IMPLEMENTATION GUIDELINES FOR IN-BUILDING OPTICAL FIBRE CABLING FOR GENERAL HOUSING DEVELOPMENT

(IFC GHD GUIDELINES)

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ACRONYM AND ABBREVIATION

ABS	–	Acrylonitrile butadiene styrene
ABCi	–	Authority for Building Control and Construction Industry
AITI	–	Authority for Info-Communications Technology Industry of Brunei Darussalam
ANSI	–	American National Standard Institute
APC	–	Angle Polished Connector
APL	–	Aluminum Polyethylene Laminate
ASTM	–	American Society for Testing and Materials
ATB	–	Access Termination Box
BOM or BOMs	–	Bill-of-Material or Bill-of-Materials
BOQ or BOQs	–	Bill-of-Quantity or Bill-of-Quantities
BST	–	Brandschutztechnik sealing system
BT Approval	–	British Approval Board for Telecommunications
CO	–	Central Office
CPE	–	Customer Premise Equipment
EGI	–	Electronic Galvanized Iron
EIA	–	Electronic Industries Alliance
ETSI	–	European Telecommunications Standard Institute
E2E	–	End-To-End
FAT	–	Fibre Access Termination
FCP	–	Fibre Concentration Point
FDA	–	Fibre Distribution Area
FDH	–	Fibre Distribution Hub
FDT	–	Fibre Distribution Terminal
FPC	–	Flat Polished Connector
FRP	–	Fibre Reinforced Plastic
FSA	–	Fibre Service Area
FTTH	–	Fibre-To-The-Home
FTTP	–	Fibre-To-The-Premise
FTTx	–	Fibre-To-The-x (Collective term for various fibre delivery)
GI	–	Galvanised Iron
GHD	–	General Housing Development
GPON	–	Gigabit Passive Optical Network
HDD	–	Housing Development Department

HDPE	–	High Density Polyethylene
HDPE-CD	–	High Density Polyethylene - Corrugated
HT	–	High Tension
IL	–	Insertion Loss
ICEA	–	Insulated Cable Engineers Association
IEC	–	International Electrotechnical Commission
IFC	–	In-building optical Fibre Cablings
IP	–	Ingress Protection
ISO	–	International Standardisation for Organisation
ITU	–	International Telecommunication Union
ITU-T	–	International Telecommunication Union – Telecommunication Standardization Sector
IW	–	Internal telecommunication Wiring
JIS	–	Japanese Institute of Standards
LSZH	–	Low Smoke Zero Halogen
MCT	–	MCT Brattberg duct sealing system
MFD	–	Mode Field Diameter
MDU	–	Multi dwelling unit
NEC	–	National Electric Code
NRB	–	Non-Residential Buildings
NTT	–	Nippon Telegraph and Telephone
ODF	–	Optical Distribution Frame
ODN	–	Optical Distribution Network
OFNR	–	Optical Fibre Non-Condutive Riser
OLT	–	Optical Line Terminal
OLTS	–	Optical Loss Test Set
ONT	–	Optical Network Terminal
ORL	–	Optical Return Loss
OSP	–	Outside Plan
OTDR	–	Optical Time Domain Reflectometer
PAC	–	Provisional Acceptance Certificate
PBTP	–	Plybutylene Terephthalene
PC	–	Polished Connector
PDL	–	Polarisation Dependent Loss
PE	–	Polyethylene

PLC	–	Planar Lightwave Circuit
PON	–	Passive Optical Network
POP	–	Point of Presence
PVC	–	Polyvinyl Chloride
P2 mP	–	Point-To-Multipoint
RBS	–	Reduced Bend Sensitive
RJ-11	–	Registered Jack-11
RJ-45	–	Registered Jack-45
RoHS	–	Restriction of Hazardous Substances
ROX	–	Roxtec sealing system
SC	–	Simplex Connector
SC/APC	–	Simplex Connector/Angle Polished Connector
SDU	–	Single Dwelling Unit
secs	–	Seconds
SFCP	–	Sub-Fibre Concentration Point
SM	–	Single Mode
SPC	–	Super Physical Contact
SZ-lay	–	Reverse Oscillation Lay
TB	–	Termination Box
TL-9000	–	Telecom's industry extension to ISO9001:2008
TIA	–	Telecommunication Industry Association
UL	–	Underwriters Laboratories
UPC	–	Ultra Polished Connector
uPVC	–	Unplasticised Polyvinyl Chloride
U/G	–	Underground
UV	–	ultraviolet
WDM	–	Wavelength Division Multiplexing
Units of Measurement		
A	–	Ampere
AC	–	Alternating Current
AWG	–	American Wire Gauge
Bar	–	Metric measurement unit of pressure
cm	–	centimeter
db	–	decibel
db/km	–	decibel per kilometer

g/cm^3	–	gram per cubed centimeter
hrs	–	hours
in	–	inch
kg	–	kilogram
kgf/m	–	kilogram force per meter
kgf/cm^2	–	kilogram force meter per square centimeter
km	–	kilometer
kpsi	–	kilopound per square inch
lbf	–	pound force
lux	–	SI unit for illuminance and luminous emittance
m	–	meter
min	–	minutes
mm	–	millimeter
Mohm	–	megaohm
MPa	–	megapascal
µm	–	micrometer
nm	–	nanometer
Ps/nm	–	temporal spread (ps) per unit propagation
Vac	–	torrs
%	–	percentage
^oC	–	degree celsius
^oF	–	degree Farenheit

ANNEX 1 | IMPLEMENTATION GUIDELINES FOR IN-BUILDING OPTICAL FIBRE CABLINGS FOR GENERAL HOUSING DEVELOPMENT 2015

01 December 2015

The Authority for Info-communications Technology Industry ("AITI") hereby issues these Implementation Guidelines for In-Building Optical Fibre Cablings for General Housing Development 2015 ("IFC GHD Guidelines").

1. INTRODUCTION

1.1 OBLIGATIONS OF DEVELOPERS OR OWNERS

1.1.1 These IFC GHD Guidelines lay down the detailed specifications of the space and facilities which developers or owners of buildings are to provide under the Code of Practice for In-building Optical Fibre Cablings For General Housing Development 2015 (IFC GHD Code) in order to enhance the range and/or quality of info-communication services, based on optical fibre, which may be provided to their buildings by telecommunication system licensees. This document is to be read together with the IFC GHD Code which sets out the mandatory requirements in respect of the space and facilities which developers or owners are required to provide. Nothing in these IFC GHD Guidelines shall waive any developer or owner of its obligation to comply with the provisions of the IFC GHD Code. In the event of any conflict between the IFC GHD Code and these IFC GHD Guidelines, the provisions of the IFC GHD Code will prevail.

1.1.2 The specifications laid down in the IFC GHD Guidelines are based on existing policies and circumstances relating to the current and presently anticipated states of technological development, infrastructure deployment and service provision of the telecommunication system licensees. As such policies and circumstances may change with technological advancements and differing service demands, AITI reserves the right to amend, add or remove any of the procedures, specifications and standards set out in these IFC GHD Guidelines from time to time.

1.2 RULES OF CONSTRUCTION

1.2.1 Except where a term is specifically defined in these IFC GHD Guidelines, capitalised terms and words used in these IFC GHD Guidelines have the same meaning as in the IFC GHD Code.

1.3 SHORT TITLE

1.3.1 These Guidelines may be referred to as the "IFC GHD Guidelines".

2. GENERAL REQUIREMENTS FOR TELECOMMUNICATION FACILITIES

2.1 GENERAL

2.1.1 This chapter specifies the general requirements for the space and facilities provided in accordance with the IFC GHD Code, including the segregation of info-communication facilities from other utilities or services, diversity of lead-in and underground pipes, general and fire protections, joint inspection and acceptance of the space and facilities, and responsibilities of licensees and developers or owners.

2.2 SEGREGATION REQUIREMENTS

2.2.1 Non-electrical Plant:

(a) All manholes, underground pipes and cables for telecommunication services shall be kept clear of gas or water mains, service pipes and also isolated from manholes and joint boxes belonging to other services. The clearance shall be 150 mm, but in difficult situations, it may be reduced to 50 mm where the plant crosses each other. Where gas and water mains are concerned, a clearance of at least 150 mm shall be maintained to permit the use of a pipe-threading machine. Underground plant, (including cables and pipes, crossing bridges constructed wholly or partly of steel) shall be insulated electrically from the steelwork throughout its entire length. Metal or PVC trunkings, tarmac and cement may be used. For non-electrical plant, segregation requirements shall be in accordance with the requirements of the Public Works Department, Ministry of Development.

2.2.2 Electrical Plant:

(a) Requirements of the clearance to be provided between power and telecommunication cables are as follows:

i. For single-core power cables (exceeding 400 V), the minimum clearance shall be 460 mm, no exception being permitted.

ii. For multi-core power cables (exceeding 400 V), the minimum clearance shall be 300 mm. Where a clearance of 300 mm cannot be obtained, a smaller clearance may be allowed. However, for clearances less than 150 mm, a slab of concrete shall be inserted between the two sets of cables.

iii. For power cables (less than 400 V), the minimum clearance shall be 50 mm. If the clearance is less than 50 mm, insulation sheets of non-combustible material with a thickness of 40 mm shall be placed between the sets of cables.

iv. Telecommunication cables shall be separated from any electrical cables by separate casings, conduits, compartment ducts, etc. Where telecommunication and electrical cables intersect, a 'bridge' or suitable cross-over joint piece shall be provided.

v. In addition to part iv. above, where telecommunication and electrical cables are housed in trunking with multiple compartments, the trunking shall be designed to ensure that the cables remain in their individual compartments and the segregation between each compartment shall be continuous.

vi. All metal trunking and conduits shall be effectively earthed in accordance with the requirements of the Department of Electrical Services, Prime Minister's office.

2.2.3 Multi-tiered cable tray:

(a) In the event that multi-tiered cable trays are used for various services, the bottommost cable tray shall be assigned to carry telecommunication cables. There shall also be a minimum of 100 mm clearance between the cable tray assigned to carry telecommunication cables and the next cable tray(s).

2.3 DIVERSITY

2.3.1 An additional set of lead-in pipes shall be provided at a different location for the following buildings for diversity purposes:

(a) Hospitals;

(b) Airports;

(c) Police stations;

(d) Fire stations;

(e) Military camps;

(f) Power generation or control plant;

(g) Radio and TV stations;

(h) Computer or data centers;

(i) Security agencies, and

(j) Financial centers.

2.3.2 In addition to the types of building listed above, for buildings where the developer or owner requires diversity for its telecommunication services, an additional set of lead-in pipes shall be provided.

2.4 GENERAL PROTECTION

2.4.1 The space and facilities provided for telecommunication cables must be able to adequately protect the cables from possible damage caused by mechanical means, exposure to weather, corrosive fumes, water or excessive dampness, accumulated dust, steam, oil, high temperature or any other conditions which may damage the cables.

2.5 FIRE PROTECTION

2.5.1 Water sprinkler systems must not be used in the telecommunication equipment room and telecommunication risers. To comply with Brunei Fire and Rescue Department's condition of waiver for such installation, the telecommunication equipment room must be accessible directly from the outside of the building.

2.5.2 In addition, other forms of fire protection systems acceptable to the Brunei Fire and Rescue Department may be provided.

2.6 FACILITY RECORD

2.6.1 For the purpose of maintenance and timely restoration of services in the event of breakdown, it is essential that the exact location of the lead-in and underground pipes, telecommunication equipment room(s), telecommunication riser(s), cable tray routes and details of any other facilities provided by developers or owners within the building compound, such as location and dimension of manholes, are properly documented on plans. A laminated set or copy should also be displayed prominently and permanently inside the main distribution frame room for easy reference during maintenance works.

2.7 INSPECTION PROCEDURE FOR COMPLETED SPACE AND FACILITIES

2.7.1 Except where the provision of telecommunication equipment room(s) is not required for certain types of building development under the IFC GHD Code, a written request shall be made to the Authority for Building Control and Construction Industry ("ABCi") for a joint site inspection upon the completion of the construction works. The written request shall be copied to AITI.

2.7.2 The joint site inspection shall be confined to the following space and facilities as may be applicable –

(a) telecommunication equipment room(s);

(b) lead-in pipes and underground pipeline system;

(c) telecommunication riser(s); and

(d) cable trays between the telecommunication equipment room(s) and the telecommunication riser(s).

2.7.3 Where any space or facility is found to be non-compliant with the IFC GHD Code during the joint site inspection, such deficiency shall be recorded in the inspection checklist, signed by the relevant parties and submitted to AITI.

2.7.4 Where no deficiencies are recorded in the inspection checklist, an arrangement may be made with any licensee, whose services are required, to deploy its installation, plant or system in the relevant space and facilities for the provision of services to the building.

2.7.5 Where deficiencies are recorded in the inspection checklist, such deficiencies shall be rectified as soon as practicable before the deployment of installation, plant or system by licensees. However, an arrangement may be made for licensees to deploy concurrently their installation, plant or system in those space and facilities which do not require rectification works.

2.7.6 Once all deficiencies recorded in the inspection checklist are rectified, the declaration form shall be submitted to AITI.

2.7.7 A flow chart depicting the inspection process is set out in Figure 1.

2.7.8 Nothing in this section shall limit AITI's right to require the developer or owner of the building to rectify any space and facilities that are not constructed in accordance with the IFC GHD Code at any time and regardless of whether or not such space and facilities have been inspected under the procedure set out in this section.

2.8 RESPONSIBILITIES OF THE LICENSEES

2.8.1 After handing over of the space and facilities to the licensees for their deployment of installation, plant and systems, the licensees shall be responsible for maintaining their installation, plant and systems and the general cleanliness of the space and facilities.

2.9 RESPONSIBILITIES OF THE DEVELOPERS OR OWNERS OF BUILDINGS

2.9.1 The developer or owner shall be responsible at its own expense for the provision and maintenance of all the facilities within the building, including but not limited to the facility records, cable trays, trunkings, lead-in and underground pipes, manholes, telecommunication equipment room, mobile deployment space and telecommunication risers, and for ensuring that they are in good serviceable condition and accessible to the licensees' personnel at all times;

2.9.2 The developer or owner shall assist the licensees at its own expense for drilling through concrete floor, ceilings or walls of buildings that form part of the facilities for telecommunication within the building; and

2.9.3 The developer or owner shall ensure at its own expense that adequate security measures are taken at the telecommunication equipment room, mobile deployment space and telecommunication risers to pre-empt trespassing by any unauthorised personnel. Under no circumstances should the telecommunication equipment room and telecommunication risers be used for any other purpose such as a store room. The developer or owner shall hand over the telecommunication equipment room and telecommunication risers to the licensees upon acceptance of the facilities by the licensees, for their deployment of telecommunication services.

2.10 INSTALLATION OF TELECOMMUNICATION CABLES

2.10.1 The developer or owner may install and maintain its telecommunication cables for its own use or for access by its tenants or lessees.

2.10.2 The developer or owner shall engage qualified or licensed wiring contractors to install telecommunication cables in its development. The developer or owner may also enter into a commercial arrangement with any licensee to install its telecommunication cables in its development.

2.10.3 However, in multi-tenanted buildings, tenants or lessees have the choice of getting any telecommunication licensee to provide any telecommunication services. A tenant or lessee may lease the telecommunication cables provided by the developer or owner based on commercial arrangements, or they may use the cables provided by a telecommunication licensee. The developer or owner shall allow any telecommunication licensee to install telecommunication cables within the building to serve any tenant or lessee, should the latter require the use of such cables.

2.10.4 For existing building, the developer or owner is required to refer and comply with the IFC GHD Code when planning or installing its own telecommunication cables. It should install its cables in a separate riser. However, in the absence of any riser, prior approval from AITI

must be sought for using the telecommunication riser which is designated for the telecommunication licensees' use. AITI may accede to the requests from the developer or owner to use the telecommunication riser where there is enough space for all users to share.

2.10.5 In relation to paragraph 2.10.4 above, the developer or owner or its tenant must remove its telecommunication cables from the telecommunication risers at its own expense, if there is insufficient space for the telecommunication licensees' use.

2.10.6 Where the telecommunication risers are congested with cables, the developer or owner shall arrange at its own cost for its contractor to remove the unused cables which are left over by its former tenants so that there will be enough space for new cables to be laid. The developer or owner may, at its own expense and subject to the telecommunication licensee's agreement, allow the licensee to use an alternative communication riser and provide the licensee with full access to such a communication riser in the same manner as the access to be provided for telecommunication risers.

2.11 DO'S AND DON'TS FOR EARTHWORKS

2.11.1 The developer or owner shall refer to the relevant telecommunication system licensee's list of "do's and don'ts" in relation to the reasonable precautions to be taken when carrying out any earthworks to prevent any damage to such telecommunication system licensee's telecommunication cable.

