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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Optical fibre cables for indoor applications

ITU-T Recommendation L.59

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Optical fibre cables for indoor applications

Summary

This Recommendation describes characteristics, construction and test methods for optical fibre cables for indoor applications. In order for an optical fibre to perform appropriately, characteristics that a cable should have are described. Also, the method of determining whether or not the cable has the required characteristics is described. Required conditions may differ according to the installation environment; detailed test conditions need to be agreed upon between a user and a manufacturer for the environment where a cable is to be used.

Source

ITU-T Recommendation L.59 was approved on 6 September 2004 by ITU-T Study Group 6 (2001-2004) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Optical fibre cables for indoor applications

1 Scope

This Recommendation:

– refers to multimode graded index and single-mode optical fibre cables to be used for telecommunication networks within buildings;

– deals with mechanical and environmental characteristics of the optical fibre cables concerned. The optical fibre dimensional and transmission characteristics, together with their test methods, should comply with ITU-T Recs G.652, G.653, G.654, G.655, G.656 and IEC 60793-2-10, which describe single-mode optical fibres and multimode graded index optical fibres;

– deals with fundamental considerations related to optical fibre cable from mechanical and environmental aspects;

– acknowledges that some optical fibre cables may contain metallic elements, for which reference should be made to the handbook, *Outside plant technologies for public networks* (see ITU-T Rec. L.1), and other L-series Recommendations;

– recommends that an optical fibre cable should be provided with cable end-sealing and protection during cable delivery and storage, as is common for metallic cables. If splicing components have been factory installed, they should be adequately protected;

– recommends that pulling devices may be fitted to the end of the cable if required.

2 References

2.1 Normative references

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.650.1 (2004), *Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable*.

– ITU-T Recommendation G.650.2 (2005), *Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable*.

– ITU-T Recommendation G.652 (2005), *Characteristics of a single-mode optical fibre and cable*.

– ITU-T Recommendation G.653 (2003), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.

– ITU-T Recommendation G.654 (2004), *Characteristics of a cut-off shifted single-mode optical fibre and cable*.

– ITU-T Recommendation G.655 (2006), *Characteristics of a non-zero dipersion-shifted single-mode optical fibre and cable*.

– ITU-T Recommendation G.656 (2004), *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport*.

– ITU-T Recommendation L.1 (1988), *Construction, installation and protection of telecommunication cables in public networks*.

– ITU-T Recommendation L.46 (2000), *Protection of telecommunication cables and plant from biological attack*.

– IEC 60332-1-1 (2004), *Tests on electric and optical fibre cables under fire conditions – Part 1-1: Test for vertical flame propogation for a single insulated wire or cable – Apparatus*.

– IEC 60332-3-24 (2000), *Tests on electric cables under fire conditions – Part 3-24 : Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C.*

– IEC 60754-1 (1994), *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the amount of halogen acid gas*.

– IEC 60754-2 (1991), *Test on gases evolved during combustion of electric cables – Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*.

– IEC 60793-1-1 (2002), *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance.*

– IEC 60793-2-10 (2004), *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*.

– IEC 60794-1-1 (2001), *Optical fibre cables – Part 1-1: Generic specification – General*.

– IEC 60794-1-2 (2003), *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*.

– IEC 60794-2 (2002), *Optical fibre cables – Part 2: Indoor cables – Sectional specification*.

– IEC 61034-1 (2005), *Measurement of smoke density of cables burning under defined conditions – Part 1: Test apparatus*.

– IEC 61034-2 (2005), *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*.

2.2 Informative references

– ITU handbook (1994), *Outside plan: Construction, installation, jointing and protection of optical fibre cables.*

3 Terms and definitions

For the purpose of this Recommendation, the definitions given in ITU-T Recs G.650.1 and G.650.2 apply.

4 Abbreviations

This Recommendation uses the following abbreviations:

SZ Reverse oscillating stranding

UV Ultraviolet ray

5 Characteristics of optical fibres and cables

5.1 Optical fibre characteristics

Optical fibres described in ITU-T Recs G.652, G.653, G.654, G.655, G.656 or IEC 60793-2-10 should be used depending upon users' environmental conditions and technical requirements.

5.1.1 Transmission characteristics

The typical transmission characteristics are described in the appropriate Recommendations on optical fibres.

5.1.2 Fibre microbending

Severe bending of an optical fibre, involving local axial displacement of a few micrometres over short distances caused by localized lateral forces along its length, is called microbending. This may be caused by manufacturing and installation strains and also dimensional variations of cable materials due to temperature changes during its lifetime.

Microbending can cause an increase in optical loss. In order to reduce microbending loss, stresses applied to a fibre randomly and longitudinally should be eliminated when manufacturing, installing and utilizing the cable.

5.1.3 Fibre macrobending

Macrobending is the resulting curvature of an optical fibre after cable manufacture and installation.

Macrobending may cause an increase in optical loss. The optical loss increases if the bending radius is lower than a minimum established limit.

5.2 Mechanical characteristics

5.2.1 Bending

Under the dynamic conditions encountered during installation, optical fibre is subject to strain from both cable tension and bending. The strength elements in the cable and the installation bend radius must be selected to limit this combined dynamic strain. Any fibre bend radius remaining after cable installation shall be large enough to limit the macrobending loss or long-term strain reducing the lifetime of the fibre.

5.2.2 Tensile strength

Optical fibre cable is subject to short-term load during manufacture and installation, and may be affected by continuous static loading and/or cyclic load during operation (e.g., temperature variation). Changes in the tension of the cable due to the variety of factors encountered during the service life of the cable can cause differential movement of the cable components. This effect needs to be considered in the cable design. Excessive cable tensile load may increase optical loss and may cause increased residual strain in the fibre if the cable cannot relax. To avoid this, the maximum tensile strength determined by the cable construction, especially the design of the strength member, should not be exceeded.

