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

# Air-assisted installation of optical fibre cables

ITU-T Recommendation L.57

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**Summary**

This Recommendation describes air-assisted methods for installation of optical fibres cables in ducts. These methods can be used to install micro cables into mini tubes, or jacketed cables into ducts or conduits. Installing conditions and equipment required shall be different in each case.



**Source**

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## FOREWORD

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## CONTENTS

# ITU-T Recommendation L.57

## Air-assisted installation of optical fibre cables

### 1 Introduction

Air-assisted installation is based on forcing a continuous high-speed airflow along the cable with an air source. Moving air force pushes the cable and makes it advance forward at a typical speed supported by the equipment.

Generally, the load on the cable is an order of magnitude lower than the typical force involved with other installation methods, like pulling techniques, reducing installation hazards. Additionally, with this technique, bends in duct run are not as important a matter of concern as they are in pulling techniques, so that installation speed increases and longer lengths of cable can be installed. Cables are installed without virtual stress, leaving the cable relaxed in the duct upon completion of the installation.

There are several variants of installation: with/without a piston at the front end of the cable, or with a leaking piston. For variants without a piston, there is no pulling force at the front end of the cable: air flow exerts a distributed force along the entire cable. In addition, the connection to a pulling cord is not needed.

### 2 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.

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

[2] ITU-T Recommendation L.10 (2002), *Optical fibre cables for duct and tunnel applications*.

[3] ITU-T Recommendation L.12 (2000), *Optical fibre joints*.

[4] ITU-T Recommendation L.35 (1998), *Installation of optical fibre cables in the access network*.

### 3 Installation of jacketed cables in ducts

#### 3.1 Considerations about elements when installing cable

##### 3.1.1 Cable duct

The combination of duct parameters and materials are critical in determining the installation requirements of specific cable designs when using air-assisted techniques (e.g., air tightness, circular shape, friction coefficient, wall thickness, etc.). Maximum duct diameter depends on the type of machine used.

Inner duct diameter shall guarantee correct installation of cable.

### 3.1.2 Cable

Maximum installation length is influenced by the stiffness and weight of the cable. A very flexible cable can only be pushed with a low pushing force and it might be necessary to use an additional element at the front end of the cable, like an open shuttle, which allows the air stream to flow through its centre bore and exert a low pulling force at the front end of the cable. This element might also be necessary when the diameter of the cable is very small compared with the internal diameter of the duct.

When using a piston at the front end of the cable, a pulling force is exerted on the cable. In this case, maximum cable stress, which depends on the cable design, shall not be exceeded.

Cable sheath friction coefficient and friction properties of the duct liner (low enough) are critical. It should be as low as possible. It could be influenced by the selection of the cable coating and duct characteristics.

If required, the use of the proper lubricant is an important factor to obtain an optimum performance.

### 3.1.3 Cable route

Very tight bends in the route shall be avoided because maximum installation length depends on the number of bends, the location of them in the route, the shape and gradient of the cable route. Usually, the straighter the duct, the longer the installation length permitted.

### 3.1.4 Compressed air

High-speed airflow that moves the cable into the duct is normally generated by a compressor on site. The maximum pressure of the compressor depends on the type of equipment used. Typically, it might be around 10-12 bar. Flow rate at the compressor output depends on the type of equipment and also on the internal diameter of the duct. Usually, the smaller the duct diameter, the lower the air flow rate and also the shorter the installation length, for a specific cable design.

Compressed-air temperature has a great influence on the relevant parameters. At high temperatures, the material used in the cable jacket and duct begins to soften. This increases the friction between cable and duct, causing a reduction in the system performance. For ambient temperatures exceeding 30º C, it is highly recommendable to use an air cooler inserted between the compressor and the blowing system.

### 3.1.5 Cable-insertion machine

A cable-insertion machine consists of a mechanical device that applies a force on the cable and controls its speed into the duct. It can be driven by an air or hydraulic motor with a manual and automatic run-stop dispositive. This element is divided into two construction principles: pushing of the cable by a rubber block caterpillar drive belt, and pushing by a notched wheel drive.

## 3.2 Variants of air-assisted installation

The choice of method, described below, depends on several factors: type of cable (diameter, weight, stiffness), duct diameter, shape of the route (number of bends, location of the bends, gradient) and the equipment to be used. In the same manner, the installed lengths and laying speed depends on all these factors.

### 3.2.1 Installation method with a piston at the front end of the cable

In this method, a piston is attached at the front end of the cable. It transfers a defined pulling force to the cable which shall not exceed the allowed tensile load. The piston exerts only a fraction of the maximum permissible pulling force on the cable.

If the piston gets to an oval section of the duct, it may get stuck in it. To avoid such a situation, the piston should have flexible cup sleeves or similar.

It is also possible to use a piston with a smaller diameter than the internal duct's diameter applied at the front end of the cable (*leaking piston*). It could be an open shuttle, which allows the air stream through its centre bore. In this case, leaking level shall affect the level of stress suffered by the cable.

### 3.2.2 Installation method without piston at the front end of the cable

In this case, the cable is inserted into the duct free of pulling force by means of a large and fast flowing air volume. The air streaming through the duct exerts a certain thrust on the cable sheath: this force is caused by friction between air particles and cable sheath. The compressor needs to provide sufficient capacity of air for the installation.

## 3.3 Operations

### 3.3.1 Precautions

When installing a cable using these methods, all precautions considered in other installation methods (reels handling, cables, personal security, cable storage in splice point, etc.), need to be taken into account.