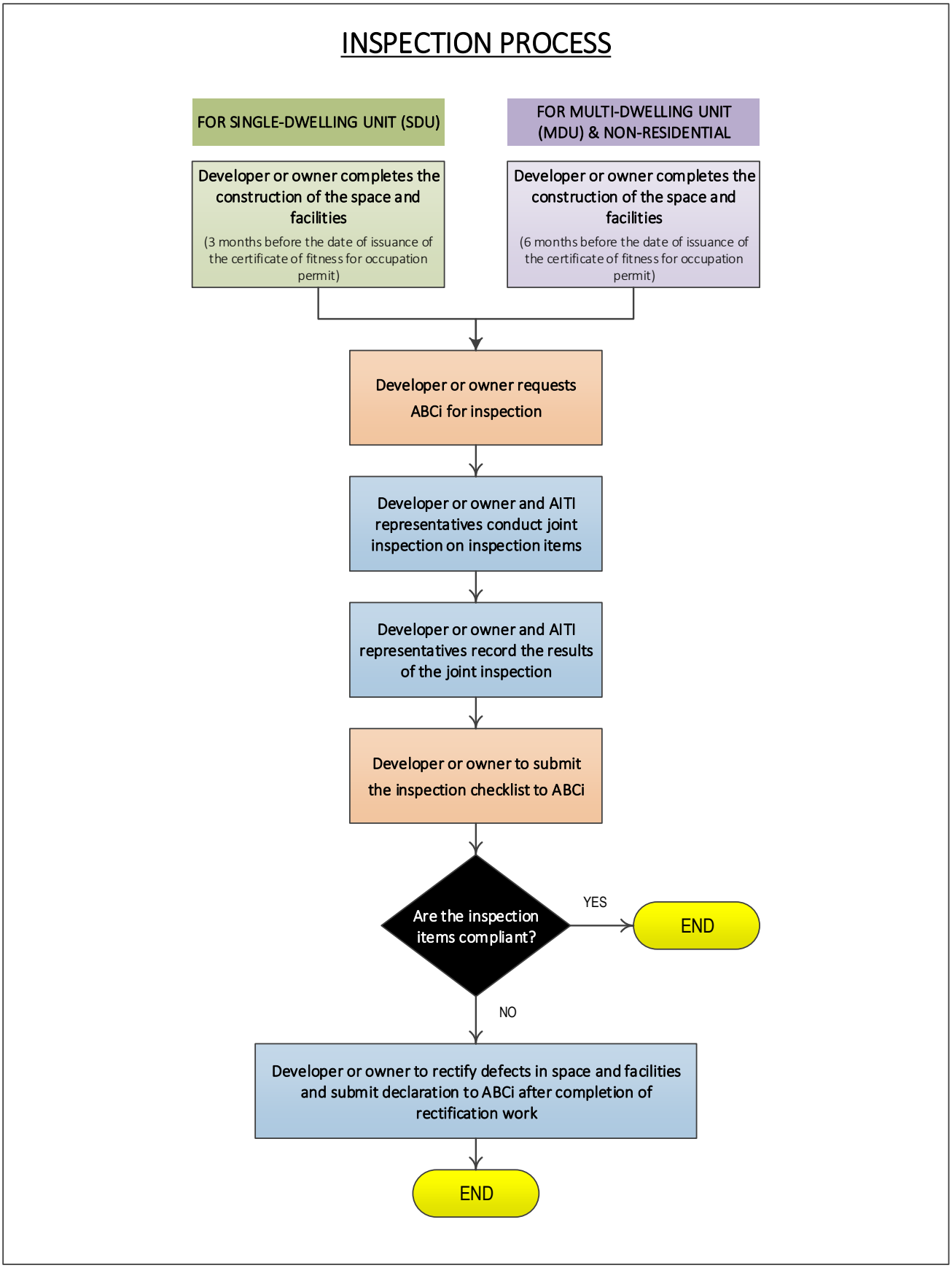


Figure 1: Inspection Process Flowchart

3. GENERAL REQUIREMENTS FOR PROVISION OF SPACE AND FACILITIES

3.1 DOCUMENTATION

3.1.1 A set of as-built installation drawings for any telecommunication cable system shall be prepared by the developer or owner for each building type as specified in Chapters 4 to 6 of the IFC GHD Code. The drawings shall show the cable routes and distances, outlet identification, detailed drawings of distribution panels, and other data that might be useful in carrying out maintenance and repair.

3.1.2 All legends and symbols in the as-built drawings shall be properly indicated. Upon request by the licensee, a copy of these drawings shall be provided to them.

3.1.3 A set of testing results for the optical fibre distribution network shall be prepared after the test have been performed and shall be submitted to ABCi and copied to AITI, in which the test documents will be treated as Acceptance document. Testing documents submitted shall be both in softcopy and hardcopy, where applicable.

3.1.4 The tests performed should strictly follow the ODN Testing Guidelines as in Appendix 8 of this document.

4. PROCEDURES AND REQUIREMENTS FOR PROVISION OF MOBILE SERVICE COVERAGE WITHIN DEVELOPMENTS

4.1 GENERAL

4.1.1 Mobile telecommunication licensees operating public cellular mobile telecommunication systems may face difficulty in providing mobile service coverage within developments, including basement levels and underground pedestrian malls, as building design and structure would affect the radio propagation characteristics. The difficulty faced by licensees in providing mobile service coverage within developments is particularly significant where building structures use materials unfavourable to radio signal penetration, e.g. metallic wall cladding, metalised window film. As such, it may take up to a year or more for licensees to plan and deploy their installation, plant and system in the development so as to provide mobile service coverage within the development.

4.1.2 This chapter serves to inform the developer or owner of any development of the procedures and requirements to facilitate the timely provision of mobile service coverage within the development.

4.2 RESPONSIBILITY OF DEVELOPER OR OWNER

4.2.1 These guidelines do not exempt the developer or owner from obtaining:

(a) Licenses from the relevant authorities to install and operate radio equipment; and

(b) Approvals from the relevant authorities for installation of physical structures and reinforcements to support antennae and other equipment, where necessary.

4.3 PROCEDURES AND REQUIREMENTS FOR THE PROVISION OF MOBILE SERVICE COVERAGE

4.3.1 The developer or owner may make a written request to any licensee for the provision of mobile service coverage within the development, and shall include in such written request relevant information relating to the development (e.g. type and size of the development).

4.3.2 The developer or owner shall provide reasonable access to its premises for licensees to conduct survey and field tests to determine the extent of mobile service coverage within the development.

4.3.3 Where the licensee agrees to provide or enhance mobile service coverage within the development and the developer or owner wishes to facilitate the timely provision or enhancement of mobile service coverage, the developer or owner may, unless otherwise agreed with the licensee:

(a) provide antennae support structure (including mounting poles with appropriate spacing between poles) at the roof-top or suitable external walls of a building, where the antennae are to be installed at the roof-top;

(b) provide a cable distribution system (with specifications to be consulted with the licensees) across the ceiling for each floor including all basement floors;

(c) provide separate sets of electrical distribution panels operating on a minimum power supply of 230 V, 32 A (3-phase) isolators for each licensee at the mobile deployment space;

(d) provide other facilities (e.g. drilling of holes between uppermost floor and the roof-top) as the licensee may request; and

(e) site the mobile deployment space in a location that:

i. would facilitate optimal signal distribution for the provision of good mobile coverage;

ii. is in close proximity to the power supply source and communication and transmission links;

iii. is properly secured to prevent unauthorised access; and

iv. has sufficient ventilation and lighting, and is free of hazards to workers.

5. CABLE DISTRIBUTION SYSTEMS

5.1 GENERAL

5.1.1 Cable distribution systems are the facilities provided to distribute telecommunication cables installed from the telecommunication equipment room to the telecommunication risers and from telecommunication risers to each residential or non-residential unit.

5.1.2 The design and capacity of the distribution system shall be flexible enough to accommodate any re-arrangement of premises layout or the changing telecommunication needs of the building tenants.

5.1.3 A properly designed distribution system will ensure that cables can be installed or changed at any time, with minimum inconvenience caused to the building tenants and without affecting the structure or appearance of the building.

5.1.4 The types of cable distribution system that can be used in a building generally depend on the types of building. Buildings can broadly be categorised into residential and non-residential buildings.

5.1.5 The types of cable distribution system suitable for use in a **non-residential building** can either be concealed or exposed.*

(a) Examples of **Concealed distribution systems** are:

i. Under-floor duct distribution system;

ii. Raised floor system;

iii. Ceiling distribution system;

iv. Perimeter raceway distribution system; and

v. Conduit distribution system.

*Note: Certain non-residential buildings may require a combination of two or more of the above mentioned system for distributing telecommunication cables.

(b) Examples of **Exposed distribution systems** are:*

i. Cable tray; and

ii. Exposed conduit.

*Note: Exposed distribution systems are normally used in places where concealed distribution systems are not practical or where aesthetics is not important.

5.1.6 For **residential buildings**, suitable types of distribution system are as follows:*

(a) Under floor distribution system;

(b) Perimeter raceway distribution system;

(c) Ceiling distribution system; and

(d) Multi-riser system.

*Note: Certain residential buildings may have a combination of two or more of the above mentioned systems for distributing telecommunication cables.

5.1.7 **Capacity of distribution system:**

(a) It is important to note that for all the systems mentioned, the practical capacity of a raceway, be it a duct, a conduit or a trunking is considerably less than the

theoretical capacity. This is because the helix of the cable is normally retained even when the cables are unwound, thereby causing the cables to wrap round one another and occupy a larger area of the raceway than the theoretical value.

5.1.8 **Identification of distribution system:**

(a) To identify and differentiate the telecommunication cable distribution system from cabling facilities for other utilities/services, all ducts, cable trays, trunking, conduits, etc. for distributing telecommunication cables shall be painted white and labeled "Telecommunications".

5.1.9 **Surface cabling:**

(a) It is important to note that for concealed cables that become defective after installation and are not accessible, the telecommunication system licensees or wiring contractors shall replace the cables using the surface cabling method, unless additional facilities suitable for concealed cabling are provided.

5.1.10 **Segregation of cabling systems**

(a) It is important to segregate the cabling systems to accommodate different types of telecommunication cables (e.g. coaxial and non-coaxial cables) to minimise the possibility of any interference.

5.1.11 **Earthing of metal parts:**

(a) All metal parts of the distribution system shall be effectively earthed complying with the requirements of the Department of Electrical Services, Prime Minister's office.

5.2 CABLE DISTRIBUTION SYSTEMS FOR NON-RESIDENTIAL BUILDING

5.2.1 The requirements of the various types of distribution system suitable for use in non-residential buildings are listed in the following paragraphs.

(a) **Under-floor duct distribution system for non-residential buildings**

i. General –

(A) A properly designed under-floor duct distribution system is a good method for distributing telephone cables (Figure 2).

(B) The under-floor duct distribution system suitable for use in non-residential buildings may be designed with total access or with junction box access.

(C) An under-floor duct distribution system designed with total access throughout its entire length to enable easy installation and maintenance of cables is known as the trench duct system (Figure 3).

ii. Basic requirements –

(A) The under-floor duct should extend into the telecommunication riser and link to the floor trench.

(B) The under-floor duct distribution system should be designed to enable access with little or no disruption to the tenants. Access to the system

should be from the floor it is designed to serve, and not from the adjacent floor.

(C) The under-floor duct distribution system should be designed with the main junction boxes along the common corridor area or passageway (Figure 4).

(D) The under-floor duct distribution system should be free from internal roughness, sharp edges, moisture and dirt.

(E) The under-floor duct distribution system should be provided with floor outlets to lead the telecommunication cables out of the ducts.

(F) For an under-floor duct distribution system with junction box access, the thickness of the floor screed on top of the ducts should not exceed 40 mm for ease of carrying out cabling work.

iii. Duct –

(A) The size of the under-floor duct should be such that the cross-sectional area of all the cables accommodated within a duct does not exceed 30 % of the cross-sectional area of the duct.

(B) The under-floor duct should be made of either high impact rigid PVC or galvanised metal or steel of welded construction and of sufficient thickness.

(C) The under-floor duct should be of a minimum internal height of 25 mm.

(D) A nylon draw wire should be provided in the duct between every two adjacent junction boxes.

iv. Junction boxes –

(A) The under-floor duct distribution system should be provided with junction boxes at all junctions and bends to enable drawing of telecommunication cables. The distance between two junction boxes in a straight run should preferably not exceed 6 m (Figure 5).

(B) Where it is not practical to have a junction box at a bend, the bend should have a minimum radius of about six times the width of the duct.

(C) The size of the junction box should increase proportionately with that of the floor ducts.

(D) The cover of the junction box should preferably be square. Junction box cover should be secured to the junction box by means of screws or other acceptable means (Figure 6). The screws should remain intact on the junction box cover when the cover is removed.

(E) The junction box cover should be as close-fitting as possible and flushed with the floor surfaces. The cover should be sufficiently robust to resist damage by floor cleaning equipment.

(F) All junction boxes and floor outlets should be readily accessible at all times. Walls or partitions should not be constructed on top of them.

(G) For carpeted floors, appropriate slits should be made on the carpet at all junction boxes and floor outlets to enable access to the under-floor ducts.

(H) Under special circumstances, the junction-box cover may be cut to accommodate the floor outlets except in common areas that are prone to washing or mopping (e.g., common corridors and lift lobby areas). Any cutting required on a junction-box cover should be done along the edges of the cover.

v. Responsibility of developer or owner:-

(A) The developer or owner should install and maintain the outlets and junction boxes.

vi. The advantages of an under-floor duct distribution system are as follows –

(A) Cables are well protected in the ducts, therefore interruption of service caused by physical damage to cables is minimised;

(B) Appearance of the premises is enhanced as the ducts are concealed under the floor screed; and

(C) Safe and easy working position.

vii. The disadvantages of an under-floor duct distribution system are as follows:-

(A) Difficult to access junction boxes or header ducts when floor is covered with carpet; and

(B) Water can seep through the junction boxes and damage the cables.

(b) **Raised floor distribution system for non-residential buildings**

i. General –

(A) A raised floor distribution system is a floor assembly superimposed on an existing floor. Telecommunication cables are distributed in the space between the floor and raised floor assembly (Figure 7).

(B) A raised floor distribution system is usually used in computer rooms and offices with a high number of telecommunication cables.

(C) The floor assembly consists of a series of square modules of steel plates or panels or concrete slabs resting upon pedestals (Figure 8).

ii. Basic requirements:-

(A) The raised floor panels should be supported on pedestals that are of a height sufficient to ensure a clear working space of at least 25 mm below the floor panel (Figure 9).

(B) Trunking or cable trays should be provided to segregate telecommunication cables from electrical cables and cables of other services placed below the raised floor.

iii. The responsibilities of the developer or owner are as follows:-

(A) The developer or owner should provide concealed floor fittings or suitable outlets for the telecommunication cables.

(B) The developer or owner should provide the trunking or cable trays required to segregate telecommunication cables from electrical cables and cables of other services placed below the raised floor (Figure 10).

(C) The developer or owner should be responsible for removing and replacing floor panels.

(D) The developer or owner should possess the necessary fitting devices for removing or replacing the floor panels.

iv. The advantages of a raised floor distribution system are as follows:-

(A) Cables are well protected below the raised floor, therefore interruption of service caused by physical damage to cables is minimised;

(B) Appearance of the premises is enhanced as the cables are concealed under the floor;

(C) Safe and easy working position;

(D) Any change in telecommunication requirements can be easily catered for; and

(E) Ability to accommodate a large number of cables.

v. The disadvantages of a raised floor distribution system are as follows:-

(A) It is more costly to provide the system comparing with other distribution systems;

(B) The system may produce sound when walked upon; and

(C) Broadloom carpet cannot be used.

(c) **Ceiling distribution system for non-residential buildings**

i. General:-

(A) The ceiling distribution system can be used when there is adequate ceiling space. The system comprises cable trays/trunking, conduits and/or utility poles (Figure 11).

(B) In a ceiling distribution system, telecommunication cables are laid onto cable trunking or laid and tied with cable ties onto the cable trays within the ceiling space and routed to the telecommunication outlets by means of conduits or utility poles.

ii. Basic requirements:-

(A) Where cable trays/trunking/conduits are concealed in false ceilings of ceiling strips or boards that are not easily accessible, access panels should be provided for easy and unrestricted access to the cable trays (Figure 12).

(B) The dimension of the access panels should not be less than 600 mm x 600 mm, and they should preferably be provided at regular intervals of 6 m as well as at positions where there is a change in the direction of the cable trays/trunking/conduits.

(C) The passage between the ceiling trays/trunking and the ceiling slabs should ideally be free from obstructions such as air-conditioning ducts,

fire sprinklers, electrical trunking, water pipes, etc. When obstructions are unavoidable, a minimum clearance as indicated in Figure 13 should be maintained.

(D) The cable trays and trunking should be in accordance with the specifications described in paragraphs 5.2.1 (f) and 5.2.1 (g) respectively.

(E) 'L' brackets used for supporting cable trays should be installed in the same direction.

iii. Responsibility of developer or owner

(A) The developer or owner should be responsible for removing and replacing ceiling boards.

iv. The advantage of a ceiling distribution system is that it provides a flexible mean of distributing telecommunication cables to specific locations.

v. The disadvantages of ceiling distribution system are as follows:-

(A) Ceiling boards must be made removable, and there is a high possibility of them being damaged or tainted due to frequent removal and replacement of these boards; and

(B) It may cause disruption to the tenants and environment when telecommunication cables installation or maintenance work is being carried out.

(d) **Perimeter raceways distribution system for non-residential buildings**

i. General

(A) Perimeter raceways are ducts or trunking installed along the perimeter of a room, shop or an office to distribute and conceal telecommunication cables.

(B) The perimeter raceway ducts or trunking are either surface mounted or recessed into the base of the wall to form a skirting.

They can also be mounted at any height along the wall provided that these raceways will not be obstructed by signboards, etc., to be erected by potential tenants or shop-owners (Figures 14 and 15).

(C) The ducts and trunking can be constructed of metal, plastic or wood.

(D) Perimeter raceways come in various sizes and may be divided into two or more compartments to accommodate power, telecommunication and cables of other services (Figure 16).

(E) A sleeve through the wall can be used to connect telecommunication outlets in adjacent rooms that are on the same floor.

ii. Basic requirements

(A) The perimeter raceways should be provided with removable covers placed at a regular interval of 2 m. The telecommunication outlets should preferably remain intact on the raceway when the covers are removed.

(B) Multi-compartment perimeter raceways should be designed to ensure that electrical cables will remain in their compartments when the covers are removed.

(C) Fittings for mounting telecommunication outlets should be provided.

(D) If telecommunication cables cross the compartment for electrical cables, a "cross-over" or "bridge" must be provided to maintain segregation.

iii. Responsibility of developer or owner:-

(A) The developer or owner should be responsible for removing any object that may obstruct the removal of the covers from the raceways.

iv. The advantages of a perimeter raceway system are as follows:-

(A) It can serve both as a skirting and a raceway for routing cables.

(B) Telecommunication outlets may be conveniently placed anywhere along the raceway.

v. The disadvantages of a perimeter raceway system are as follows:-

(A) Extensive use of this system is made difficult by the columns and doors in the buildings; and

(B) It is only suitable for premises where the telecommunication outlets are placed near the wall. In large offices where telecommunication outlets are required in the center of the offices, other types of distribution system such as under-floor ducts need to be incorporated (Figure 17).

(e) **Conduit distribution system for non-residential buildings**

i. General

(A) Conduits can be used to distribute cables in those parts of a building where the telecommunication usage density is low and flexibility in relocating the telecommunication outlets is not required. Examples of such areas of a building are guest rooms in a hotel and patient rooms in a hospital.

(B) The telecommunication outlets in the hotel guest rooms and hospital patient rooms can be fixed and are unlikely to change in position.

(C) Other types of distribution systems such as the under-floor duct system are used to serve the other areas of the building, e.g., administration office, where flexibility in relocating telecommunication outlets is required.

ii. Basic requirements

(A) The size of the conduit should be such that the cross-sectional area of all the cables placed in the conduit does not exceed 30 % of the cross-sectional area of the conduit.

(B) Conduits should preferably be at least 20 mm in diameter.

(C) Conduits provided should be as straight as possible and should be rigidly mounted.

(D) Conduits should be provided with junction boxes to enable drawing of telecommunication cables. The distance between two junction boxes in a straight run should preferably not exceed 6 m. A junction box should also be provided at every junction and bend.

(E) Where it is not practical to have a junction box at a bend, the bend should have a minimum radius of about six times the internal diameter of the conduit. Not more than one such bend is allowed between two junction boxes and the distance between them should preferably be not more than 2 m.

(F) A nylon draw rope should be provided in the conduit between every two junction boxes to enable the drawing of cables.

(G) Flexible conduits should not be used.

(H) Conduits should be free from internal roughness, sharp edges, moisture and dirt.