NOTE – Where a cable is subject to permanent load during its operational life, it is preferable that the fibre does not experience additional strain.

5.2.3 Crush and impact

The cable may be subject to crush and impact during both installation and operational life.

The crush and impact may increase the optical loss (permanently or for the time of application of the stress) and excessive stress may lead to fibre fracture.

5.2.4 Torsion

Under dynamic conditions encountered during installation and operation, the cable may be subject to torsion, resulting in residual strain of the fibres and/or damage of the sheath. If so, the cable design should allow a specified number of cable twists per unit length without an increase in fibre loss and/or damage to the sheath.

5.3 Environmental conditions

Environmental conditions for indoor cables may not be as severe as those for outdoor cables. Therefore, if environmental conditions are not defined, it is recommended that the same requirements which are used for outdoor cables apply.

5.3.1 Temperature variations

During their operational lifetime, cables may be subject to severe temperature variations. In these conditions the increase of attenuation of the fibres shall not exceed the specified limits.

5.3.2 Biotic damage

The small size of an indoor optical fibre cable makes it more vulnerable to rodent attack. Where rodents cannot be excluded, a suitable and effective protection should be provided. Further information is described in ITU-T Rec. L.46, *Protection of telecommunication cables and plant from biological attack*.

An effective protection is provided by a metallic barrier (steel tape or wire armouring) or a non-metallic barrier (e.g., fibreglass rods, glass yarns/tapes).

5.3.3 Vibration

In buildings, there are various kinds of vibrations caused by construction, generators, elevators, etc. Usually cable elements are maintained in position by friction and vibration may cause reduction of friction. It may cause moving of cable elements which affects transmission or mechanical characteristics of cables. It may have a greater effect when optical fibre cables are installed on a vertical cable shaft. Cables must withstand these vibrations without failure or signal degradation. Care should be exercised in the choice of the installation method.

5.4 Fire safety

In buildings and houses, fire safety presents two major issues. Firstly, cables and cable elements should be difficult to burn. In another words, cables and cable elements should have flame retardant characteristics. Secondly, cables and cable elements should not generate toxic gases and smoke when burning. Requirements for fire performance may differ in each country. Optical cables for indoor applications should meet regulations on fire safety as foreseen in each country, or by telecommunication operators.

6 Cable construction

6.1 Fibre coatings

6.1.1 Primary coating

See 3.2.1/G.650.1.

6.1.2 Secondary coating

See 3.2.2/G.650.1.

6.1.3 Fibre identification

Fibre should be easily identified by colour and/or position within the cable core. If a colouring method is used, the colours should be clearly distinguishable and have good colourfast properties also in the presence of other materials, during the lifetime of the cable.

6.1.4 Removability of coating

The primary and secondary coatings should be easy to remove and should not hinder splicing, or the fitting of fibre to optical connectors.

6.2 Cable element

The make-up of the cable core, in particular the number of fibres, their method of protection and identification, the location of strength members and metallic wires or pairs, if required, should be clearly defined.

6.2.1 Fibre ribbon

Optical fibre ribbons consist of optical fibres aligned in a row. Optical fibre ribbons are divided into two types, based on the method used to bind optical fibres. One is the edge-bonded type, the other is the encapsulated type shown in Figures 1 and 2, respectively. In the case of the edge-bonded type, optical fibres are bound by adhesive material located between optical fibres. When the encapsulated type is adopted, optical fibres are bound by coating material. In ribbons, optical fibres shall remain parallel, and do not cross. Each ribbon in a cable is identified by a printed legend or unique colour. Optical fibre ribbons are specified in IEC 60794-3.

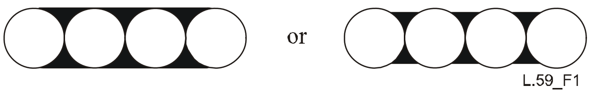

Figure 1/L.59 – Cross-section of a typical edge-bonded ribbon

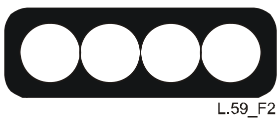

Figure 2/L.59 – Cross-section of a typical encapsulated ribbon

6.2.2 Slotted core

In order to avoid direct pressure from the outside of the cable on optical fibres, optical fibres and/or ribbon fibres may be located into slots. Usually, slots are provided in a helical or SZ configuration on a cylindrical rod. The slotted core usually contains a strength member (metallic or non-metallic). The strength member shall adhere tightly to the slotted core in order to obtain temperature stability and avoid their separation when a pulling force is applied during installation.

6.2.3 Tube

A tube construction is frequently used for protecting and gathering optical fibres and/or ribbon fibres. Filling material may be contained within the tube.

6.2.4 Strength member

The cable should be designed with sufficient strength members to meet installation and service conditions so that fibres are not subject to strain levels in excess of those agreed upon between user and manufacturer. The strength member may be either metallic or non-metallic.

6.3 Sheath

The cable core shall be covered with a sheath or sheaths suitable for the relevant environmental and mechanical conditions associated with storage, installation and operation. The sheath may be of a composite construction and may include strength members.

Sheath considerations for optical fibre cables are generally the same as for metallic conductor cables. Consideration should also be given to the amount of hydrogen generated from a metallic moisture barrier. The minimum acceptable thickness of the sheath should be stated, together with any maximum and minimum allowable overall diameter of the cable.

Selection of sheath material is one of many important issues to be considered in order to satisfy fire safety requirements. Polyethylene is widely used as cable sheath material; however, it may not be suitable for indoor cables from the viewpoint of fire safety.

6.4 Identification of cable

If visual identification is required to distinguish an optical fibre cable from a metallic cable, this can be done by visibly marking the sheath of the optical fibre cable. For identifying cables, embossing, sintering, imprinting, hot foil and surface printing can be used by agreement between user and manufacturer.

