account:

- *Temperature rise*

A rise of temperature in a tunnel will have only a negligible effect on the quality of drinking water.

- *Freezing in ducts*

The temperature in inspectable tunnels rarely falls below freezing. Should there be a risk of freezing, appropriate measures should be taken to protect the duct.

- *Bleeding and draining*

Bleeding and draining facilities should generally be located outside tunnels.

3.3.6 District heating

The following requirements should be taken into account:

- *Position of ducts*

For assembly purposes, the distance between district heating ducts (not including insulation) and the tunnel wall should not be less than 0.3 m.

- *Heatproofing*

Continuous thermal insulation will diminish heat losses and help prevent the occurrence of thermal shock in the event of a burst water duct.

- *Junctions and intersections*

Permitted radii of curvature for ducts should be observed at junctions and intersections.

- *Dilation devices*

Plans should allow sufficient space for dilation devices.

3.3.7 Water drainage

The following aspects should be considered:

- *General*

In most cases pipes will be naturally drained. The means that their level and slope can be adapted to tunnel layouts only within certain limits.

- *Link between drain and tunnel*

In view of the risk of backflow, there should be no open link between the drain and the tunnel.

4 Safety plan

4.1 Safety objectives

Various aspects of safety should be considered:

- safety of persons working in the tunnel;
- safety of persons and property outside the tunnel;
- security of distribution.

For the first two items, safety objectives concern the risk of personal injury.

Security of distribution is independent of personal safety. The importance of distribution ducts should not be overlooked, however, not only because of the convenience they provide to the public in general, but also because they may constitute in certain circumstances a vital factor of survival.

4.2 Safety plan

4.2.1 Safety during the construction and installation phase

The safety plan should comply with existing rules governing safety at work. Special attention should be paid to rules concerning construction work in enclosed spaces. In all cases, the maximum permissible levels of harmful substances or vapours, as defined by insurance companies, should not be exceeded.

4.2.2 Safety during the operational phase

The company owning an installation should be responsible for issuing instructions to be observed from the start of operations.

In the event of maintenance or extension work, the safety measures laid down for the construction phase should be observed.

Fire risk and fire-fighting facilities should be established in consultation with the fire brigade.

Tables A-1/L.11 and A-2/L.11 show a model of a safety plan in the operational phase, with an indication of possible preventive measures.

The rules applicable to the construction of a tunnel, as described in § 5, should be established in the light of the safety plan.

4.3 Special problems to be considered

A special study of safety aspects should be made, where necessary, with regard to the following points:

- interference between telecommunication lines and high voltage or d.c. railway lines;
- tunnel design;
- ventilation;
- thermal protection;
- water drainage;
- electrical installations;
- gas or fire detection systems.

5 Construction

5.1 Transversal cross-section

5.1.1 General

The transversal cross-section of a tunnel comprises the following elements:

- ducts and related facilities, including free spaces for repairs and maintenance;
- reserve spaces;
- duct intersections and junctions;
- service gangways.