(f) **Cable trays**

i. Basic requirements

(A) The material used for the cable tray should be perforated and galvanised;

(B) All cable trays should be aligned and securely mounted;

(C) Cable trays should not be routed through toilets, high-tension (HT) switch rooms, and other non-accessible areas;

(D) Cable trays should be straight run, and for any change in direction, the bend should have a minimum radius of 600 mm (Figure 18);

(E) No bolts, screws or sharp objects should protrude through the cable-bearing surface of the trays;

(F) The cable tray support must be L-shaped or inverted T-shaped;

(G) Where cable trays run alongside or across electrical cables, they should be separated for their entire length by a clearance as specified in Chapter 2, paragraph 2.2 of these Guidelines. The electrical cables should be clearly indicated by signs or symbols;

(H) The minimum clearance between ceiling/beam and cable tray should be 300 mm;

(I) For cable trays installed within false ceilings, there may be instances that require the cable trays to be replaced with pipes for easy installation of cables. For such cases, access must be provided in the false ceilings at appropriate locations;

(J) Slots provided in the wall for cable trays to go through should have a minimum height of 300 mm; and

(K) Where cable trays are concealed in false ceilings, the panels of the false ceiling should be fully and easily removable to allow unrestricted access.

(g) **Exposed conduits / trunking**

i. General –

(A) The requirements for conduits, mounted and exposed along walls, are similar to conduits that are concealed under-floor or in the ceiling. Please see paragraph 5.2.1 (e) for detailed requirements.

(h) **Concealed cabling in office furniture**

i. General –

(A) Office furniture with built-in channels to conceal cables is becoming more common. This furniture includes not only free-standing desks, but also flexible screens that are fitted adjacent to the desks and which can accommodate shelving, etc.

ii. To ensure a safe and efficient system, this office furniture should meet the following basic requirements:

(A) The cable channel should be easily accessible for the installation of cables by the telecommunication system licensees' or the tenants' wiring contractors;

(B) Segregation of telecommunication cables and power cables should be maintained;

(C) If metal channels or ducts are used, they should be installed and earthed according to the requirements of the Department of Electrical Services;

(D) When the cable channels are part of a flexible screen, the cable across the flexible junction between the screen panels should be protected and flexing of the panels should be prevented after the cables have been installed;

(E) The furniture should be positioned as close to the socket outlets as possible; and

(F) Once the cables are installed, movement of the furniture should be minimised.

(i) **Suitable distribution systems for various types of premises**

(A) The suitable distribution systems for various premises are as shown below in Table 1.

Table 1: Suitable distribution systems for various types of premises

	TYPES OF DISTRIBUTION SYSTEM					
Types of Premises	**Under-floor duct**	**Raised Floor**	**Cellular Floor**	**Ceiling Distribution**	**Exposed cable Tray / Trunking**	**Exposed Conduit**
Shop-houses				/	/	/
Shopping Centers	/			/	/	/
Office Complexes	/	/	/	/	/	/
Factories (Terrace and Flatted)				/	/	/
Markets, Hawker / Food Centers				/	/	/

5.3 CABLE DISTRIBUTION SYSTEMS FOR RESIDENTIAL BUILDINGS

5.3.1 The requirements of the various types of distribution system suitable for use in residential buildings are listed in the following paragraphs.

(a) **Under-floor distribution system for residential buildings**

i. General –

(A) Under-floor distribution system suitable for use in residential buildings is constructed of either ducts, conduits, or a combination of both.

(B) At common corridor areas, the ducts or conduits are laid in the floor slab to distribute cables from the telecommunication riser. Junction boxes are provided at all junctions and bends (Figure 20).

(C) Within each residential unit, conduits are used to distribute the cables to various telecommunication outlets in each room (Figure 21).

ii. Basic requirements –

(A) The duct or conduit at common corridor areas should extend into the telecommunication riser or to the telecommunication closet.

(B) For joint-usage with electrical cables, a separate compartment should be provided for telecommunication cables. The segregation requirements should be in accordance with Chapter 2, paragraph 2.2 of these Guidelines.

(C) Under-floor ducts or conduits should be made of either galvanised metal or high impact rigid PVC.

(D) The duct or conduit should be free from internal roughness, sharp edges, moisture or dirt.

(E) The thickness of the floor screed on top of the ducts should not exceed 40 mm for ease in carrying out cabling work.

iii. Common corridor area –

(A) The system should be provided with junction boxes at all junctions and bends to enable drawing of telecommunication cables. The distance between two junction boxes in a straight run should preferably not exceed 6 m (Figure 5).

(B) Where it is not practical to have a junction box at a bend, the bend should have a minimum radius of about six times the internal diameter of the conduit or six times the width of the duct, whichever is applicable. Not more than one such bend is allowed between two junction boxes.

(C) The size of the junction box should increase proportionately with that of the floor ducts.

(D) The cover of the junction box should preferably be square. Junction box covers should be secured to the junction box by means of screws or other means acceptable to the telecommunication system licensee. The screw should remain intact on the junction box cover when the cover is removed (Figure 6).

(E) The junction box cover should be as close-fitting as possible and flushed with the floor surfaces. The cover should be sufficiently robust to resist damage by floor cleaning equipment.

(F) For carpeted floors, appropriate slits should be made on the carpet at all junction boxes to enable access to the floor ducts.

(G) All junction boxes should be readily accessible at all times.

(H) A nylon draw rope should be provided in the duct or conduit between every two adjacent junction boxes.

iv. Within each residential unit –

(A) Conduit laid inside the housing unit should have a maximum of two 'L' bends between two outlets. These bends must be smooth and gradual. Prefabricated gradual bends are preferred.

(B) Conduits should preferably be of at least 20 mm in diameter.

(C) The conduit should be free from internal roughness, sharp edges, moisture and dirt.

(D) The conduit should be as straight as possible and should be rigidly mounted.

v. Responsibility of developer or owner –

(A) The developer or owner should be responsible for opening the junction box cover, when required by telecommunication system licensees to provide telecommunication service.

vi. The advantages of an under-floor system are as follows –

(A) Cables are well protected in the duct and conduits, therefore interruption of services caused by physical damage to cables is minimised;

(B) Appearance of the premises is enhanced as the ducts or conduits are concealed in the floor slab; and

(C) Safe and easy working position.

vii. The disadvantages of an under-floor distribution system are as follows –

(A) Junction boxes must be made accessible even when covered with carpet; and

(B) Water can seep through the junction boxes and damage the cables.

(b) **Perimeter raceway distribution system**

(A) Perimeter raceways that are suitable for use in residential buildings to distribute cables are similar to those used in commercial buildings. For details on the system, please refer to paragraph 5.2.1 (d).

(c) **Ceiling distribution system**

i. General –

(A) Cable trays or conduits are used to distribute telecommunication cables along common corridors in residential building.

(B) From the cable tray or conduit along common corridors, the cables leading to an individual residential unit and within the unit can be routed using conduits installed above false ceiling and brought down to socket point through conduit in the wall.

ii. Basic requirements –

(A) Where cable trays/trunking/conduits are concealed in false ceilings, access panels should be provided for easy and unrestricted access to cable trays/trunking/conduits.

(B) The dimension of the access panels should not be less than 600 mm x 600 mm, and they should be provided at regular intervals of 6 m as well as at positions where there is a change in the direction of the cable trays/trunking/conduits.

(C) All cable trays should be aligned and securely mounted.

(D) Cable trays should not be routed through toilets, high-tension (HT) switch rooms, and other inaccessible areas.

(E) "L" brackets for supporting cable trays should be installed in the same direction.

(F) No bolts, screws or sharp objects should protrude through the cable bearing surface of the trays.

(G) Where cable trays run alongside or across electrical cables, segregation according to the specifications stipulated in Chapter 2, paragraph 2.2 of these Guidelines should be compiled with.

(H) The maximum height of cable trays for horizontal cabling should not exceed 4 m from the floor level.

(I) There should be a minimum clearance of 50 mm between the cable tray and any obstruction above it. The space between the tray and false ceiling should be between 75 mm and 150 mm (Figure 13).

iii. Where conduits are used within each residential unit to distribute telecommunication cables above a false ceiling, the following requirements should be met:

(A) Each conduit can have a maximum of two "L" bends. The bends should be smooth and gradual. Prefabricated gradual bends should be preferred. The distance between any two bends should preferably not exceed 2 m;

(B) Where many bends are required, junction boxes should be provided at these bends to permit cabling works. An access panel or removable ceiling board should be provided at every junction box location;

(C) Conduits should preferably be at least 20 mm in diameter.

(D) The conduit should be free of internal roughness, sharp edges, moisture and dirt;

(E) The conduit should be as straight as possible and should be rigidly mounted;

(F) Conduits within each residential unit should be used to lead the cable from false ceiling to each telecommunication outlet on the wall (Figure 22);

(G) The telecommunication outlets within each residential unit should be located at least 300 mm above floor level;

iv. Responsibility of developer or owner:-

(A) The developer or owner should be responsible for removing and replacing ceiling boards to enable the telecommunication system licensees to have access to the cables above the false ceiling.

v. The advantages of a ceiling distribution system are as follows:-

(A) It provides a flexible means of distributing telecommunication cables to specific locations.

(B) The possibility of physical damage to cables is minimised as the cables are protected.

vi. The disadvantages of ceiling distribution system are as follows:-

(A) Telecommunication cables may be damaged when other work is being done in the ceiling area;

(B) Ceiling boards should be made removable, and there is a high possibility of them being damaged or tainted due to frequent removal and replacement; and

(C) Dirt and debris may be deposited on surrounding furniture when ceiling boards are removed and replaced.

(d) **Multi-riser system**

i. General –

(A) Instead of providing one telecommunication riser in a multi-storey residential building to serve all the units on the same floor, a multi-riser system with one telecommunication riser serving one or more units per floor can be used.

(B) The telecommunication riser should have outlets at every housing unit. Wherever possible, the outlets should be located at the anticipated telephone locations to eliminate the cost of providing additional distribution systems from the outlet(s) to the telephone locations.