7 Test methods

7.1 Test methods for cable element

7.1.1 Tests applicable to optical fibres

In this clause, optical fibre test methods related to splicing are described. Mechanical and optical characteristics test methods for optical fibres are described in ITU-T Recs G.650.1 and G.651 and in the IEC 60793-1 series.

7.1.1.1 Dimensions

For measuring secondary coating diameter, method B in IEC 60793-1-21 shall be used.

For measuring tube, slotted core and other ruggedized elements, method B in IEC 60793-1-21 or IEC 60189 shall be used.

7.1.1.2 Coating strippability

For measuring the strippability of primary or secondary fibre coatings, IEC 60793-1-32 shall be used.

7.1.1.3 Compatibility with filling material

When fibres contact a filling material, the stability of a fibre coating and a filling material should be examined by tests after accelerated aging.

Stability of coating stripping force shall be tested in accordance with method E5 of IEC 60794-1-2.

Dimension stability and coating transmissivity should be examined by the test method agreed upon between a user and a supplier.

7.1.2 Tests applicable to tubes

7.1.2.1 Tube kink

For measuring kink characteristics of tube, G7 of IEC 60794-1-2 shall be used.

7.1.3 Tests applicable to ribbons

7.1.3.1 Dimensions

For measuring ribbon dimensions, three test methods should be used properly. Firstly, one termed a type test is used to establish and assure the ribbon manufacturing process. The type test shall be carried out in accordance with method G2 of IEC 60794-1-2, the visual measurement method. The two remaining methods are used only for product inspection after the manufacturing process has been established. Those test methods are described as G3 of IEC 60794-1-2, aperture gauge and G4 of IEC 60794-1-2, dial gauge. For inspection purposes, a visual measurement method can also be used.

7.1.3.2 Separability of individual fibres from a ribbon

A separability requirement can be given to a fibre ribbon if a user and manufacturer agree. When separability is required, the following items should be avoided in order to ensure an extended reliability of the fibres:

1) damage to mechanical characteristics of fibres;

2) removal of colour coding of each fibre.

If a user and a supplier agree, G5 of IEC 60794-1-2 test method should be used to examine fibre separability. Also, other special test methods may be used on agreement between a user and a supplier.

7.2 Test methods for mechanical characteristics of the cable

This clause recommends appropriate tests and test methods for verifying the mechanical characteristics of optical fibre cables.

7.2.1 Tensile strength

This test method applies to optical fibre cables installed under all environmental conditions.

Measurements are made to examine the behaviour of the fibre attenuation as a function of the load applied to a cable during installation.

The test shall be carried out in accordance with the IEC 60794-1-2 E1 method.

The amount of mechanical decoupling of the fibre and cable may be determined by measuring the fibre elongation, with optical phase shift test equipment, together with the cable elongation.

This method may be non-destructive if the tension applied is within the operational values.

7.2.2 Bending

This test method applies to optical fibre cables installed under all environmental conditions.

The purpose of this test is to determine the ability of optical fibre cables to withstand bending around a pulley, simulated by a test mandrel.

This test shall be carried out in accordance with the IEC 60794-1-2 E11 method.

7.2.3 Bending under tension (flexing)

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with the IEC 60794-1-2 E8 method.

7.2.4 Crush

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with the IEC 60794-1-2 E3 method.

7.2.5 Torsion

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with the IEC 60794-1-2 E7 method.

7.2.6 Impact

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with the IEC 60794-1-2 E4 method.

7.2.7 Kink

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with the IEC 60794-1-2 E10 method.

7.2.8 Repeated bending

This test shall be carried out in accordance with the IEC 60794-1-2 E6 method.

7.3 Test methods for environmental characteristics

This clause recommends the appropriate tests and test methods for verifying the environmental characteristics of optical fibre cables.

7.3.1 Temperature cycling

This test method applies to optical fibre cables installed under all environmental conditions.

Testing is by temperature cycling to determine the stability of the attenuation of a cable due to ambient temperature changes which may occur during storage, transportation and operation.

This test shall be carried out in accordance with the IEC 60794-1-2 F1 method.

7.3.2 Vibration

This subject is for further study.

7.3.3 Aging

Under consideration.

7.4 Test methods for fire safety

This clause recommends the appropriate tests and test methods for verifying the fire safety characteristics of optical fibre cables.

7.4.1 Flame retardant characteristics

This test shall be carried out in accordance with the IEC 60332-1 or IEC 60332-3-24 methods, unless there is a different agreement between a manufacturer and a user.

7.4.2 Toxic gases characteristics

This test shall be carried out in accordance with the IEC 60754-1 or IEC 60754-2 methods, unless there is a different agreement between a manufacturer and a user.

7.4.3 Smoke characteristics

This test shall be carried out in accordance with the IEC 61034-1 or IEC 61034-2 methods, unless there is a different agreement between a manufacturer and a user.

Appendix I

Overview on IEC specifications for indoor optical fibre cable

This appendix is intended to provide an overview of the specifications of indoor optical fibre cables defined in the system of the IEC. The complete IEC optical fibre cable specification structure is also described in ITU-T Supplement G.40, *Optical fibre and cable Recommendations and standards guideline*.

The IEC optical fibre cable structure specification is hierarchical, with the different levels being identified with numeric suffixes of different levels of detail. These are:

Generic: The general framework.

Sectional: Attributes for a broad category of applications, e.g., indoor, outdoor, etc.

Family: Attributes and values or ranges of values for different constructions, e.g., simplex/duplex, ribbon, etc.

Product: Detailed requirements specific to particular applications, e.g., specific cable attenuation coefficients, multimode fibre bandwidth, or temperature ranges.

In addition to the generic specification, IEC 60794-1, and test methods, IEC 60794-1-2, the relevant specifications for indoor cables are:

IEC 60794-2 (2002), *Optical fibre cables – Part 2: Indoor cables – Sectional specification*.

IEC 60794-2-20 (2003), *Optical fibre cables – Part 2-20: Indoor cables – Family Specification for multi-fibre optical distribution cables*.