Additionally, and previous to the installation of the cable, it shall be recommended:

- To plan the route, and determine the best locations where the blowing-in machines shall be placed, in order to achieve an optimum adaptation between the machine and the duct. This installation method allows the use of several blowing machines in series at different points of the same route, to obtain longer installation lengths or to solve complexity problems of the route. It may be possible to achieve installation lengths of 3 km, using only one blowing machine, depending on the characteristics of the route, the type of cable, duct and machine used.
- To check the continuity and integrity of the duct, in order to avoid losses of air pressure which may limit the performance of the system. In the points of discontinuity of the duct, it shall be necessary to splice the duct.
- To check the duct inside, in the direction of installation, in order to ensure the absence of obstruction elements inside the duct, like water, dust or even stones. In the same manner, the absence of any flattening in the complete length of the duct should be checked[1].
- If required, a liquid lubricant can be added to the duct. To spread the lubricant uniformly along the duct, a sponge pushed by the air flow may be used. In some cases, the pouring of additional lubricant during the installation of the cable could be necessary.
- To clean the cable before inserting it into the cable-insertion machines.
- To take into account that a number of persons may be necessary in the installation process, in order that the following processes can be safely managed: handling the cable reel; handling the blowing machine; inserting the cable into the machine, and receiving the cable at the far end.
- When required, the cable may be installed from an intermediate point. In this case, once the first part of the cable has been installed, it is recommended to lay the remaining part of the cable as a figure of eight, or push it into a fleeting cage by means of the blowing-in machine.
- The maximum pressure the duct can support shall not be exceeded.

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[1] There are different methods to check duct suitability (e.g., to blow in a sizing mandrel or a sponge).

### 3.3.2 Installation process

Once all precautions detailed in the previous paragraphs have been taken, and the blowing-in machines have been located in the right places, it is recommended:

- To prepare the front end of the cable. When using the installation method without piston, a light-weight cable guide shall be fitted over the cable sheath to ease the movement of the cable around bends and through subduct connectors. When using the installation method with piston, the right cable grips shall be prepared: they will be attached at the front end of the cable
- To prepare the duct in order to adapt the blowing machine to the duct.
- If necessary, to fit the cable pushing elements of the blowing machine to the cable diameter.
- To put the cable into the insertion elements of the machine.
- To introduce the cable into the duct.
- To fix the cable to the insertion elements of the machine.
- To fix the duct to the blowing machine using an appropriate connector, in order to avoid air losses during the process.
- To start up the machine. The airflow generated by the compressor will begin dragging the cable inside the duct.
- At the distant end of the duct, the cable should be received. Care must be taken by operatives because the cable may come out quite fast. If the installation process finishes at that point, a remaining length of cable, for cable splicing purposes, should be stored in the usual conditions.
- In case of several blowing machines being used in series, when the cable reaches the second installation point, it is necessary to stop the first machine and to introduce the cable into the second machine and duct, like previously detailed, and fix them to the cable. Afterwards, start up the first machine and then the second one. If any additional blowing machine is being used, proceed as detailed.
- When the cable is installed from an intermediate point, to install the first length of the cable in one direction. Once it is finished, lay the remaining cable as a figure of eight, or coil it into the special coiling apparatus by means of the blowing machine. Special care must be taken in order to prevent the cable getting dirty. Place the blowing machine in order to allow the installation in the opposite direction and proceed in a similar way as detailed previously.

## 4 Installation of microcables in minitubes

Similar considerations, as previously detailed, shall be taken into account when installing microcables in miniducts. In this case, usually the diameter of the cables and ducts will be smaller. The characteristics of the ducts, materials and properties may be different. The blowing machines may also be different but precautions and installation process will be similar to the one previously detailed.

# Appendix I

## Indian experience: Installation of Optical Fibre Cables (OFC) by Air blowing method

Liberalization of Telecommunications, the advent of Internet and advances in Optical fibre technology, have all led to increased need for efficient, fast and highly reliable methods for the installation of OFC. The lightness of weight of OFCs has led to the development of the Air Blowing Technique for their installation. This technique essentially requires two main products viz., an ultra-smooth duct and an Air-Blowing Machine.

The duct is made of high quality HDPE pipe co-extruded with a special solid polymer lubricant as inner lining. The important characteristics of this type of pipe are:

a) Low internal coefficient of friction with the sheath of the OFC;

b) Absence of coil-set;

c) Bending radius: minimum 10 times the outer diameter of the pipe;

d) Installation over wide range of temperature –5º C to +50º C;

e) Accurately controlled dimensions to enable leak-proof joints with suitable accessories;

f) Expected life span minimum 50 years.

The Air blowing machine is capable of supplying a moisture-free Air jet at pressure through a feed machine that introduces the OFC into the duct. It basically consists of:

a) A compressor, capable of delivering air at 10 kg pressure continuously.

b) An air cooler with facility to remove water vapour.

c) A cable feed system fitted with a pneumatic motor to feed the cable continuously at a speed of up to 100 metres per minute. Generally, a speed of about 60 metres per minute is chosen. The advantages of the blowing method for OFC installation into the duct are:

   i) There is no stress on the OFC, as the inner surface of the duct is ultra smooth. Typically, the coefficient of friction is less than 0.08. It is a pushing rather than pulling action of the cable.

   ii) It allows a longer installation in a faster and more efficient way. A one-kilometre OFC can be laid in less than 20 min.

   iii) The influence of bends and curves is minimum.

   iv) There are a minimum number of joints in the duct and cable splices.

   v) The overall cost of installation and maintenance is reduced.

   vi) Future upgrading is facilitated.

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