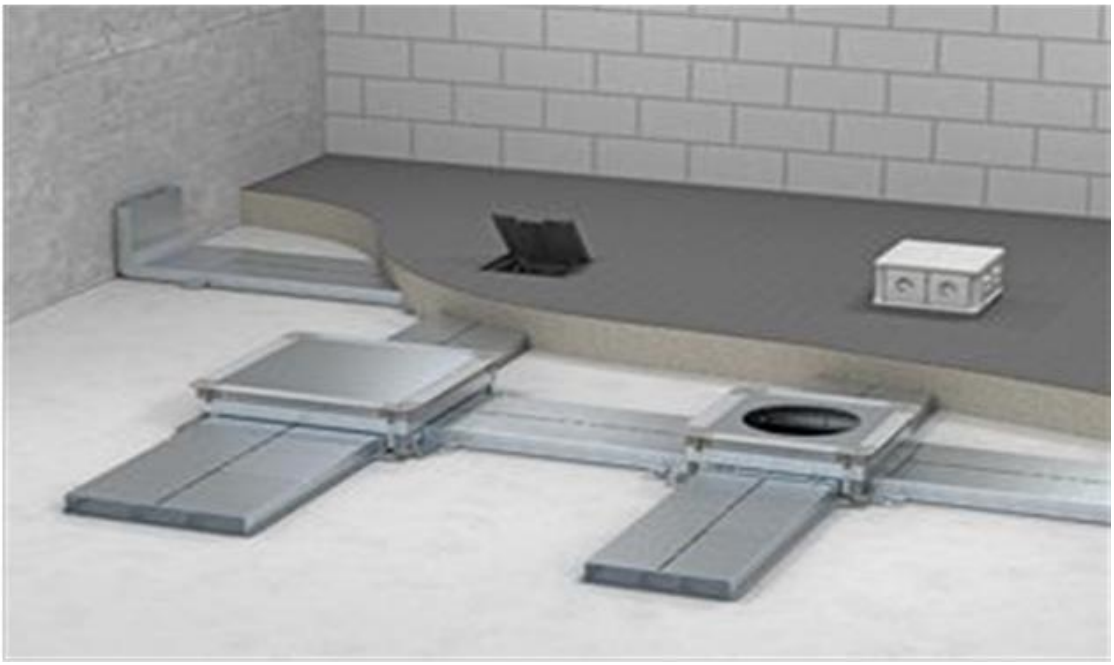


Figure 2: Under-floor duct distribution system

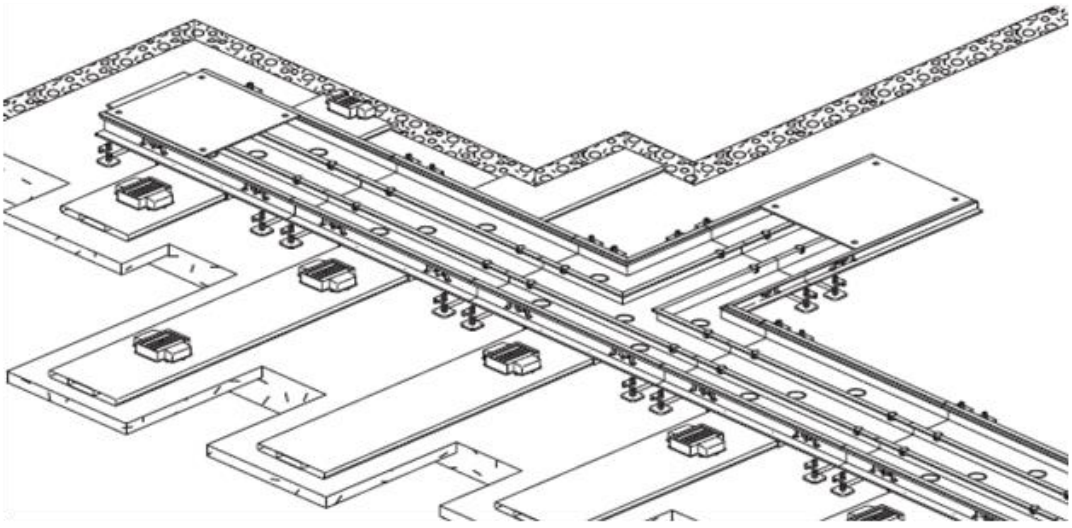


Figure 3: Trench duct system

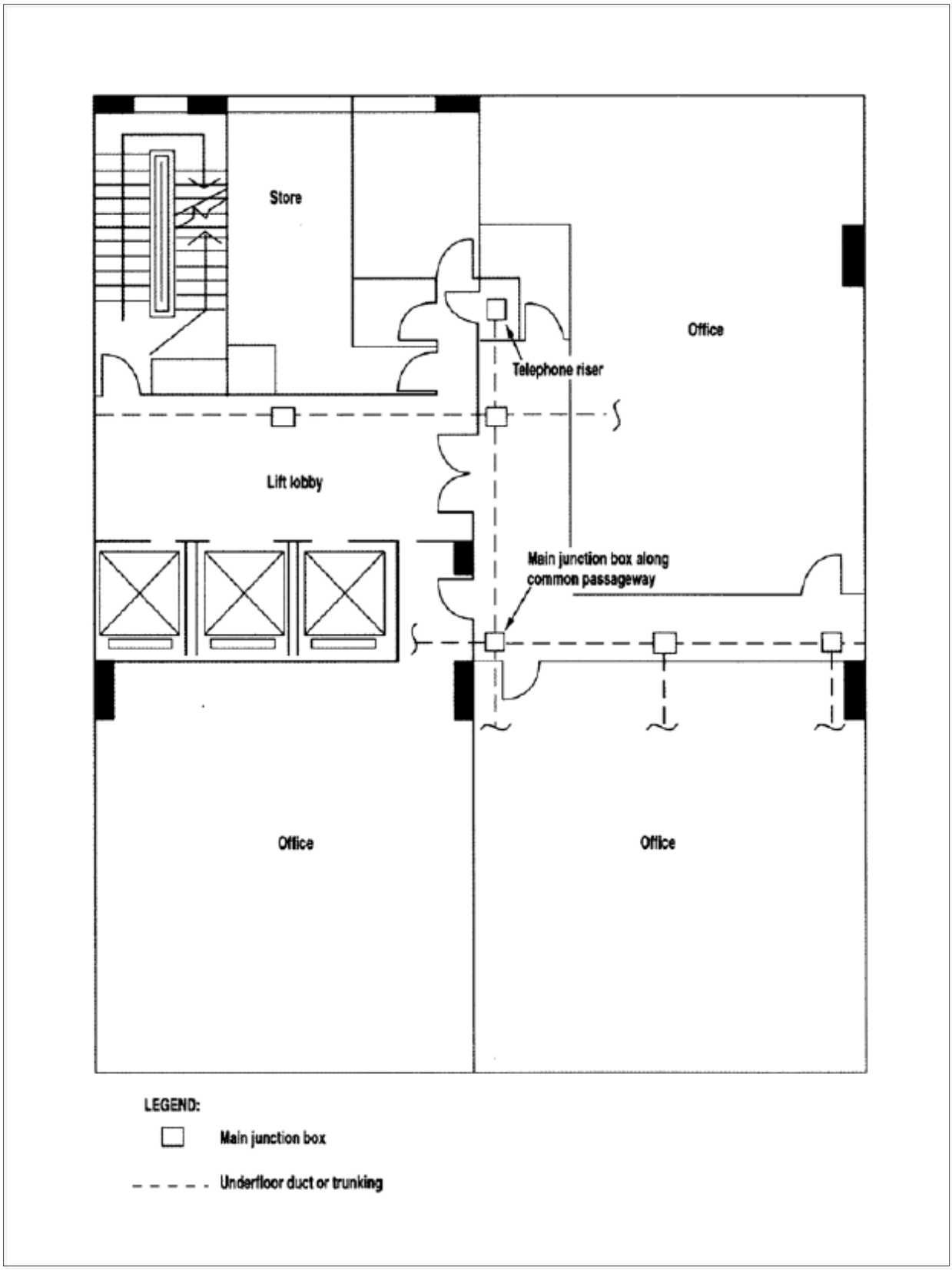


Figure 4: Main junction boxes along common corridor area passageway

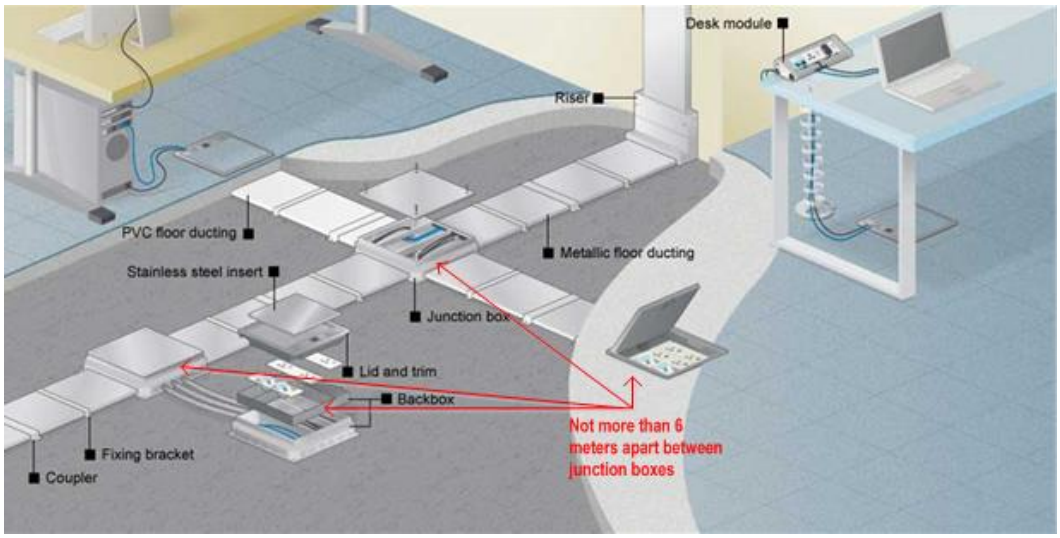


Figure 5: Junction boxes installed not more than 6 meters apart

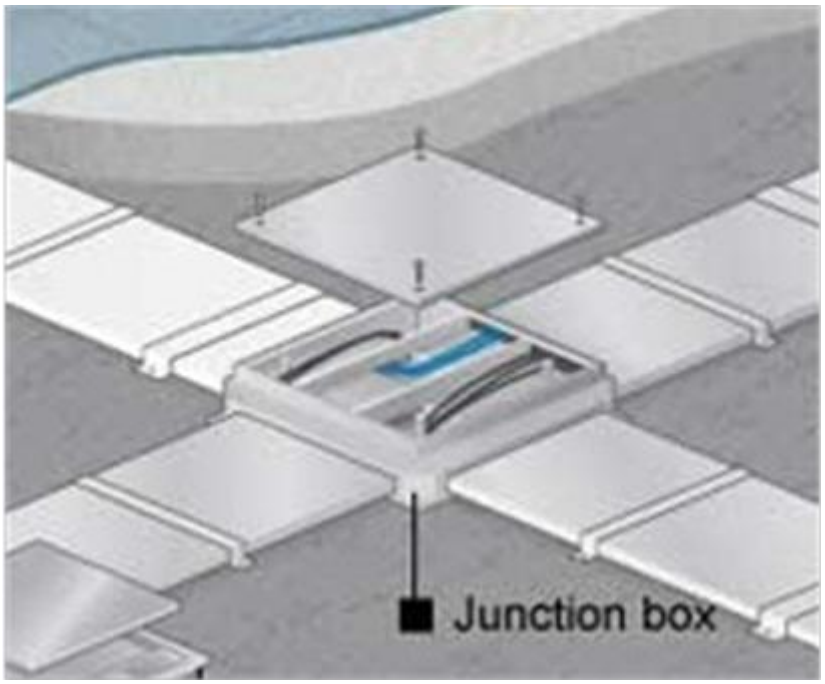


Figure 6: Exploded view of junction box

Figure 7: Raised floor system

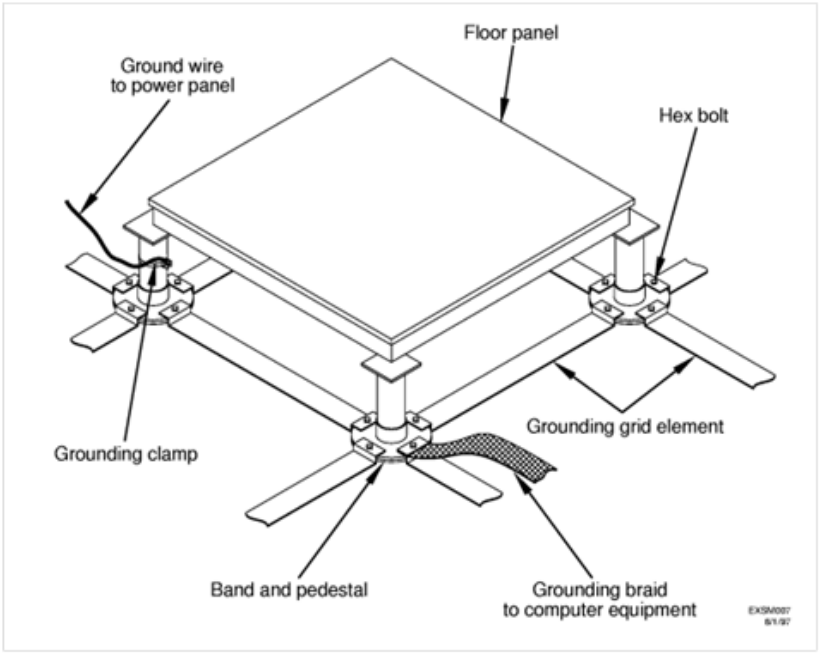


Figure 8: Floor assembly of raised floor system

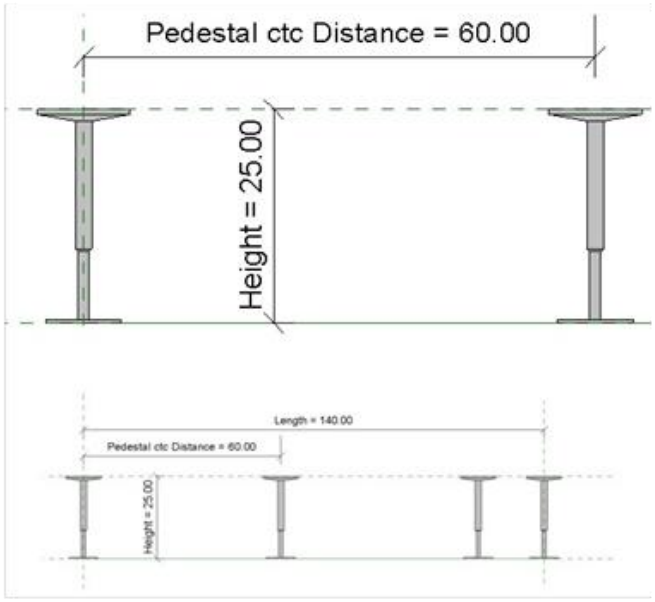


Figure 9: Pedestal minimum height

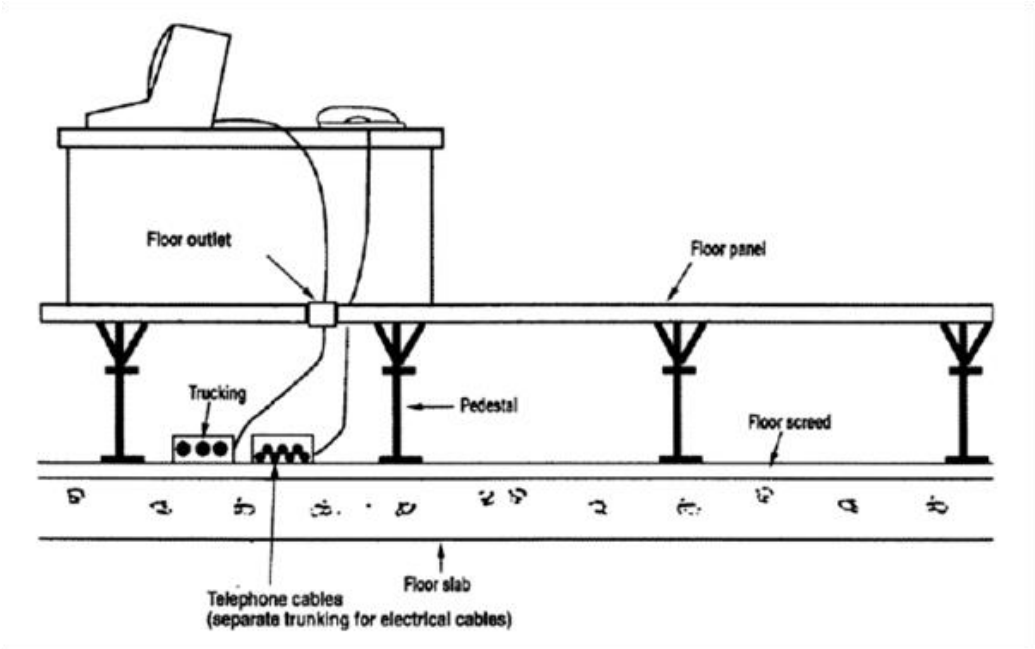


Figure 10: Typical sections of raised floor system

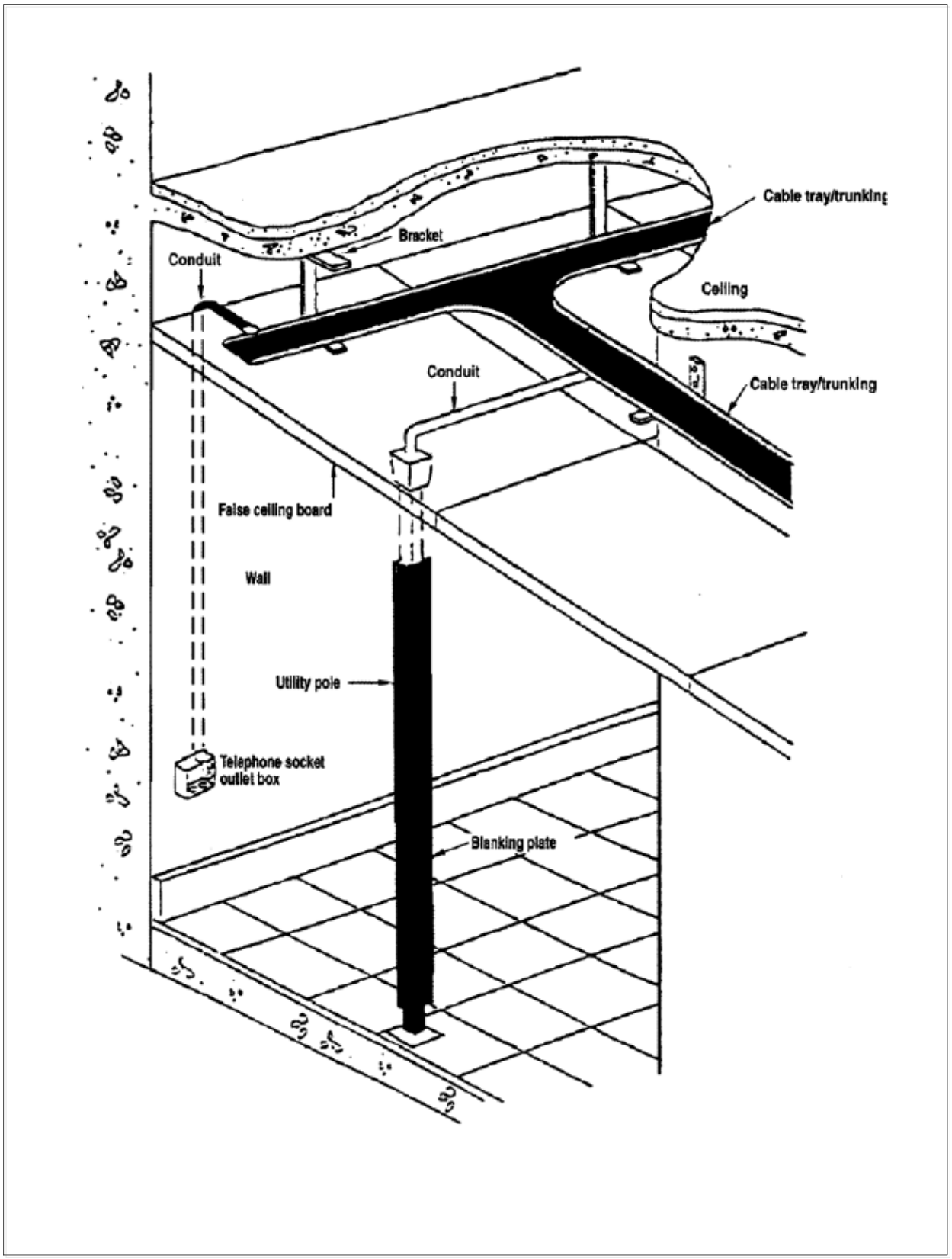


Figure 11: Ceiling distribution system using cable/trunking link with conduit and utility pole

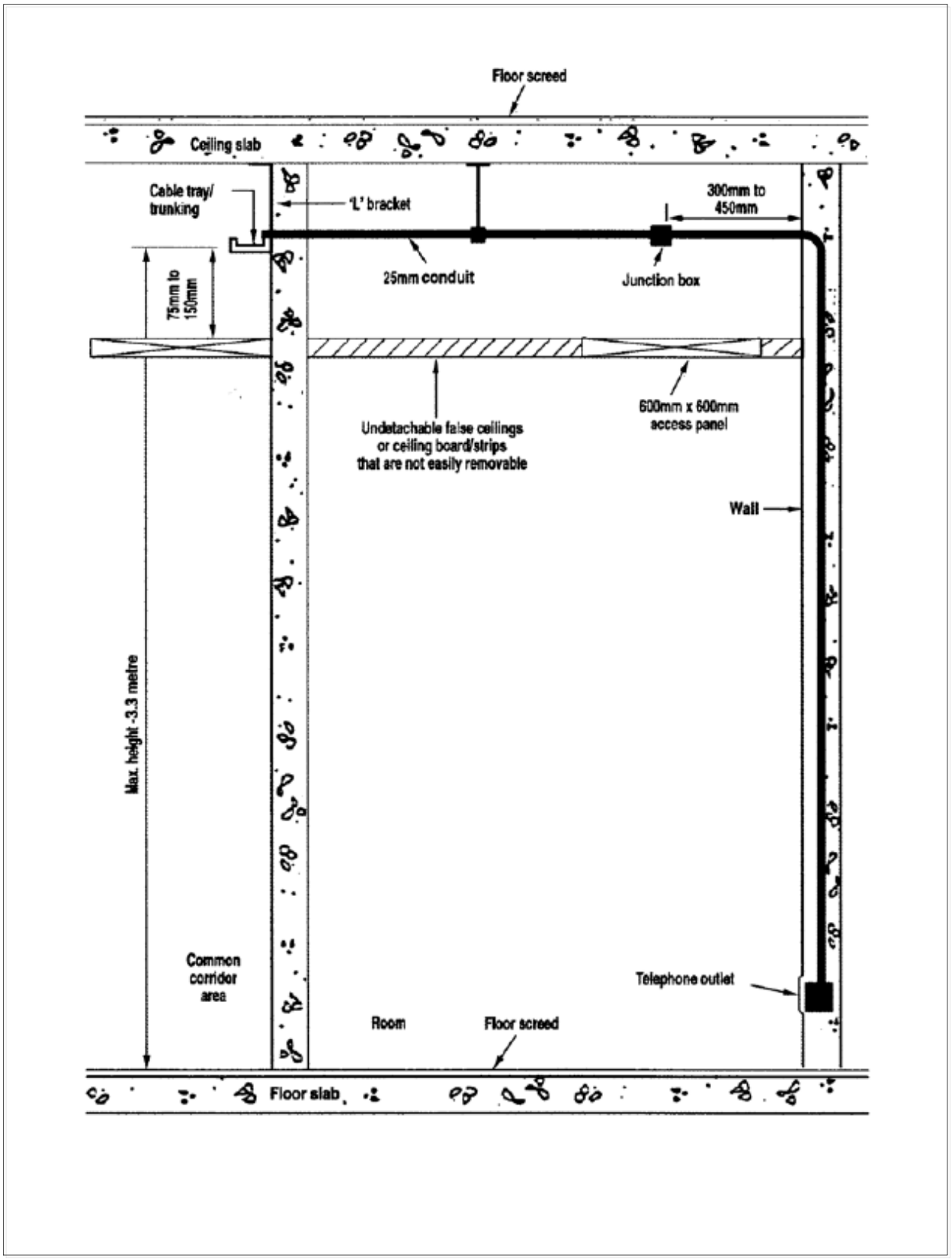
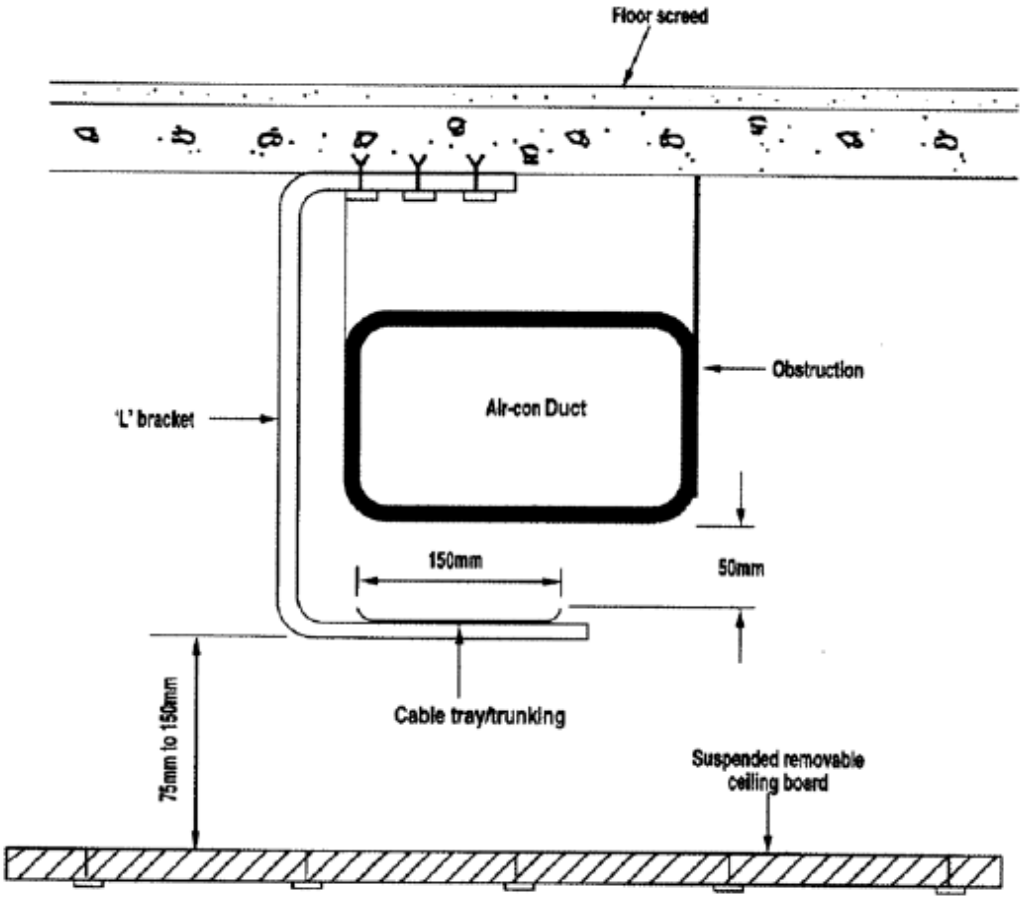