IEC 60794-2-30 (2003), *Optical fibre cables – Part 2-30: Indoor cables – Family Specification for optical ribbon cables*.

The Family Specifications call out the attribute and values for the different main types of constructions. For some attributes, a number of value ranges may be listed, taking into account that not all of the specific applications or different regions may need the same values. The Product specification level of the hierarchy, is intended to provide specific values for specific applications.

The following Product Specifications are intended to define the product requirements specific to the ISO/IEC 11801, *Information technology – Generic cabling for customers premises*:

IEC 60794-2-11 (2005), *Optical fibre cables – Part 2-11: Indoor cables – Detailed specification for simplex and duplex cables for use in premises cabling*.

IEC 60794-2-21 (2005), *Optical fibre cables – Part 2-21: Indoor cables – Detailed specification for multi-fibre optical distribution cables for use in premises cabling*.

IEC 60794-2-31 (2005), *Optical fibre cables – Part 2-31: Indoor cables – Detailed specification for optical fibre ribbon cables for use in premises cabling*.

These documents also refer to the following fibre Specifications:

IEC 60793-2-10 (2004), *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*.

IEC 60793-2-50 (2004), *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*.

Appendix II

Indoor cable pathway (Japanese experience)

Indoor pathway systems for optical fibre cables

II.1 General

An optical fibre cable is normally led into a building through an underground conduit from a manhole or hand hole. Pathway systems for optical fibre cables in a building consist of a vertical pathway in the height direction and a horizontal pathway along the floors. This appendix outlines the pathway systems for optical fibre cabling in a building and important points to be kept in mind when selecting from among them.

II.2 Vertical cable pathway systems

An optical fibre cable led into a building is terminated at the building distributor and then routed vertically to provide cabling to respective floors or to each floor distributor.

As shown in Table II.1, there are three types of vertical cable pathway systems, namely, the ladder cable tray system, the metal duct system and the conduit tube system (see II.4 for further information).

Table II.1/L.59 – Comparison of vertical cable pathway systems

Pathway systems	Ladder cable tray system	Metal duct system	Conduit tube system
Outline	Cabling performed on ladder cable tray installed in the cable shaft area	Cabling performed in metal wiring duct fixed on the building wall, etc.	Cabling performed in conduit tube installed in the building wall, etc.
Cabling capability	Large	Medium	Small
Flexibility for cabling modification	High	Higher than conduit tube	Low because of cable removal needed
Security	Ensured with lock and key for the cable shaft	Slightly low because duct cover can be opened easily	Slightly low when installed in a tenanted area, although tube protection itself good
Fireproof performance	Secured by making a cable shaft to fireproof run	Slightly low because fire protection only performed by the metal cover, although no flame reach to cables	Slightly low because fire protection only performed by the metal conduit tube, although no flame reach to cables
Needed space	Large space needed due to large cable shaft requirement	Slightly large space needed because medium sizes metal wiring duct required	Small because conduit tube usually installed with an exposure
Cost	Advantageous for a large number of cables	Advantageous for large number of cables	Advantageous for small number of cables

The vertical cable pathway system requires high flexibility for subsequent extension of optical fibre cabling, capacity to house distributors and network equipment and security for the network system. It is, therefore, recommended that a dedicated cable shaft is provided as an architectural space in the building and ladder cable trays are installed in it up to the needed floor for vertical cabling. Metal ducts or conduit tubes may be installed where the cable shaft includes power lines, low-voltage lines, etc., or where there is no cable shaft. But these systems show less flexibility in cabling capacity and cabling modification than the ladder cable tray system, so the size and number of them should be selected with great care.

The cable shaft is, as a rule, located in the shared area of a building, so that operators for equipment maintenance or cabling system extension can work out of the tenant occupied area. To ensure security against human interference (intentional and unintentional), the entrance/exit doors should be kept under lock and key, and the entrances/exits should be located away from the flow lines of occupants, visitors and others. In a tenanted building, the cable shaft dedicated to each tenant should be provided if necessary. A cable shaft, which can be in danger of providing a spreading route for fire, should form vertical runs and horizontal runs with fireproof floors and walls in agreement with an architectural plan.

The parts where the ladder cable tray or optical fibre cable pass through the fire-resistant floor or wall should be given fireproofing treatments as specified in building standards law. The same requirements should be applied to metal ducts and conduit tubes as well. Where certain equipment is located in it, the cable shaft, which forms a closed space, should be provided with an appropriate ventilation system or air-conditioning system in order to maintain the temperature at 0° C to 40° C and the humidity at 80% or below.

II.3 Horizontal cable pathway systems

A horizontal cable pathway system is installed on the floor slabs, in the floor slabs or in the ceilings. It should be selected from the under-carpet cabling system, simplified access floor system (Figure II.3), raised access floor system, under-floor duct system, cellular raceway system, conduit tube system, ladder cable tray system and metal duct system (see II.4 for further information).

Table II.2 shows the advantages, disadvantages and application of these systems. In selection, careful consideration should be paid to the construction of the floor (thickness of floor slabs, reinforcement bar arrangement, floor finish, etc.), cabling capacity, expected movement and increase or decrease of terminal equipment, arrangement of furniture and fixtures, economy, etc.

The simplified access floor system is very advantageous because the whole space under the floor can be used for cabling, such selection can be made using a wide variety of products, and that cabling procedure can be simply carried out by removing the floor panels. Use of this system is therefore recommended in ordinary office buildings. The following points should be taken into consideration in selecting this system.

When re-cabling is done after desks and equipment are placed in the completed office, cables may be laid obliquely to save the trouble of moving the equipment and unnecessary cables may be left unremoved. As a result, the cabling space will become full quickly and the existing cables may suffer damage easily. It is therefore necessary to manage the cabling system with ample care. This is particularly important when the low floor mounted type, with minimum cabling space, is employed from the viewpoints of economy, and as much space as possible is needed above the floor within a limited story height.