Figure 12: Typical detail of ceiling distribution system



Width of Cable tray/trunking	Minimum clearance between cable tray & obstruction
150mm	50mm
300mm	75mm
450mm	100mm
1000mm	150mm

Figure 13: Clearance between cable tray / trunking and obstructions

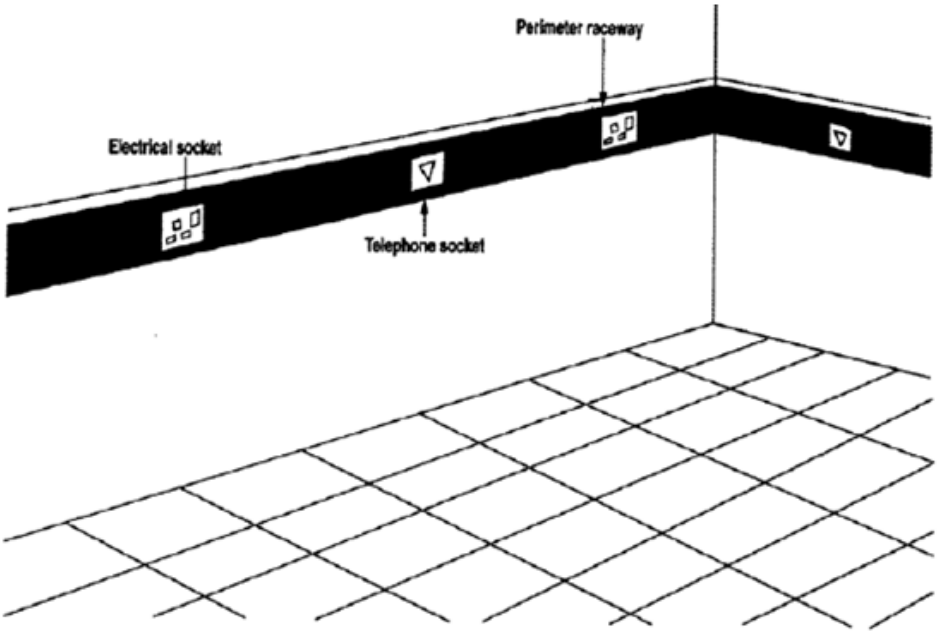


Figure 14: Perimeter raceways mounted at table height level

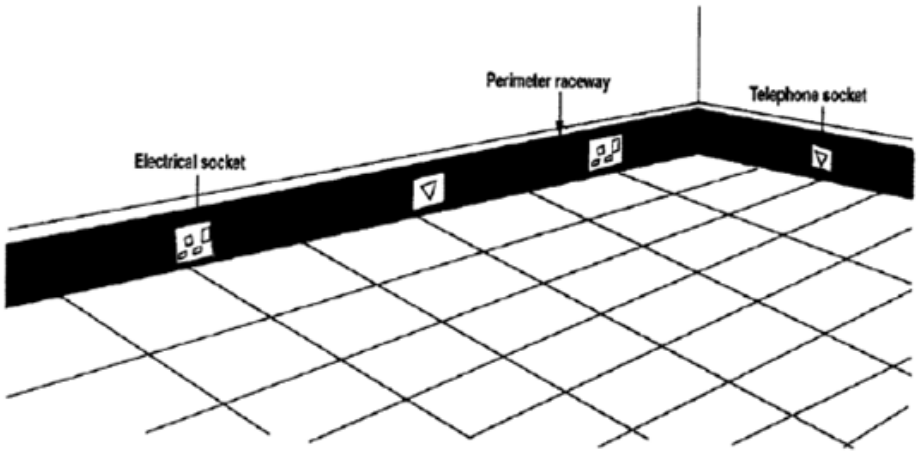


Figure 15: Perimeter raceways mounted at floor level

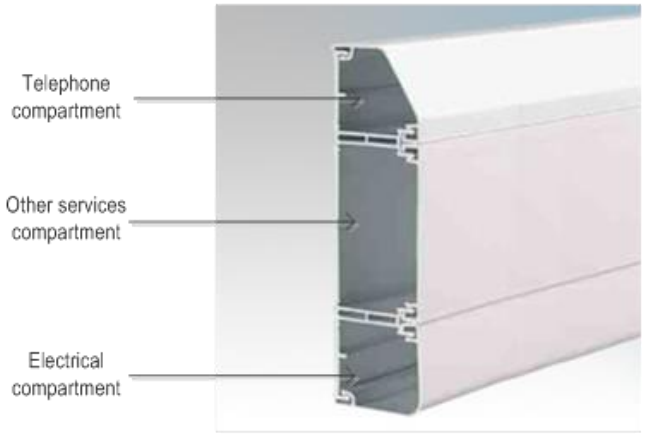


Figure 16: Three compartment skirting trunking

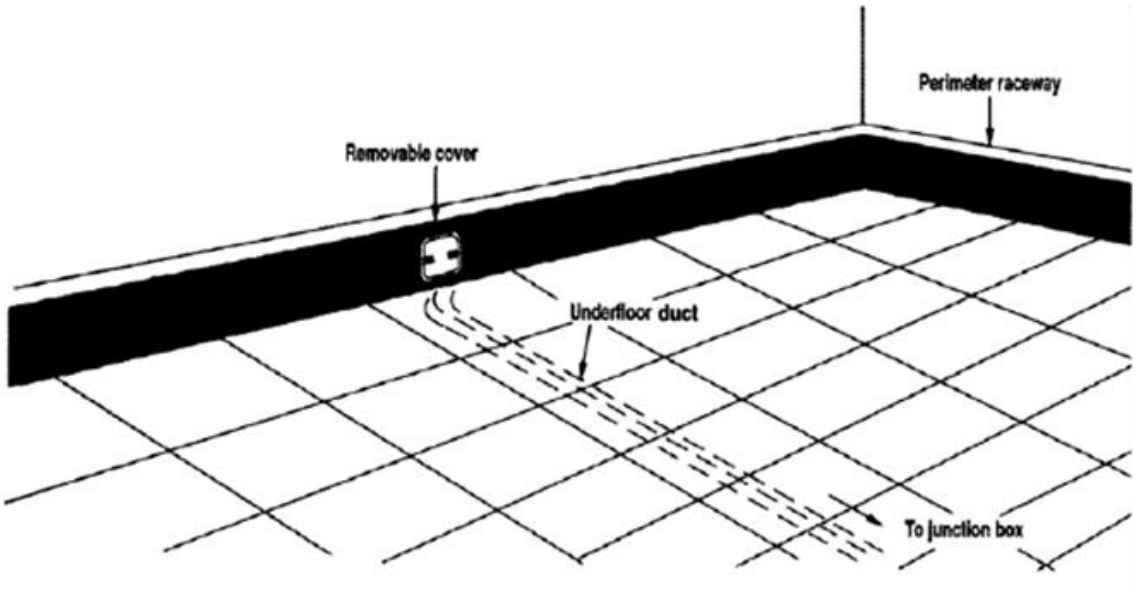


Figure 17: Perimeter raceways linked to under floor duct distribution

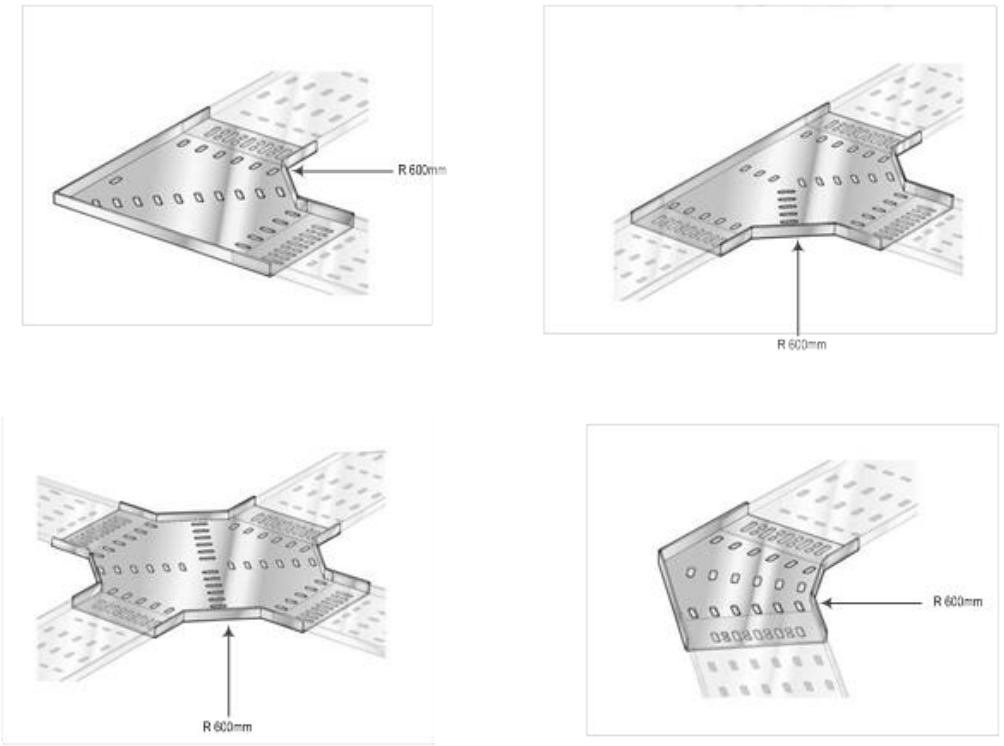


Figure 18: Cable tray bends and fittings (with 600 mm minimum radius)

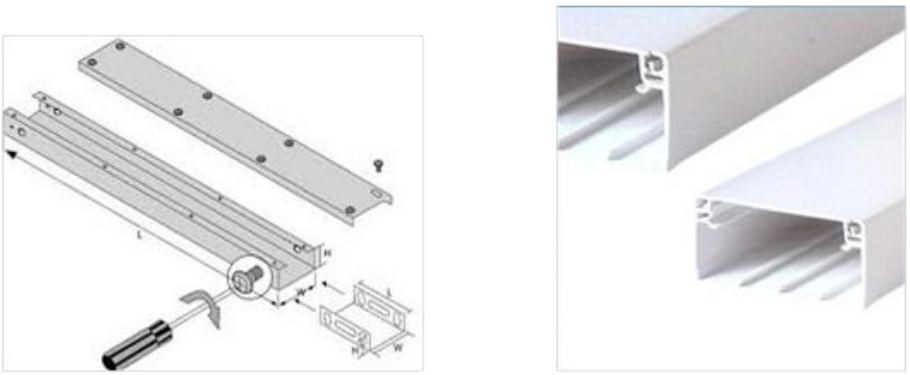


Figure 19: Typical example of a trunking system

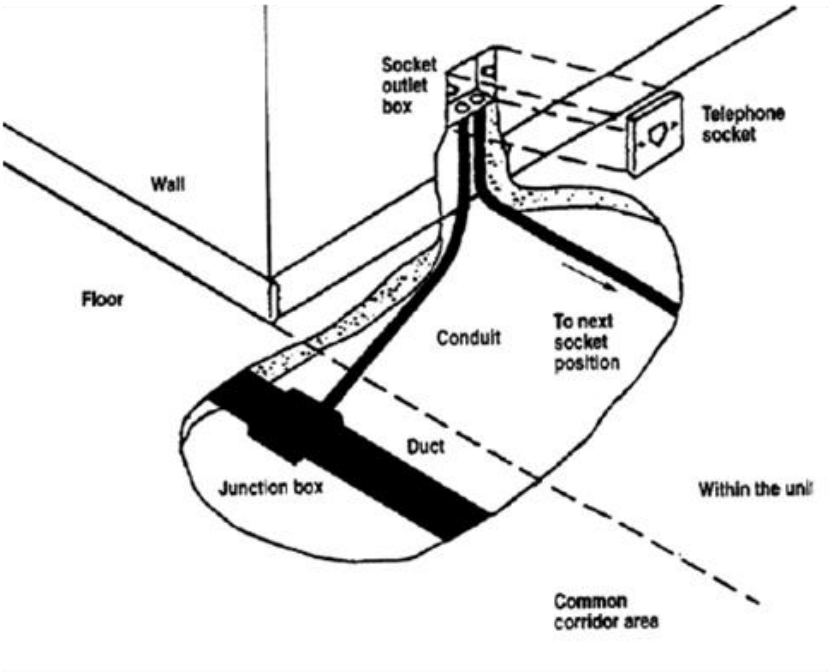


Figure 20: Combination of duct and conduit distribution system

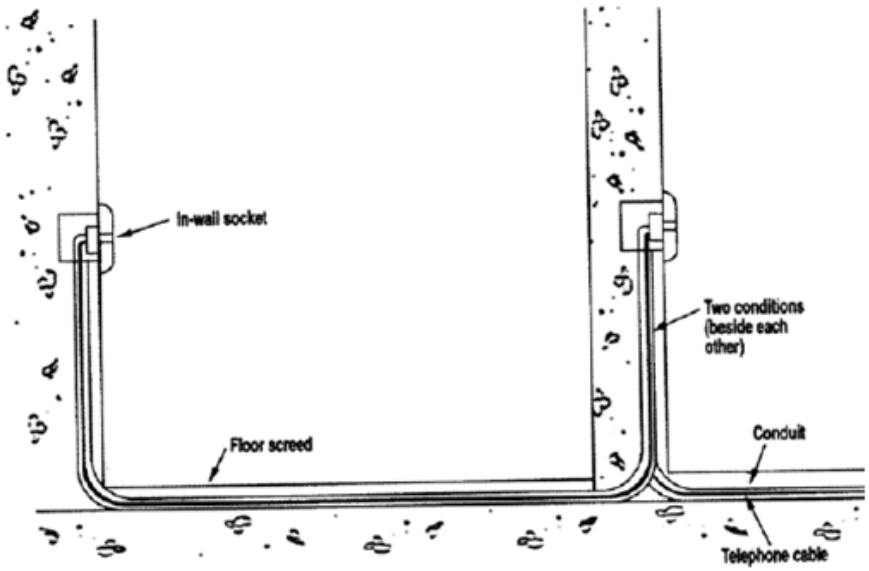


Figure 21: Using conduits for distribution cables

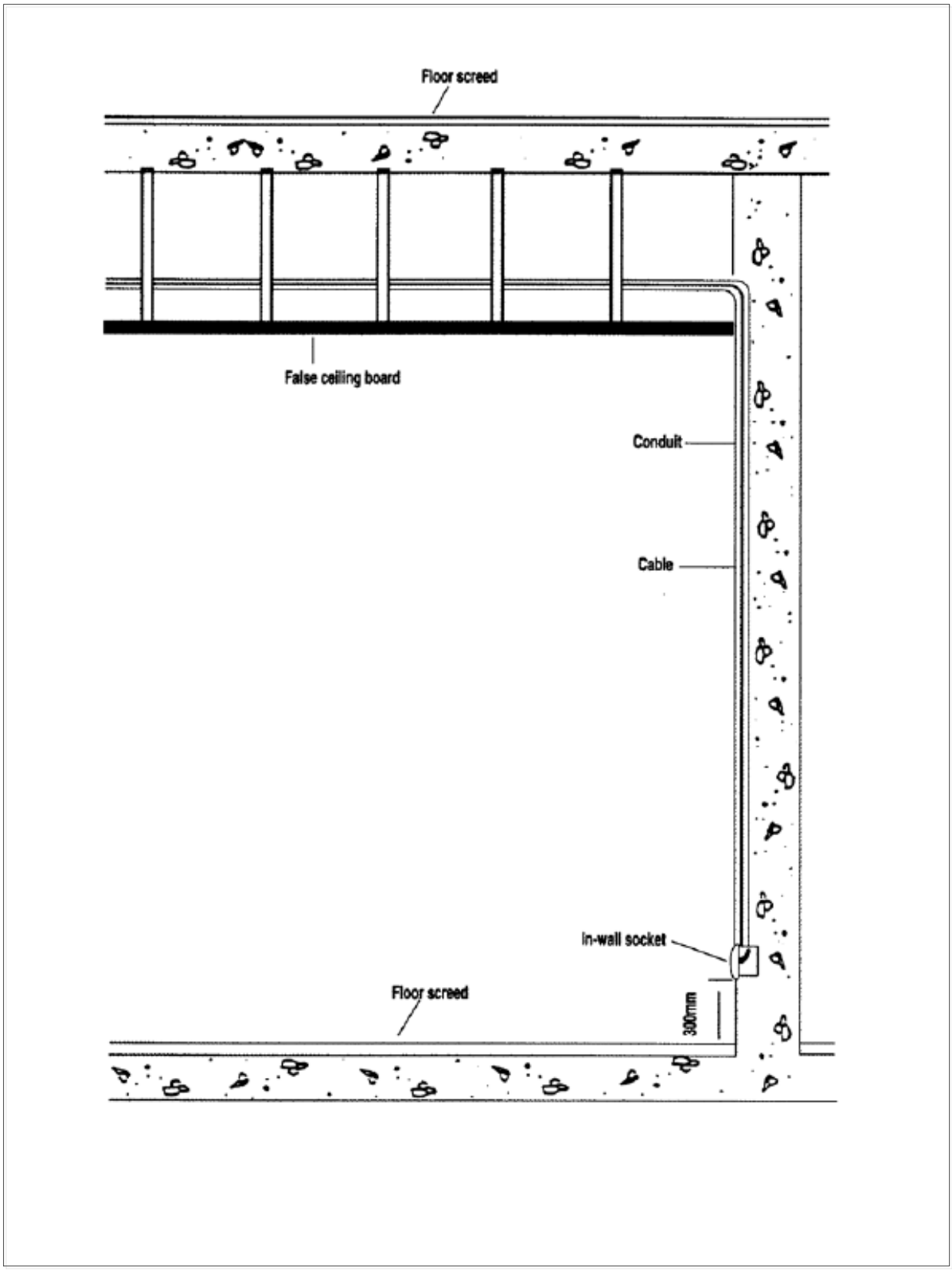


Figure 22: Conduit in false ceiling and wall to distribution cables

6. USER PREMISES CABLING AND INTERFACE POINT

6.1 INTERFACE POINT FOR USER PREMISES CABLING

6.1.1 **Internal telecommunication wiring:**

Internal telecommunication wiring ("IW") means any telecommunication line, wire, cable, optical fibre, conduit or other physical medium connecting a user's telecommunication equipment and any interface point ("IP") but does not include the use of extension cords with built-in connectors and sockets. IW at the user's premises shall be supplied and installed by licensed and certified installers and contractors.

6.2 RECORD OF CABLE DISTRIBUTION SYSTEM AND DOCUMENTATION OF PRE-CABLING OR INTERNAL TELECOMMUNICATION WIRING WORK

6.2.1 The developer or owner shall keep an up-to-date set of the telecommunication cable distribution system drawings and a record of the pre-cabling or internal telecommunication wirings for reference purpose.

APPENDIX 1 FUNCTIONS OF THE BUILDING PLAN CO-ORDINATION AND APPROVAL PROCESS

1.1 BUILDING PLAN CO-ORDINATION AND APPROVAL PROCESS

1.1.1 For large developments, the owner or developer may require pre-consultation meeting with the AITI on the provision of telecommunication facilities. They may contact and arrange an appointment with the AITI via contacting ABCi.

1.1.2 For small developments or projects in which pre-consultation is not required, the owner or developer shall submit the building plans and the site plan to ABCi.

1.1.3 AITI's representative will acknowledge the receipt of building plans. AITI will co-ordinate site meetings (with presence of representatives from licensees) to discuss in details on the provision of building telecommunication facilities. ABCi will collate and forward final telecommunication service plan to building owners/ developers/ architects/ consultants and the other licensees. ABCi will arrange for site inspection and telecommunication room hand-over when facilities are ready.

1.1.4 The flow chart for building plan co-ordination and approval process is attached (Figure 23).

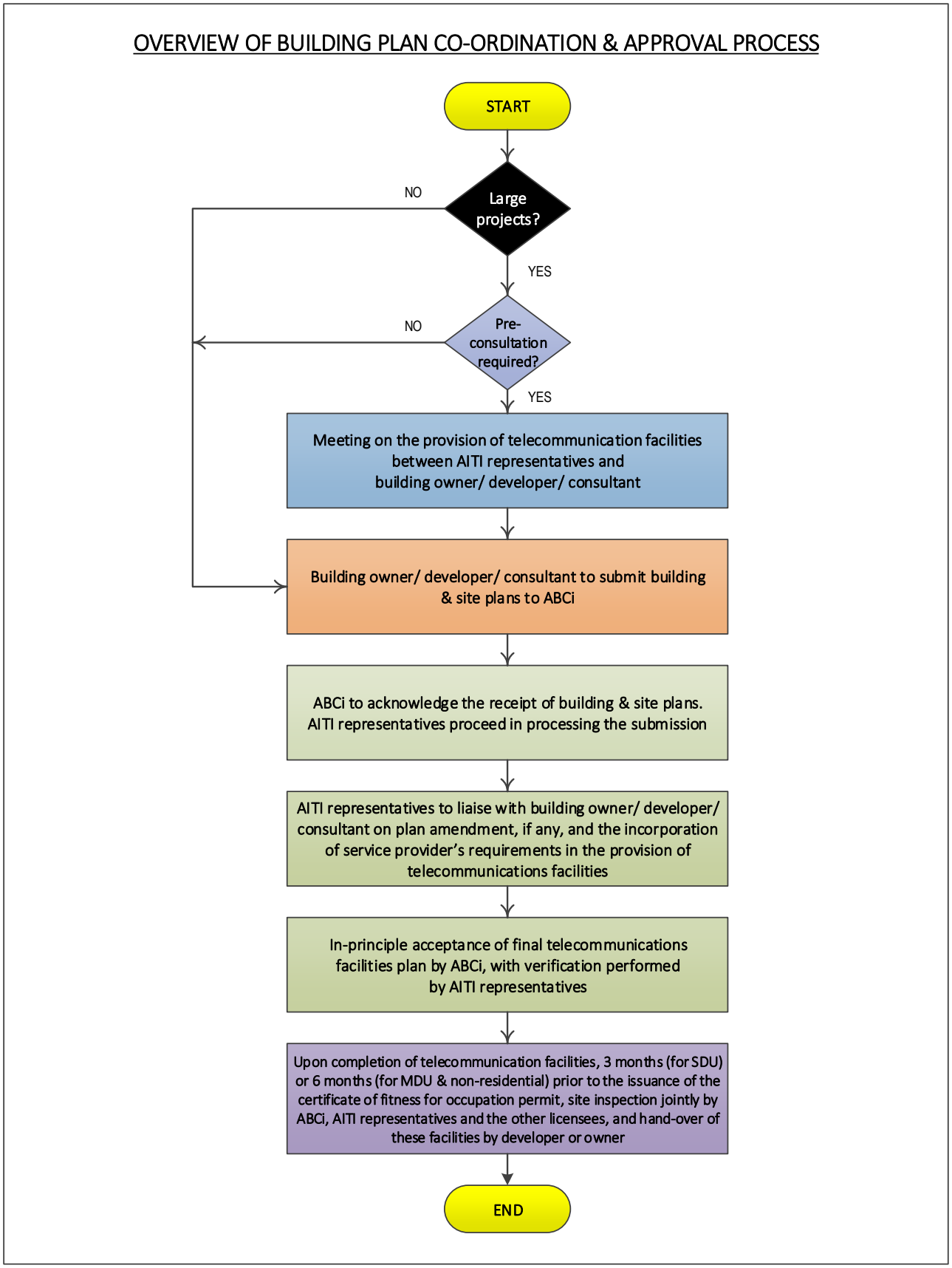


Figure 23: Flow chart for building plan co-ordination and approval process

APPENDIX 2 DUCT SEALING SYSTEM FOR BUILDING WITH BASEMENT

2.1 Systems used

(a) MCT − Transit for round holes/pipes, type RGP-150, split type.

(b) ROX − Multi-diameter-modules with adaptable cores.

(c) BST – Multi cable transit, modular system.

Please refer to Figure 24 for typical view of duct sealing system.

2.2 Builder's responsibility

2.2.1 The developer or owner shall be responsible for the maintenance of the duct sealing system throughout the lifespan of the building, including ensuring there are no water leaks on the duct sealing system.

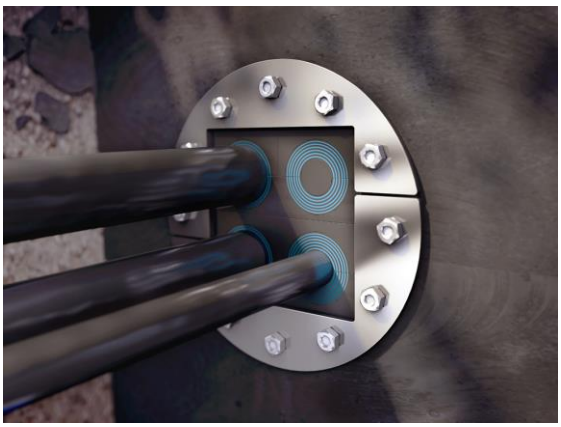


Figure 24: Typical view of duct sealing systems

APPENDIX 3 TESTING AND ACCEPTANCE PROCEDURE FOR CIVIL INFRASTRUCTURE FACILITIES PROVIDED BY DEVELOPER OR OWNER

3.1 Pipe Testing

3.1.1 Upon completion of pipe laying works, the developer or owner shall make arrangements with the licensees through the ABCi to have the pipes tested in accordance with the following procedures for:

(a) 100 mm diameter nominal size uPVC Pipe:

A brush of appropriate size shall be drawn through each pipe to remove any debris which may have entered. A standard wooden test mandrel as shown in Figure 25 shall then be drawn through each pipe from both ends of the pipe.

(b) 20 mm and 50 mm diameter nominal size uPVC Pipes:

A 2 m length of cable with diameter 15 mm smaller than the internal diameter of the pipe shall be drawn through each pipe from both ends.

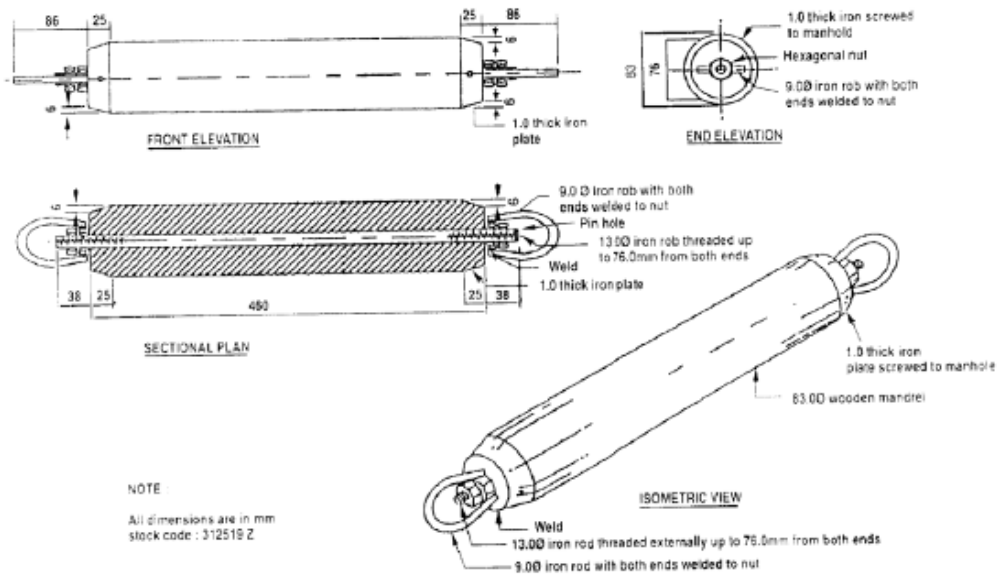


Figure 25: Ducting pipes testing and acceptance

APPENDIX 4 OPTICAL DISTRIBUTION NETWORK (ODN) IN-BUILDING INFRASTRUCTURE GUIDELINES FOR SINGLE DWELLING UNIT (SDU).

4.1 GENERAL

4.1.1 This document is to outline the infrastructure requirements for the purpose of setting up a common and integrated fixed network distribution system to be made available in the buildings. It also provides the minimum technical specifications necessary for the in-building fibre cabling FTTP distribution system to function as required in buildings.

4.1.2 The document covers on the system infrastructure requirement and facilities to be provided for a development consisting of one (1) or more single dwelling-houses adjoining a new road to be constructed by the developer or owner, as well as the minimum installation guidelines and standards.

4.1.3 This document is to be read together with the Code of Practice for In-building Optical Fibre Cablings for General Housing Development 2015 ("IFC GHD Code"), which sets out the mandatory requirements in respect of the space and facilities which developers or owners are required to provide.

4.2 EXTERNAL INFRASTRUCTURE REQUIREMENTS

4.2.1 INFRASTRUCTURE DEMARCATION

(a) The infrastructure demarcation for all housing or building development area will be the Private Property Line, where this will be the demarcation point or boundary between the telecommunication licensee and housing or building development.

(b) For SDU, the Private Property Line shall be at the fence, and/or its boundary mark of the premise.

(c) The infrastructure inside the Private Property Line is under responsibility of the developer or owner. The developer or owner is responsible to ensure all required infrastructure is available as per AITI's requirement.

(d) Infrastructure outside the Private Property Line shall be under responsibility of the telecommunication licensee, except for the lead-in pipes and its associated manhole.

4.2.2 MANHOLE

(a) The manholes on the road side outside the building/compound must be prepared by the Developer or owner so that the telecommunication licensee can connect their underground manholes and ducts network.

(b) A manhole shall be constructed at every location where there is a change of direction (e.g. a 90º bend) in the underground ducting

(c) A minimum of one (1) manhole must be provided for every 200 m section length of underground pipes laid.

(d) For manhole reserved for connection of Drop Fibre, the manhole cover shall be made from fibre or any light material type which should be possible to be accessed by one (1) person only.

(e) The manhole cover must sustained loading and sustain up to twenty (20) years.

4.2.3 UNDERGROUND DUCT (LEAD-IN PIPES AND U/G PIPES)

(a) The developer or owner shall provide the underground ducting within the development to enable the telecommunication licensee to connect the development to the main point of presence (POP).

(b) The underground duct-ways are required to connect the road side manhole direct to the building. The number of the duct-ways depends on the size and types of the building and number of users.

(c) Apart from the 50 mm diameter lead-in duct connecting the landed dwelling houses to the manholes, all underground ducting shall be made of unplasticised polyvinyl chloride (uPVC) material with a diameter of 100 mm.

(d) The duct provision shall be made to accommodate the local line installation envisaged for the period of twenty (20) years.

(e) The duct routes must be as straight without sharp bends and not obstructed. The maximum allowable bending radius is twenty (20) times of duct diameter.

(f) Duct plugs or caps must be installed at both ends of every empty or unused duct inside every manhole or jointbox.

4.2.4 SUB-DUCT

(a) Sub-ducts are required for the construction of underground duct system for fibre optic in the telecommunication's outside plant network.

(b) Sub-ducts are intended to be installed as a sub-duct for every 100 mm GI or PVC pipe in each section between two (2) manholes.

(c) Every sub-ducts installed are to be accompanied by the pulling rope.

(d) The sub-ducts are intended for housing of fibre optic cables installed by traditional pulling techniques.

(e) Duct plugs or caps must be installed at both ends of every empty or unused sub-duct inside every manhole or jointbox.

4.2.5 UNDERGROUND DUCT ROUTE DESIGN FOR SDU

For the SDU serve via underground access, the recommended design for the duct route is shown below.

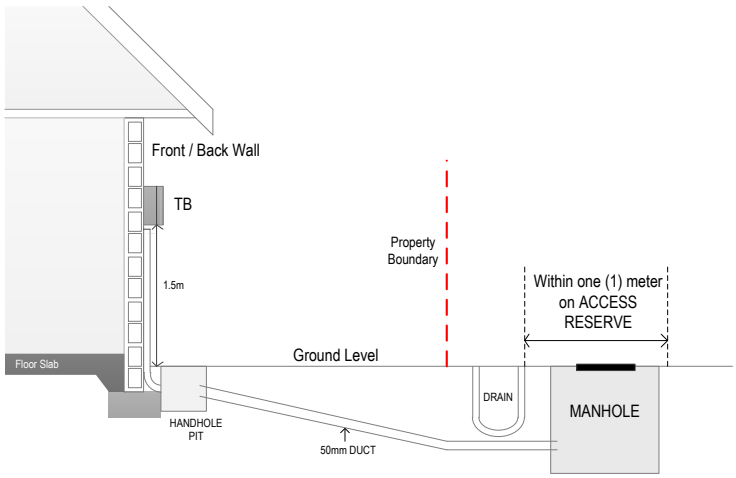


Figure 26: Design of under drain duct connection

(a) Lead-in ducting shall be made of unplasticised polyvinyl chloride (uPVC) material with a minimum inside diameter of 50 mm.

(b) The lead-in duct shall be installed in a straight run from the manhole to the house wherever possible. Any bends in the duct shall be a purpose made preformed uPVC duct bend with maximum bend of 90 degrees and a minimum bend radius of 400 mm. Figure 27 below shows the recommended size and allowable bending radius for the premise accessing duct.

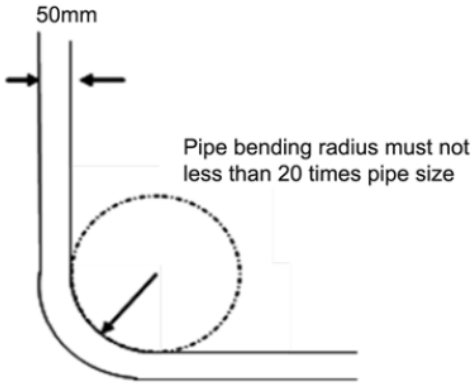


Figure 27: Design of Premise's entering Duct

(c) Developer to install a pulling rope in the 50 mm duct to facilitate the fibre installation.

(d) Before entering the wall section of the premise, small pit with minimum size 300 mm x 300 mm x 300 mm shall be prepared for easy access during the maintenance work.

(e) The Optical Fibre Termination Box (TB) at outside of the wall must be provided for easier future operation and maintenance.

4.3 INTERNAL INFRASTRUCTURE REQUIREMENTS

4.3.1 OPTICAL FIBRE TERMINATION BOX (TB)

(a) The Termination Box (TB) acts as the connection point between the drop cable fibres and the in-building fibre cable. It also acts as the distribution point for in-building cabling.

(b) For the SDU, TB is located at individual customer's premise either at a back or in front of the premise depend on the developer's design. TB acts as the demarcation point between the outdoor Drop Fibre and the indoor cable into the customer's premise.

(c) The TB should be installed at a height of 1.5 m from the floor of the house.

(d) The developer must provide the TB with Type-SC/APC connector typed. TB must be robust and weather proof especially for outdoor installation.

4.3.2 ACCESS TERMINATION BOX (ATB)

(a) The Access Termination Box (ATB) is a termination point for the internal fibre cable from the Termination Box (TB) and provides the connection point for the Optical Network Terminal (ONT).

(b) The ATB shall be provided by the developer with Type-SC/APC output connector for connection with ONT's patch cord. The ONT patch cord will be provided by the telecommunication licensee during the service activation.

(c) The ATB shall be placed at 0.3 m above the floor level and at the same height, with a distance of 0.3 m apart from the corner of the wall or from electrical points.

(d) A minimum of one (1) 13 A-AC electrical power socket shall be provided as the ONT requires main electricity connection.

(e) A minimum one unit of ATB must be provided by the developer in all premises.

(f) Further details on the location of ATB installation is described in "Internal Telecommunication Wiring" under "CABLING FOR SINGLE-DWELLING UNIT (SDU)".

4.3.3 FIBRE DISTRIBUTION TERMINAL (FDT)

(a) The Fibre Distribution Terminal (FDT) located at the ground floor near the staircase, acts as the connection point between the low density fibre count distribution cables and individual Drop Fibre into the customer premise via optical splitters.

(b) The indoor FDT enclosure provides a vital cross-connect/interconnect interface for optical transmission signals.

(c) The FDT shall be provided by the developer for each part of the building within the serving stairways, with Type-SC/APC output connector and adaptor for connection.

(d) The indoor FDT enclosures are for indoor wall mount applications and provide complete access for maintenance and service provisioning.

4.3.4 TRUNKING / CONDUIT

(a) The trunking or conduit is required for laying the cable inside the building and acts as the protection and cable guide.

(b) For SDU, the trunking or conduit must be used to lay the cable between the TB, located at the outside wall, and the ATB located inside the premise.

(c) The bending radius of the trunking or conduit must be greater than ten (10) times of the trunking or conduit size to ensure that the fibre cable meet the minimum bending radius.

(d) The SDU's trunking or conduit must be made from PVC or harder type of conduit with minimum 20 mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to reduce the aesthetics within or outside the premise.

4.4 CABLING FOR SINGLE-DWELLING UNIT (SDU)

4.4.1 CABLING FOR SDU SERVED VIA UNDERGROUND

(a) Generally, premise internal cabling covers the interconnections from the TB to the ATB. For SDU, TB is referred to the termination box at every individual premise and ATB is the socket located inside each individual premise for connection with the customer premises equipment (CPE).

(b) The internal fibre cable between and inclusive of the TB and ATB shall be provided by the developer or owner. For each unit of the SDU, only single core of Internal Optical Fibre cable is required.