Table II.2/L.59 – Comparison of horizontal cable pathway systems

Place	Systems	Outline	Advantage	Disadvantage	Application
On the floor slab	Under-carpet wiring system	A flat cable installed under the carpet	– No influence to story height – Cable pulling out from anywhere	– High cost – Small cabling capacity	Small wiring quantity, and when simplified access floor system is not available
	Simplified access floor system	– Two types – Panel-leg monoblocks and panel-leg separate type (Height: 50-150 mm)	– Easy cabling modification – Free cable pulling out position – Applicable to existing building	Slightly high cost	Fairly large wiring quantity, frequent cabling modification, and when space from 50 mm to 150 mm can be ensured
	Raised access floor system	Panels with legs placed on the floor slab (Height: 200-500 mm)	– Extremely large cabling capacity – Free cable pulling out position	– High cost – Difficult cabling modification with time – High story height needed	Extremely large wiring quantity for computer room or dealing room, for instance
In the floor slab	Floor duct system	Steel ducts cast in floor slabs, and cable access hatches installed at intervals	Well arranged cabling	– Relatively small capacity – Fixed cable pulling out point	– Infrequent cabling modification – Available together with under-carpet wiring system
	Cellular raceway system	Cabling raceway where cover plates enclose gaps in corrugated deck plates	– Large cabling capacity – Well arranged cabling	– Capacity depends on header duct – Troublesome cabling modification	Large wiring quantity, and when cabling route fixed
	Conduit tube system	Conduit tubes buried in floor slabs	Low cost	– Small capacity – Fixed cable pulling out point – Repairing becomes difficult due to pipe corrosion	Small wiring quantity, and when cabling fixed for a meeting room, for instance

Table II.2/L.59 – Comparison of horizontal cable pathway systems

Place	Systems	Outline	Advantage	Disadvantage	Application
In the ceiling	Ladder cable tray system	Ladder cable tray installed in the ceiling	– Big capacity – Easy cabling maintenance	– Troublesome cable protection and fireproofing – Aesthetically unpleasing due to exposed cabling	Large wiring quantity, and when simplified double floor system not available
	Metal duct system	Ducts placed in the ceiling and cables installed in it	Easy maintenance	Smaller cabling capacity than that of ladder cable tray system	Small wiring quantity and when exposed cabling prohibited

II.4 Pathway systems facilities

II.4.1 Ladder cable tray

Ladder cable trays are used to install a large number of cables for power supply, telecommunications, etc. Recently they have been used more widely because of their greater receptivity to installation and extension of cable systems than rigid metal conduits and metal ducts.

Tray materials are metals and plastics. The metal trays include steel trays (including zinc-coated ones) and aluminum trays, which are selected according to the place of use. In selecting ladder cable trays, careful consideration should also be paid to their load capacities.

Figure II.1 illustrates an example of a ladder cable tray system. The supporting interval is generally 2.0 m or less for steel ladder cable trays or 1.5 m or less for aluminum ladder cable trays. Aseismic design metal fittings should also be attached below the main beams, wall surfaces and posts to protect the trays against earthquakes. Ladder cable trays may have widths of 200 mm, 300 mm, 400 mm, 500 mm and 600 mm. Cables should be installed on the trays in single-level arrays in principle. Ladder cable trays of proper dimensions should be selected by taking into consideration the cable dimension, the required cable separation from each other, and the margins at each end of the trays.

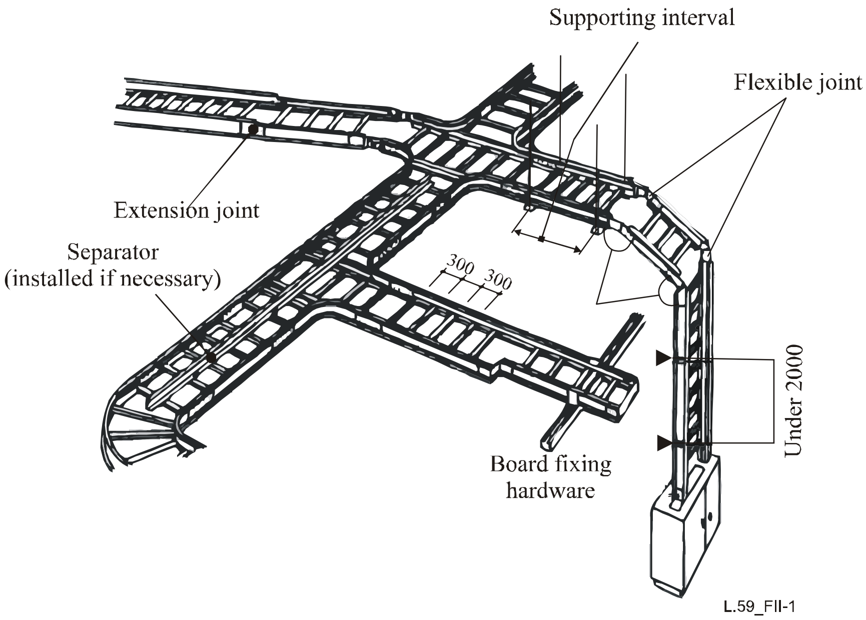

Figure II.1/L.59 – Example of ladder cable tray system

II.4.2 Metal duct

Metal ducts, which have structures like the one shown in Figure II.2, are used to install a large number of electric wires or cables. The electrical installations technical standard according to electric appliance and material control law states that metal ducts should have steel sheets with a width of 50 mm or more and a thickness of 1.2 mm or more, or other metallic material of equal or superior strength. They should be supported securely at intervals of 3 m or less on the ceiling or the equivalent (6 m or less where the metal duct is installed vertically in a place to which no one except the authorized personnel has access). The total cross-sectional area of electric wires and cables (incl. insulation) installed in a metal duct should be 20% or less of the cross-sectional area of the duct. (It can be 50% or less for the wires for control circuits or in-out annunciators.) Also, it is desirable that the number of wires is less than 30.