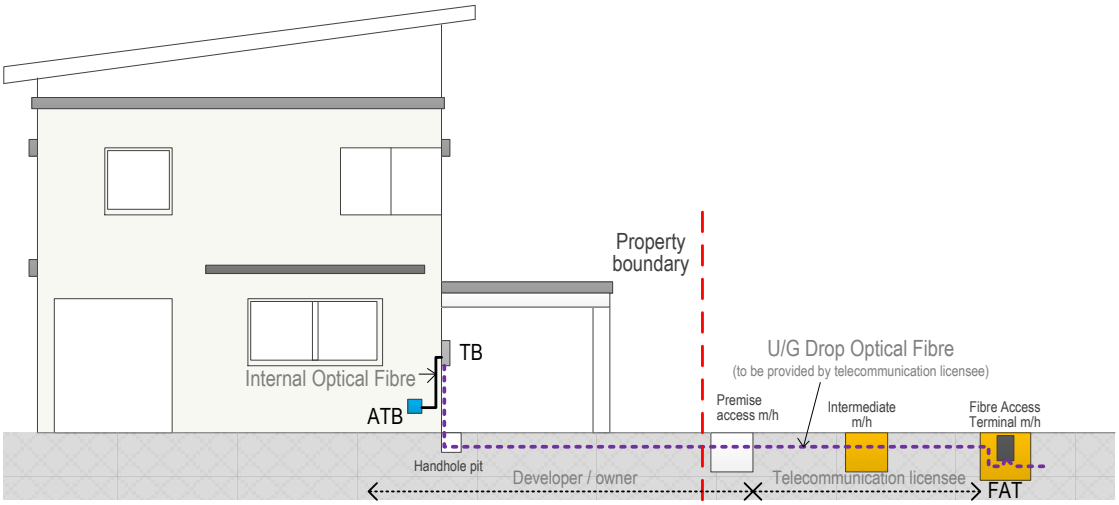


Figure 28: SDU cabling via underground

(c) Underground Optical Fibre Drop cable must be connected to the premise wall TB and at the other side it must be coiled inside the manhole and must terminate the fibre core inside the cable closure. This will be provided by the telecommunication licensee during service activation. The label of premise number must be pasted inside the closure and the label must be made from polyethylene or material which is able to sustain at up to ten (10) years or more.

(d) Distance of underground Optical Fibre Drop cable generally must not exceed 50 m to ensure the power attenuation loss is within allowable range. At every unit of premise, minimum two (2) core of fibre must be provided.

(e) Underground Optical Fibre Drop cable must be laid inside underground duct. The underground duct or conduit must be from uPVC or harder type of conduit with minimum size of 50 mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to keep the aesthetics either within or outside the customer premise. The underground duct or conduit and the premise access manhole shall be provided by the developer or owner.

4.4.2 CABLING FOR SDU – SHOP LOTS

a) The Fibre Distribution Terminal (FDT) that serves one (1) area of the shop lot building must be mounted on the wall in the staircase area or in the utility room beside the staircase.

b) The FDT will acts as the demarcation point or boundary between the premise developer or owner and the telecommunication licensee. The FDT will also act as connection point between the telecommunication licensee and each shop unit.

c) Developer or owner must prepare the ATB at each shop unit and must be connected to the FDT via internal fibre cable.

d) The internal fibre cable between and inclusive of the FDT and ATB shall be provided by the developer or owner and will be under the premise owner's responsibility. For each unit of the shop lots, at least two (2) cores of Internal Optical Fibre cable are required.

(a) For each unit of residential type of premise of the shop lots, only single core of Internal Optical Fibre cable is required.

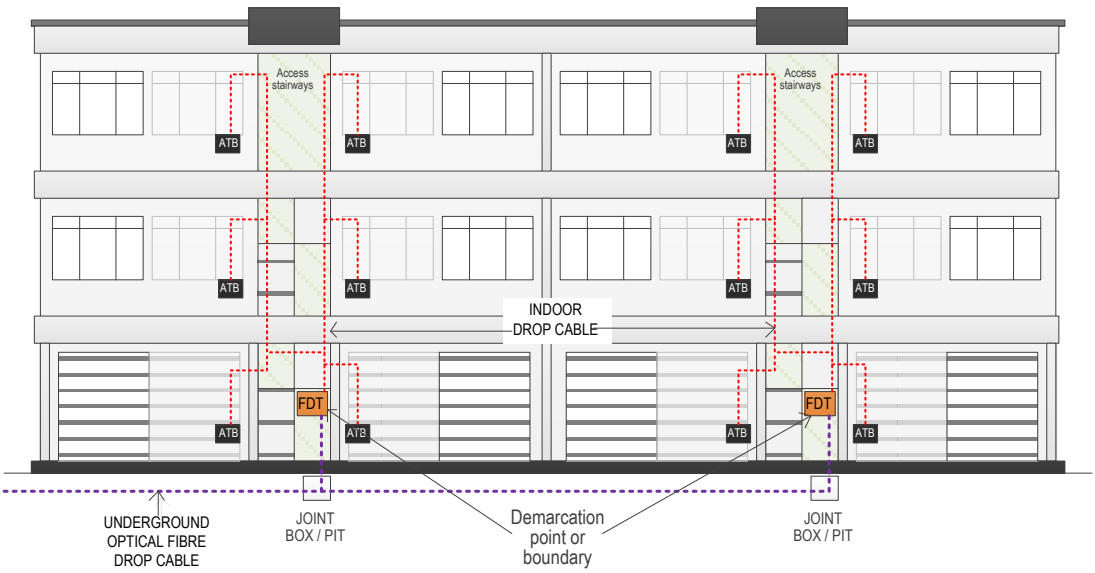


Figure 29: SDU shop Lots cabling

4.4.3 INDOOR TELECOMMUNICATION WIRING FOR SDU

(a) The Indoor Telecommunication Wiring for SDU Residential Unit is referred to the cabling inside each SDU residential unit, which runs across every living room and master bedroom, using an unshielded twisted pair cable.

(b) Under the presence of utility room/closet, in each SDU residential unit :

i. The utility room/closet shall act as a centralized location for both active and passive components installation, such as Optical Network Terminal (ONT), incoming access from Access Termination Box (ATB) and cable distribution to a minimum of one (1) living room and one (1) master bedroom in the unit.

(c) Whereas under the absence of a utility room/closet, in each SDU residential unit :

i. Both active and passive components installation such as Optical Network Terminal (ONT) and incoming access from Access Termination Box (ATB) shall be placed in a strategic location, preferably at the center of the unit, which shall allow the ease of cable distribution to the master bedroom only and living room (if applicable).

(d) Both end-to-end connections of the unshielded twisted pair cable shall be terminated with a similar outlet affixed against the wall. The RJ-11 outlet shall be terminated with a Category 5 cable in accordance with TIA 568-A/B, while the RJ-45 outlet shall be terminated with a Category 6 cable in accordance with TIA 568-C.

(e) The number of telecommunication outlet termination of each unit shall be dependent on the presence of utility room/closet.

(f) If the active equipment is kept in the utility room/closet, there shall be a telecommunication outlet consisting of RJ-11 and RJ-45 installed and terminated, interconnecting to a minimum of one (1) living room and one (1) master bedroom.

(g) If the active equipment is kept at a strategic location, in the absence of utility room/closet, the telecommunication outlet consisting of RJ-11 and RJ-45 outlet shall be installed and terminated, interconnecting only to the master bedroom and living room (if applicable) in the unit.

(h) A minimum of one (1) 13 A- AC power supply shall be installed, next to both active and passive components such as Optical Network Terminal (ONT), Access Termination Box (ATB) and telecommunication outlets (RJ-11 and RJ-45).

4.4.4 INDOOR TELECOMMUNICATION WIRING FOR SDU's SHOP LOTS

(a) The Indoor Telecommunication Wiring for SDU Shop Lot is referred to the cabling inside each open space of a SDU shop lot unit, using an unshielded twisted pair cable.

(b) Under the presence of utility room/closet, in each SDU shop lot unit :

i. The utility room/closet shall act as a centralized location for both active and passive components installation, such as Optical Network Terminal (ONT), incoming access from Access Termination Box (ATB) and cable distribution to the open space in the unit.

(c) Whereas under the absence of a utility room/closet, in each SDU shop lot unit :

i. Both active and passive components installation such as Optical Network Terminal (ONT) and incoming access from Access Termination Box (ATB) shall be placed in a strategic location, preferably at the center of the unit, which shall allow the ease of cable distribution.

(d) Both end-to-end connections of the unshielded twisted pair cable shall be terminated with a similar outlet affixed against the wall. The RJ-11 outlet shall be terminated with a Category 5 cable in accordance with TIA 568-A/B, while the RJ-45 outlet shall be terminated with a Category 6 cable in accordance with TIA 568-C.

(e) The number of telecommunication outlet termination of each unit shall be dependent on the presence of utility room/closet.

(f) If the active equipment is kept in the utility room/closet, there shall be a telecommunication outlet consisting of RJ-11 and RJ-45 installed and terminated, interconnecting to a strategic location at the center of the unit.

(g) If the active equipment is kept at a strategic location, in the absence of utility room/closet, the telecommunication outlet consisting of RJ-11 and RJ-45 outlet shall not be necessary.

(h) A minimum of one (1) 13A- AC power supply shall be installed, next to both active and passive components such as Optical Network Terminal (ONT), Access Termination Box (ATB) and telecommunication outlets (RJ-11 and RJ-45).

APPENDIX 5 OPTICAL DISTRIBUTION NETWORK (ODN) IN-BUILDING INFRASTRUCTURE GUIDELINES FOR MULTI DWELLING UNIT (MDU).

5.1 GENERAL

5.1.1 This document is to outline the infrastructure requirements for the purpose of setting up a common and integrated fixed network distribution system to be made available in the buildings. It also provides the minimum technical specifications necessary for the in-building fibre cabling FTTP distribution system to function as required in buildings.

5.1.2 The document covers on the system infrastructure requirement and facilities to be provided for a development consisting of two (2) or more multi dwelling-houses to be constructed by the developer or owner, as well as the minimum installation guidelines and standards.

5.1.3 This document is to be read together with the Code of Practice for In-building Optical Fibre Cablings for General Housing Development 2015 ("IFC GHD Code"), which sets out the mandatory requirements in respect of the space and facilities which developers or owners are required to provide.

5.2 EXTERNAL INFRASTRUCTURE REQUIREMENTS

5.2.1 INFRASTRUCTURE DEMARCATION

(a) The infrastructure demarcation for all housing or building development area will be the Private Property Line, where this will be the demarcation point or boundary between the telecommunication licensee and housing or building development.

(b) For MDU, the Private Property Line shall be the common access manhole connected to the building's Telecommunication Room or direct to the building and Telecommunication Licensee manhole.

(c) The infrastructure inside the Private Property Line is under responsibility of the developer or owner. The developer or owner is responsible to ensure all required infrastructure is available as per AITI's requirement.

(d) Infrastructure outside the Private Property Line shall be under responsibility of the telecommunication licensee, except for the lead-in pipes and its associated manhole.

5.2.2 MANHOLE

(a) The manholes on the road side outside the building/compound must be prepared by the Developer or owner so that the telecommunication licensee can connect their underground manholes and ducts network.

(b) A manhole shall be constructed at every location where there is a change of direction (e.g. a 90º bend) in the underground ducting

(c) A minimum of one (1) manhole must be provided for every 200 m section length of underground pipes laid.

(d) For manhole reserved for connection of Drop Fibre, the manhole cover shall be made from fibre or any light material type which should be possible to be accessed by one (1) person only.

(e) The manhole cover must sustained loading and sustain up to twenty (20) years.

5.2.3 UNDERGROUND DUCT (LEAD-IN PIPES AND U/G PIPES)

(a) The developer or owner shall provide the underground ducting within the development to enable the telecommunication licensee to connect the development to the main point of presence (POP).

(b) The underground duct-ways are required to connect the road side manhole direct to the building. The number of the duct-ways depends on the size and types of the building and number of users.

(c) All underground ducting shall be made of unplasticised polyvinyl chloride (uPVC) material with a diameter of 100 mm, inclusive of the lead-in pipes to the building.

(d) The duct provision shall be made to accommodate the local line installation envisaged for the period of twenty (20) years.

(e) The duct routes must be as straight without sharp bends and not obstructed. The maximum allowable bending radius is twenty (20) times of duct diameter.

(f) Duct plugs or caps must be installed at both ends of every empty or unused duct inside every manhole or jointbox.

5.2.4 SUB-DUCT

(a) Sub-ducts are required for the construction of underground duct system for fibre optic in the telecommunication's outside plant network.

(b) Sub-ducts are intended to be installed as a sub-duct for every 100 mm GI or PVC pipe in each section between two (2) manholes.

(c) Every sub-ducts installed are to be accompanied by the pulling rope.

(d) The sub-ducts are intended for housing of fibre optic cables installed by traditional pulling techniques.

(e) Duct plugs or caps must be installed at both ends of every empty or unused sub-duct inside every manhole or jointbox.

5.2.5 MANHOLE AND UNDERGROUND DUCT ROUTE DESIGN FOR MDU

(a) The developer shall provide the access infrastructure manhole and the underground duct-ways to connect to the building Telecommunication Room. The size of manhole and the number of duct depend on the capacity of the building.

(b) Lead-in ducting shall be made of unplasticised polyvinyl chloride (uPVC) material with a minimum inside diameter of 100 mm.

(c) The lead-in duct shall be installed in a straight run from the manhole to the Telecommunication Room wherever possible. Any bends in the duct shall be a purpose made preformed uPVC duct bend with maximum bend of 90 degrees and a minimum bend radius of 400 mm. Figure 31. below shows the recommended size and allowable bending radius for the premise accessing duct.

(d) Developer to install a pulling rope in the 100 mm duct to facilitate the fibre installation.

(e) Duct plugs or caps must be installed at both ends of every empty duct inside every manhole or jointbox and inside of the Telecommunication Room.

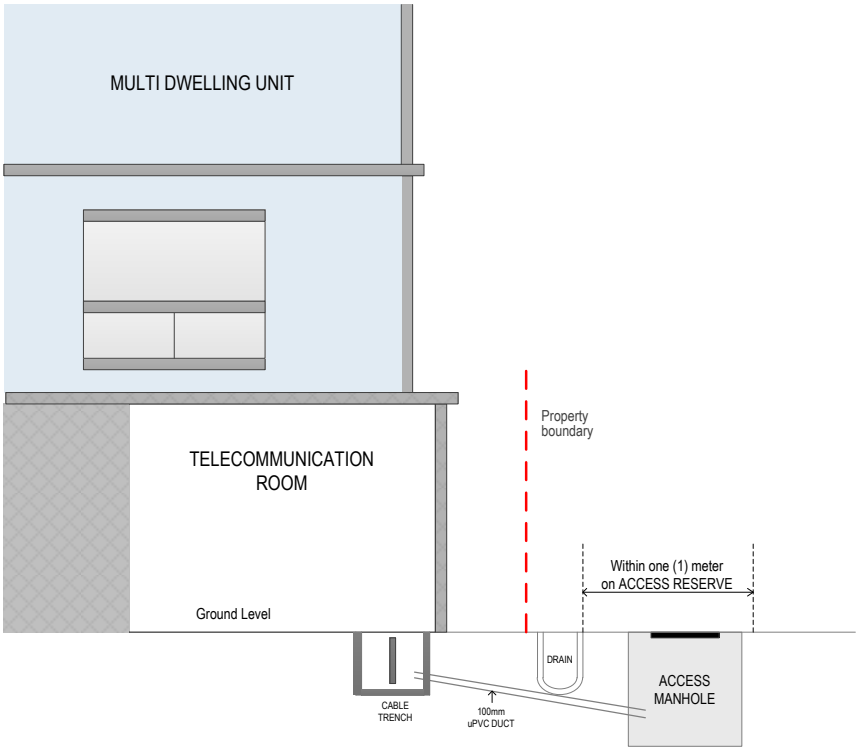


Figure 30: MDU manhole connection to building's Telecommunication Room

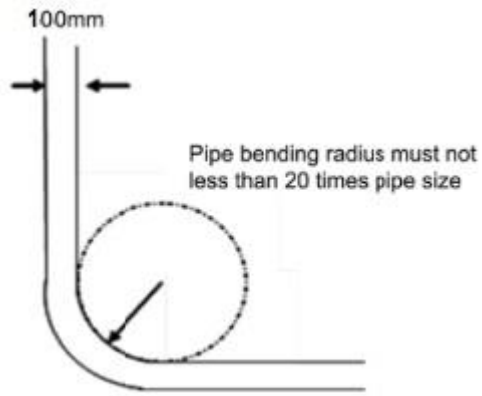


Figure 31: Design of premise's entering duct

5.3 INTERNAL INFRASTRUCTURE REQUIREMENTS

5.3.1 TELECOMMUNICATION ROOM

(a) A Telecommunication Room shall be provided in every multi dwelling unit (MDU) or multi-storey residential building within the housing development.

(b) A dedicate room with security lock to locate all Fixed Network equipment and cables.

(c) The floor area required for the Telecommunication Room, inclusive of the Main Distribution Frame and termination equipment shall depend on the type and demand of the building:

i. For Medium Rise MDU, the Telecommunication Room's floor space will be of two and half (2.5) meters in length by two (2) meters in breath and by three and half (3.5) meters in height (2.5 m x 2 m x 3.5 m).

ii. For High Rise MDU, the Telecommunication Room's floor space will be of three (3) meters in length by three (3) meters in breath and by three and half (3.5) meters in height (3 m x 3 m x 3.5 m).

(d) If the usable floor area of the telecommunication room is up to and 6 m^2, the minimum width of the telecommunication room shall be two (2) meters. The ratio of the length and width to be provided for a telecommunication room with a floor area of 8 m^2 or greater shall be between 1:1 and 2:1.

(e) The Telecommunication Room shall be placed on the Ground floor area and connected to the access infrastructure manhole and underground duct, as well as connecting to the available Telecommunication Risers. Ducting, sewage pipes air condition pipes shall not pass through the Telecommunication Room and should be locate free from perceptible vibration.

(f) The Telecommunication Room shall be provided with electrical AC supply with solidly earth system. The type of AC supply and rating will be dependent on the expected load. An earth leakage circuit breaker shall be installed inside the room.

(g) Any Telecommunication Rooms under the development of multi-dwelling unit, irrespective of the size, a minimum number of three (3) by two (2) gang thirteen (13) A (3 x 2-gang 13 A) switch socket outlets shall be provided.

(h) The Telecommunication Room shall be equipped with daylight type fluorescent lighting that can provide a minimum of 300-Lux luminance at floor level. The earthing system shall be connected to the building main grounding.

(i) The Telecommunication Room shall be fitted with a ventilation fan system.