Careful consideration should be paid to the use of a metal duct since it contains a large number of electric wires or cables and the fireproofing procedure is difficult at the point where it penetrates the firewall within the building.

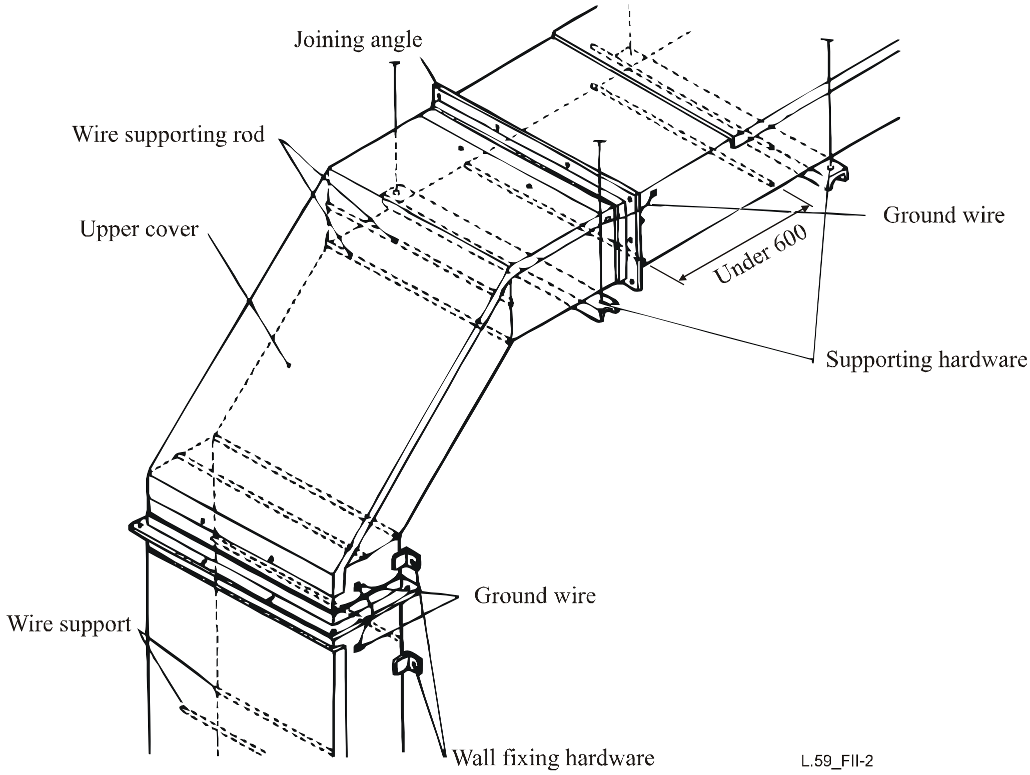

Figure II.2/L.59 – Metal duct system

II.4.3 Conduit tube

Conduit tubes, which are used to protect electric wires or cables, are chosen from metal tubes (steel conduit tubes) and plastic tubes. There are three types of metal tubes, namely, thin wall steel conduit, thick wall rigid steel conduit and plain conduit.

Type	Name	Outer diameter mm	Thickness mm	Inner diameter mm
Thin wall steel conduit	C19	19.1	1.6	15.9
	C25	25.4	1.6	22.2
	C31	31.8	1.6	28.6
	C39	38.1	1.6	34.9
	C51	50.8	1.6	47.6
	C63	63.5	2.0	59.5
	C75	76.2	2.0	72.2
Thick wall rigid steel conduit	G16	21.0	2.3	16.4
	G22	26.5	2.3	21.9
	G28	33.3	2.5	28.3
	G36	41.9	2.5	36.9
	G42	47.8	2.5	42.8
	G54	59.6	2.8	54.0
	G70	75.2	2.8	69.6
	G82	87.9	2.8	82.3
	G92	100.7	3.5	93.7
	G104	113.4	3.5	106.4

Type	Name	Outer diameter mm	Thickness mm	Inner diameter mm
Plain conduit	E19	19.1	1.2	16.7
	E25	25.4	1.2	23
	E31	31.8	1.4	29
	E39	38.1	1.4	35.3
	E51	50.8	1.4	48.0
	E63	63.5	1.6	60.3
	E75	76.2	1.8	72.6

II.4.4 Raised access floor (including simplified access floor)

A great variety of raised access floors are available on the market today. Raised access floors, which are made up of floor panels constituting part of residential space, and legs to support the floor panels above floor slabs, are classified into the following types:

II.4.4.1 Panel-leg separate type

Method — Removable panels are placed on legs fixed to floor slabs.

Placement — Legs are fixed to floor slabs with adhesive or rivets, and panels are secured on top of the legs.

Level adjustment — ±10 mm adjustable by floor-level adjusting nuts on legs.

Cabling space — Largest, with wide selectability of floor height.

Material — Panel: steel, aluminum, ceramic, composite steel.

Leg: steel, aluminum.

II.4.4.2 Panel-leg combined type

Method — Panel has legs in four corners. Panel and legs cannot be separated.

Placement — Panel-leg monoblocks are placed on structural floor.

Level adjustment — ±10 mm adjustable by screw elements on legs.

Cabling space — Relatively large.

Material — Panel: steel, aluminum, ceramic, composite steel.

Leg: steel, aluminum.

II.4.4.3 Floor mounted type

Method — Panel and legs are unified. Panel and legs cannot be separated.

Placement — Panel-leg monoblocks are placed on floor slabs.

Level adjustment — Level difference between panels is prevented by choice of small dimensions of panel. Level difference due to installation error of floor slabs cannot be absorbed.

Cabling space — Small.

Material — Plastic, ceramic, aluminum, composite steel.

Raised access floor panels (elements) on the market are made of metallic panels (steel moldings, aluminum castings), ceramic panels (fibre-reinforced calcium silicate plates, fibre-reinforced concrete plates, etc.), organic panels (plywood-resin moldings) and composite panels (wood core and steel, mortar core and steel, etc.). Panels with metal legs (steel welded structure, aluminum castings) or organic legs (resin moldings) are also commercially available.

Figures II.3 and II.4 illustrate an example of a simplified access floor system and an example of a floor-mounted type simplified access floor system, respectively, which are both widely used in ordinary offices.

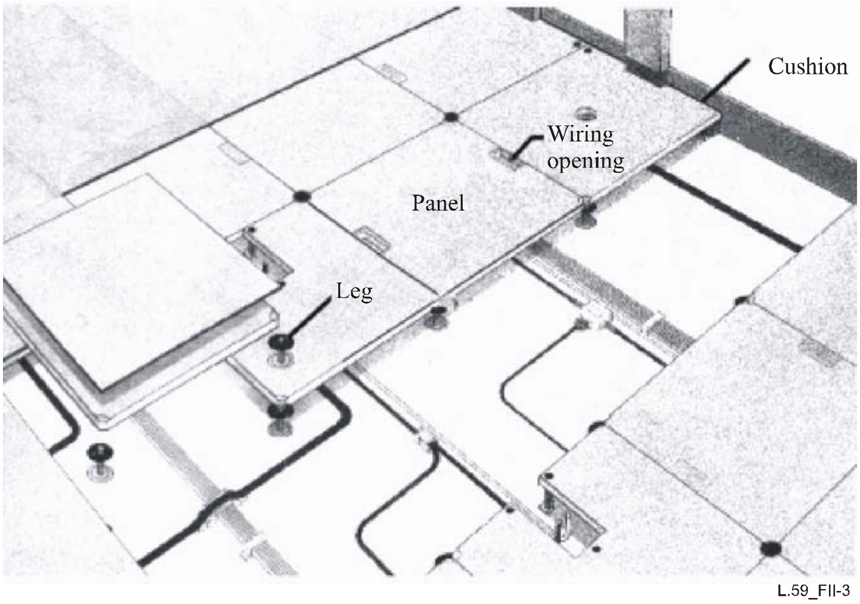

Figure II.3/L.59 – Example of simplified access floor system (Panel-leg separate type)

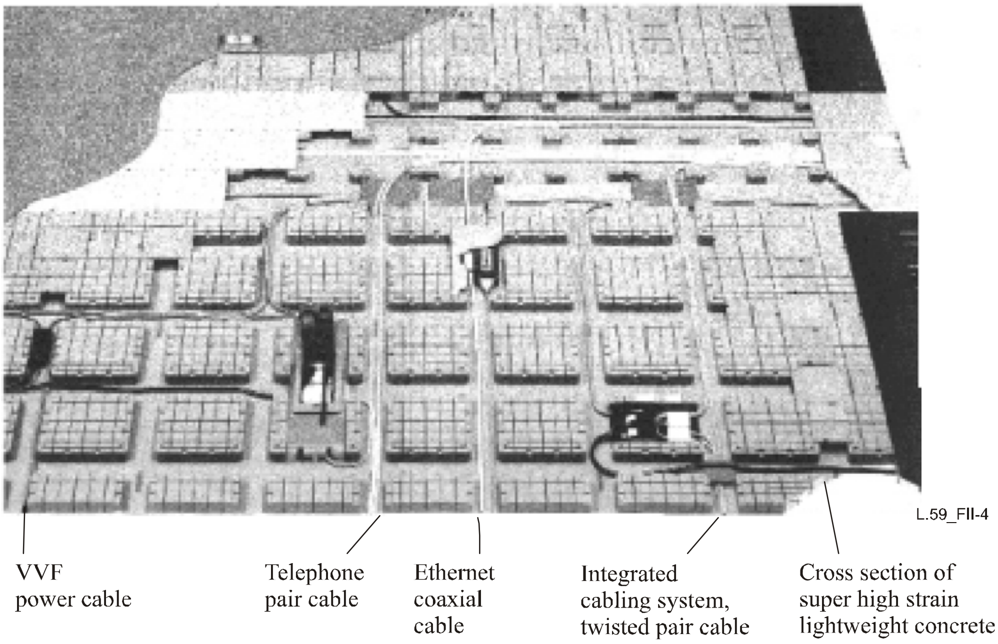

Figure II.4/L.59 – Example of simplified access floor system (Floor-mounted type)

II.4.5 Under-floor duct

The structure of under-floor ducts is shown in Figure II.5. Steel ducts buried in concrete floor slabs are used for power cabling, for plug sockets, etc. as well as telecommunication and information cabling for telephones, OA equipment, etc. Figure II.6 gives an example of installation.

Wires and cables in the buried floor ducts are led out from the insert studs provided at 600 mm intervals.

Piping to cabinets and distribution panels inside a cable shaft should be so arranged that pipes do not cross each other or converge on the same point, in order to not weaken the strength of floor slabs around the cable shaft.

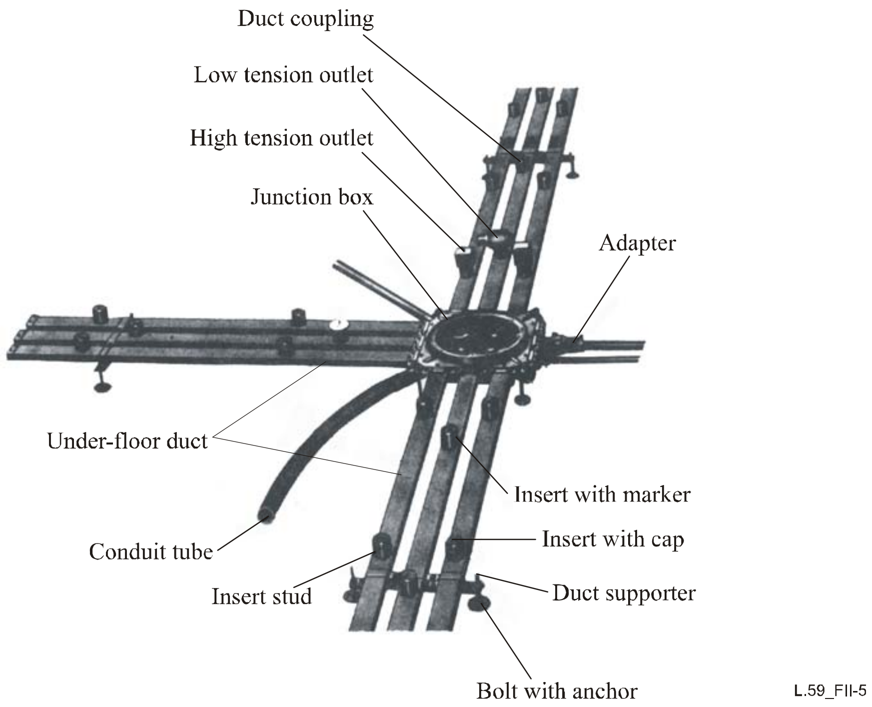

Figure II.5/L.59 – Outline of under-floor duct system

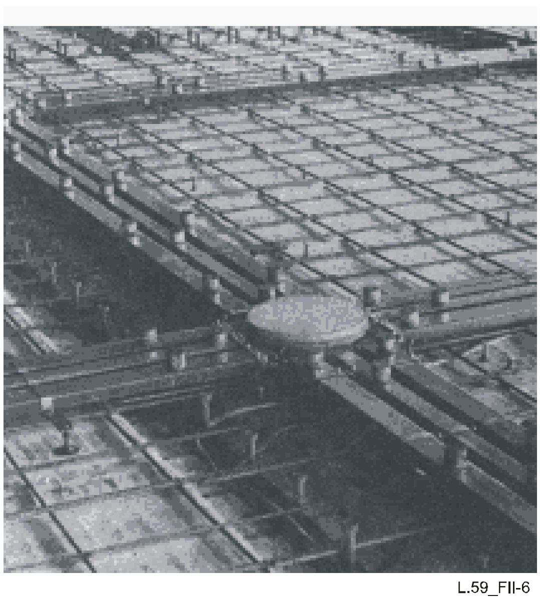

Figure II.6/L.59 – Example of under-floor duct installation

II.4.6 Cellular raceway

Cellular raceways are cabling ducts formed by enclosing with cover plates the gaps in corrugated deck plates used as floor formworks in a building.

With larger cross-sectional areas than under-floor ducts, cellular raceways can hold more wires and cables. Also, cabling is easier because of the larger diameter studs for outgoing cables. Some fireproofing procedures should be followed for the cellular raceways buried in the floor, which may reduce the cross-section of the floor. Also, consideration should be given to cracks in the concrete.

As shown in Figure II.7, cellular raceways are normally used in combination with under-floor ducts. Figure II.8 gives an installation example of a cellular raceway for reference.

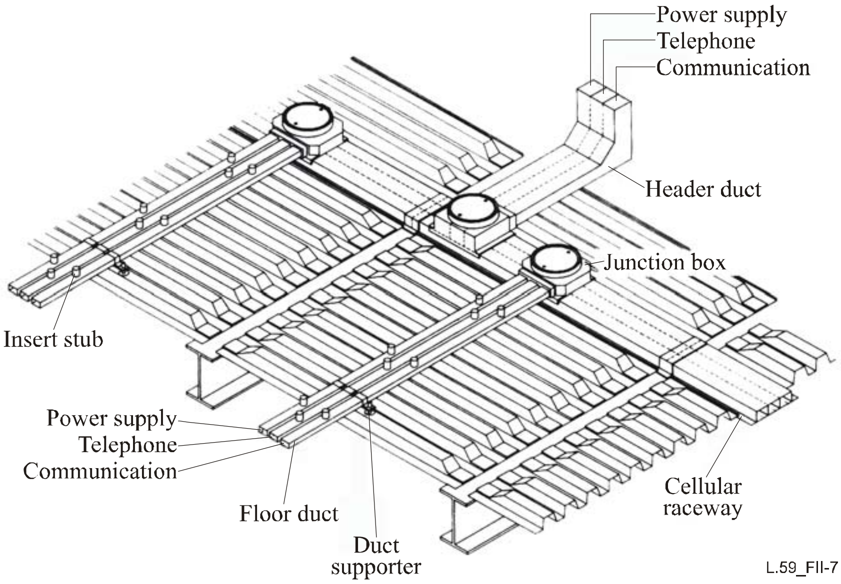

Figure II.7/L.59 – Outline of cellular raceway system

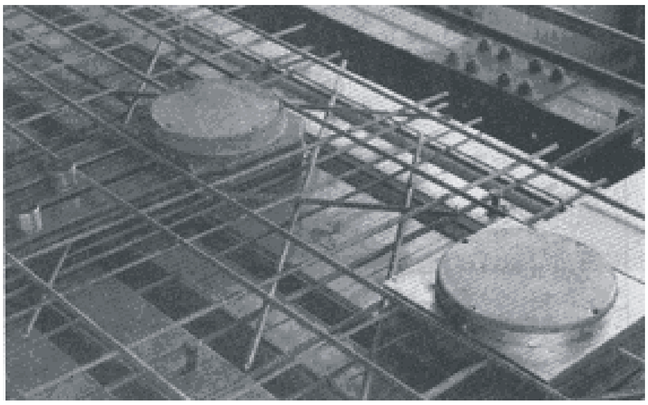

Figure II.8/L.59 – Example of cellular raceway installation

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