(j) The Telecommunication Room shall have no other opening except for the door, the ventilation and cable trays. The door dimension shall be of two and a half (2.5) meters by one (1) meter (2.5 m x 1 m). The room must be flood free. A 150 mm kerb across the doorway is required to prevent water from entering the room.

(k) Developer should observe all relevant ordinance and regulation, regarding the fire safety requirements during the design of the Telecommunication Room, by having:

i. Portable hand-operated fire extinguisher; and

ii. Emergency lighting connection to back up power supply.

5.3.2 TELECOMMUNICATION RISER, CABLE TRAY AND TRUNKING

(a) The riser duct should be placed centrally with respect to the distribution in which it is to serve to obtain maximum benefit from the distribution system.

(b) The distance or serving radius between the riser duct and the outlet point in the home unit should be kept as short as possible, that is less than thirty (30) meters

(c) A 150 mm high kerb across the doorway is required to prevent water from entering the room and each Telecommunication Riser shall be labeled as “Telecom Riser” and numbered for easy identification.

(d) The size of the Telecommunication Riser shall minimum and is based on the type of building:

i. Medium Rise MDU: Closet space (W x D) = 900 mm x 600 mm;
Floor opening (W x D) = 400 mm x 180 mm;
Cable tray (W x D) = 300 mm x 25 mm;

ii. High Rise MDU: Closet space (W x D) = 1200 mm x 600 mm;
Floor opening (W x D) = 600 mm x 180 mm;
Cable tray (W x D) = 400 mm x 25 mm;

(e) For every floor opening in the telecommunication riser, a height of 150 mm and thickness of 100 mm kerb shall be constructed surrounding the floor opening.

(f) Every floor opening shall be sealed with fire resistant material, which can be easily removed and in compliance with the Director of Brunei Fire and Rescue Department requirement.

(g) Access to each Telecommunication Riser will be necessary on each floor and should always be available from a corridor or other common area. The riser shafts must be constructed in a direct vertical line throughout the building.

(h) The Telecommunication Riser shall have a hinged and locked door on every floor which can be fully opened outwards throughout the entire width and it is critical to be fire proof. If the width of the telecommunication riser exceeds 1.2 m, a double leaf door shall be provided. The specifications shall be at its minimum and in accordance with dimension specified below:

i. Medium Rise MDU: Closet space (W x D) = 900 mm x 600 mm;
Door Dimension (H x W) = 2100 mm x 500 mm;

ii. High Rise MDU: Closet space (W x D) = 1200 mm x 600 mm;
Door Dimension (H x W) = 2100 mm x 600 mm;

(i) In the Telecommunication Riser, there will be a minimum of two (2) riser cable trays. The cable trays are affixed vertically and running across every level or floors, against the walls of the Telecommunication Riser. The cable trays are placed opposite facing each other in the Telecommunication Riser. Each cable tray will hold the telecommunication cables separately such as coaxial and non-coaxial cables.

(j) In case of cable trays being installed from the telecommunication room to each telecommunication riser, a minimum of two (2) cable trays shall be provided with minimum specifications as specified below. A minimum height of 300 mm opening shall also be provided in the wall of each telecommunication riser for cable trays to pass through.

i. Medium Rise MDU: Width of cable tray (W x D) = 300 mm x 25 mm

ii. High Rise MDU: Width of cable tray (W x D) = 400 mm x 25 mm

(k) Vertical cable trays in the Telecommunication Room can share with Broadcast Services, and other Telecommunications Services.

(l) The trunking located outside the Telecommunication Riser at each floor, via Fibre Distribution Terminal (FDT) to the Access Termination Box (ATB) inside each individual unit of premise is referred to as the Horizontal Trunking. Horizontal Trunking must be provided in all MDU properties.

(m) Trunking is required for laying the cable inside the building and acts as the protection and cable guide.

(n) The size of Horizontal trunking along the corridor shall be according to the number of cables;

i. For number of cables less than ten (10), the size of trunking on ceiling will be one (1) number of 100 mm by 50 mm

ii. For number of cables from ten (10) to twenty (20), the size of trunking on ceiling will be two (2) number of 100 mm by 50 mm.

iii. For number of cables more than twenty (20), the size of trunking on ceiling needs to comply with the 50 % space factor.

(o) The bending radius of the trunking must be greater than 10 times of the trunking size to ensure that the fibre cable meet the minimum bending radius.

(p) The size of the horizontal trunking for the horizontal drop cable into the individual unit shall be using a PVC or harder type conduit of 20 mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to reduce the aesthetics within or outside the premise.

5.3.3 FIBRE CONCENTRATION POINT (FCP)

(a) The Fibre Concentration Point (FCP) is the inter-connection point between the building's internal fibre network and to the service provider's incoming trunk or feeder fibre cables.

(b) The FCP is where feeder cabling is converted into smaller distribution cables by splicing for further routing via the outgoing distribution cables and can be seen as the first point of flexibility.

(c) The location of the FCP shall be located inside the Telecommunication Room of the main building.

(d) The FCP will function as both the Fibre Distribution Hub (FDH) of the main building and also for distribution of smaller outgoing cables to the other Fibre Distribution Hub (FDH) in another building.

(e) The FCP shall be provided by the developer inclusive of the plinth, in accordance to the FCP dimension; with Type-SC/APC output connector and adaptor for connection.

5.3.4 FIBRE DISTRIBUTION HUB (FDH)

(a) The Fibre Distribution Hub (FDH) serves as distribution and termination point of bulk fibre optic drop cables or multicore riser cables. The FDH also acts as the connection point between FCP's fibres and the in-building fibre cables via optical splitters.

(b) FDH should be installed with sufficient space around the cabinet to allow access to installation and maintenance. Its dimensions and type varies depending on the number of cables to be terminated.

(c) Free standing type FDH - This type of FDH cabinet is recommended for high rise and multi-storey buildings, shopping malls, hospitals, airports, large commercial establishments, etc. with more than one hundred (100) tenancies.

(d) Wall-mount type FDH - Low-rise buildings including complex of villas may use wall-mount FDH cabinet. This cabinet is recommended for less than one hundred (100) tenancies.

(e) The indoor FDH enclosure provides a vital cross-connect/interconnect interface for optical transmission signals at the MDU. The enclosure provides mechanical protection for cables, splices, connectors and passive optical splitters.

(f) The FDH shall be provided by the developer for every individual building in the Telecommunication Room, with Type-SC/APC output connector and adaptor for connection. The requirement of plinth construction shall be dependent on the dimension of the FDH structural design.

(g) The Fibre Distribution Hub (FDH) must be located at the nearest point leading to the internal riser.

5.3.5 FIBRE DISTRIBUTION TERMINAL (FDT)

(a) The Fibre Distribution Terminal (FDT) located at floor riser room acts as the connection point between the medium or low density fibre count distribution cables and individual Drop Fibre into the customer premise via optical splitters.

(b) The indoor FDT enclosure provides a vital cross-connect/interconnect interface for optical transmission signals at the MDU.

(c) The FDT shall be provided by the developer for every floor of the building in the Telecom riser room, with Type-SC/APC output connector and adaptor for connection.

(d) The indoor FDT enclosures are for indoor wall mount applications and provide complete access for maintenance and service provisioning.

5.3.6 ACCESS TERMINATION BOX (ATB)

(a) The Access Termination Box (ATB) is a termination point for the internal fibre cable from the Termination Box (TB) and provides the connection point for the Optical Network Terminal (ONT).

(b) The ATB shall be provided by the developer with Type-SC/APC output connector for connection with ONT's patch cord. The ONT patch cord will be provided by the telecommunication licensee during the service activation.

(c) The ATB shall be placed at 0.3 m above the floor level and at the same height, with a distance of 0.3 m apart from the corner of the wall or from electrical points.

(d) A minimum of one (1) 13 A-AC electrical power socket shall be provided as the ONT requires main electricity connection.

(e) A minimum one unit of ATB must be provided by the developer in all premises.

(f) Further details on the location of ATB installation is described in “Internal Telecommunication Wiring” under “CABLING FOR MULTI-DWELLING UNIT (MDU)”.

5.4 CABLING FOR MULTI-DWELLING UNIT (MDU)

5.4.1 CABLING FOR MDU

(a) Generally premise internal cabling for MDU covers the elements and interconnections from the FDH, inside the Telecommunication Room to the individual premise’s ATB. For MDU, FDH is referred to the distribution and termination point in the Telecommunication Room, whereas FDT is the connection point inside every floor of the Telecommunication Riser and ATB is the socket located inside each individual premise for connection with CPE or specifically, ONT.

(b) The internal fibre cable between FCP/FDH and ATB via FDT shall be provided by the developer or owner.

(c) For each unit of residential type of MDU, at least two (2) core of Indoor Fibre cable must be provided inside each unit. However it can be multiple cores depending on Developer’s design.

(d) For each unit of residential type of premise, only single core of Internal Optical Fibre is required.

(e) Distance between the riser duct and the outlet point in the home, ATB unit should be kept as short as possible, generally must not exceed 30 m to ensure the power attenuation loss is within allowable range.

(f) All infrastructures inside the building and connection shall be made available by the Developer or owner and be maintained by the building management.

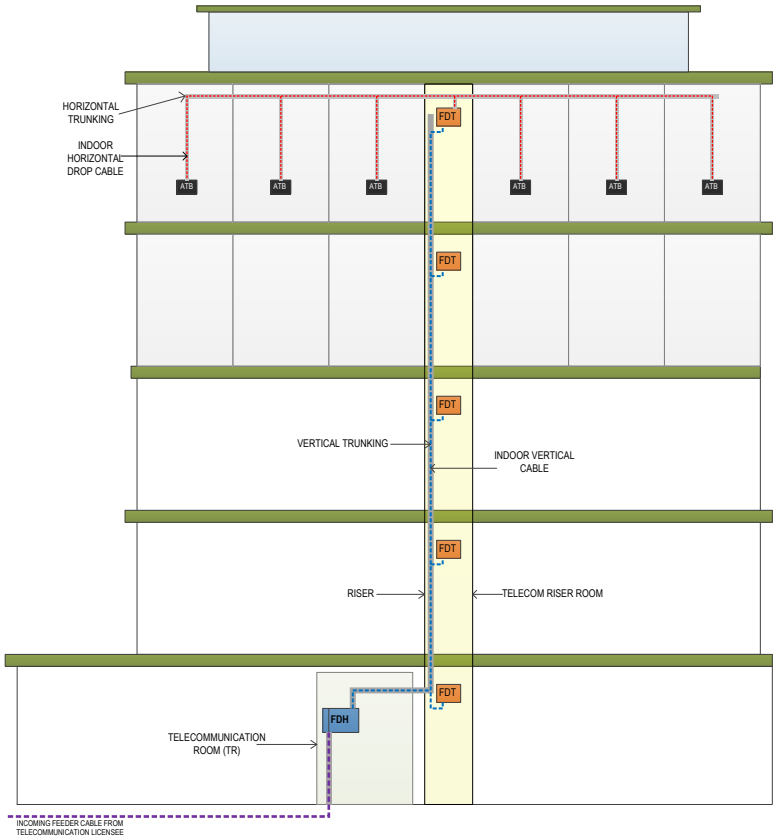


Figure 32: MDU and indoor fibre cabling and trunking

5.4.2 DISTRIBUTION CABLE

(a) The distribution cable is referred to the cabling from the main Telecommunication Room, where the cable is terminated and cross connect to the FCP in one building, to the Telecommunication Room in another building, where the cable is connected and terminated to the FDH. The distribution cable must be provided by the Developer or owner, and must be approved during acceptance procedure.

(b) Number of cable core for every distribution cable is depend on the size of the MDU and also on the design of the network but must be same or more than the number of Indoor Vertical Cable core.

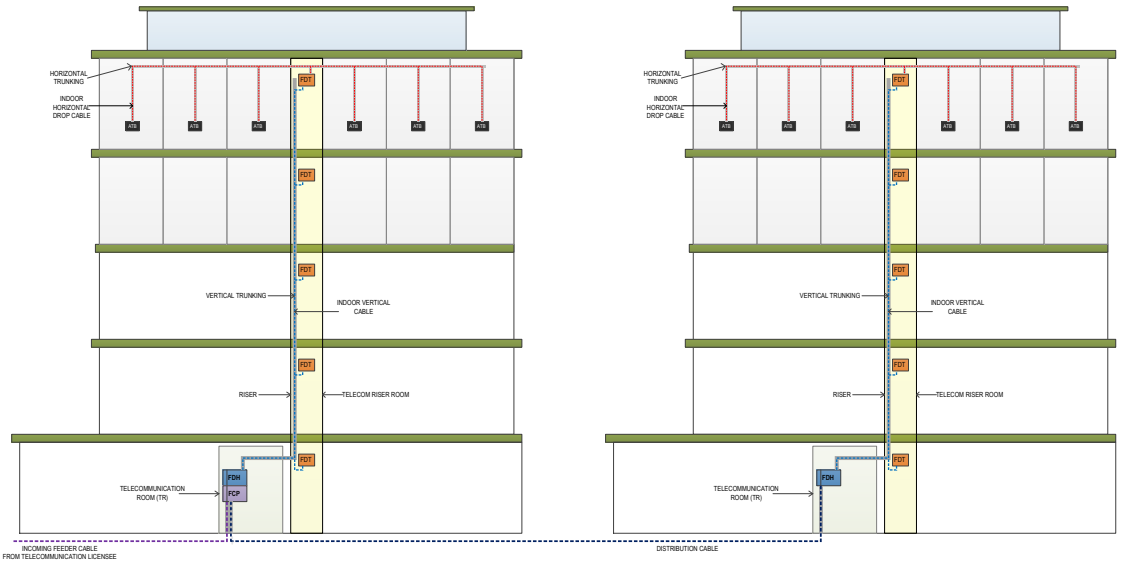


Figure 33: Multiple MDUs external and indoor fibre cabling and trunking

5.4.3 INDOOR VERTICAL CABLE

(a) The Indoor Vertical Fibre Cable is referred to the cabling between the FDH in the Telecommunication Room, and FDT at each floor Telecommunication Riser in the same building. Indoor Vertical Cable must be provided by the Developer and must be approved during acceptance procedure.

(b) The Indoor Vertical Fibre Cable is laid onto a riser cable tray which runs across each level of the floor. The Indoor Vertical Cable can be laid using a normal fibre cable.

(c) For business type of MDU, the number of effective vertical fibre cable core must at least two (2) cores for each individual premise unit. However, it should depend on the numbers of potential resident in each premise unit.

(d) For residential, the number of effective vertical fibre cable core must be at least 1 core for each individual premise unit in the building.

(e) For the maintenance and future used purpose, it is highly recommended to have minimum 30 % spare cores for business and 10 % of spare core for residential building.

5.4.4 INDOOR HORIZONTAL CABLE

(a) The Indoor Horizontal Drop Fibre Cable is referred to the cabling between the FDT at each floor of the Telecommunication Riser, and ATB inside each individual unit premise. Indoor Horizontal Drop Cable must be provided by the Developer and must be approved during acceptance procedure.

(b) The Indoor Horizontal Drop Fibre cable must be covered or protected with surface mounted PVC duct or concealed inside the wall, or using conduit through the ceiling. The Indoor Horizontal Drop Cable must be laid using a bend-insensitive fibre cable.

(c) Indoor Horizontal Drop Cable shall be laid separately with Indoor Vertical Cable and will be spliced and connected using adaptor inside the Telecommunication Riser's FDT. In this case, the core arrangement of Indoor Horizontal Drop Cable must follow

the same sequence of premise numbering system, where premise with unit number one (1) must be connected with core number one (1).

(d) Number of effective core for each premise is two cores for business building and one core for residential building.

(e) For the maintenance and future used, it is highly recommended to have minimum 20 % of spare cores for business and 10 % of spare cores for residential type in each of Indoor Horizontal Drop Cable.

5.4.5 INTERNAL TELECOMMUNICATION WIRING

(a) The Internal Telecommunication Wiring is referred to the cabling inside each residential unit, which runs across every living room and master bedroom, using an unshielded twisted pair cable.

(b) Under the presence of utility room/closet, in each residential unit :

i. The utility room/closet shall act as a centralized location for both active and passive components installation, such as Optical Network Unit (ONU), incoming access from Access Termination Box (ATB) and cable distribution to a minimum of one (1) living room and one (1) master bedroom in the unit.

(c) Whereas under the absence of a utility room/closet, in each residential unit :

i. Both active and passive components installation such as Optical Network Unit (ONU) and incoming access from Access Termination Box (ATB) shall be placed in a strategic location, preferably at the center of the residential unit, which shall allow the ease of cable distribution to the master bedroom only and living room (if applicable) in the residential unit.

(d) Both end-to-end connections of the unshielded twisted pair cable shall be terminated with a similar outlet affixed against the wall. The RJ-11 outlet shall be terminated with a Category 5 cable in accordance with TIA 568-A/B, while the RJ-45 outlet shall be terminated with a Category 6 cable in accordance with TIA 568-C.

(e) The number of telecommunication outlet termination of each residential unit shall be dependent on the presence of utility room/closet.

(f) If the active equipment is kept in the utility room/closet, there shall be a telecommunication outlet consisting of RJ-11 and RJ-45 installed and terminated, interconnecting to a minimum of one (1) living room and one (1) master bedroom.

(g) If the active equipment is kept at a strategic location, in the absence of utility room/closet, the telecommunication outlet consisting of RJ-11 and RJ-45 outlet shall be installed and terminated, interconnecting only to the master bedroom and living room (if applicable) in the residential unit.

(h) A minimum of one (1) 13 A- AC power supply shall be installed, next to both active and passive components such as Optical Network Unit (ONU), Access Termination Box (ATB) and telecommunication outlets (RJ-11 and RJ-45).

APPENDIX 6 OPTICAL DISTRIBUTION NETWORK (ODN) IN-BUILDING INFRASTRUCTURE GUIDELINES FOR NON-RESIDENTIAL BUILDING (NRB).

6.1 GENERAL

6.1.1 This document is to outline the infrastructure requirements for the purpose of setting up a common and integrated fixed network distribution system to be made available in the buildings. It also provides the minimum technical specifications necessary for the in-building fibre cabling FTTP distribution system to function as required in buildings.

6.1.2 The document covers on the system infrastructure requirement and facilities to be provided for a development consisting of one (1) or more non-residential buildings to be constructed by the developer or owner, as well as the minimum installation guidelines and standards.

6.1.3 This document is to be read together with the Code of Practice for In-building Optical Fibre Cablings for General Housing Development 2015 ("IFC GHD Code"), which sets out the mandatory requirements in respect of the space and facilities which developers or owners are required to provide.

6.2 EXTERNAL INFRASTRUCTURE REQUIREMENTS

6.2.1 INFRASTRUCTURE DEMARCATION

(a) The infrastructure demarcation for all non-residential building development area will be the Private Property Line, where this will be the demarcation point or boundary between the telecommunication licensee and building development.

(b) For NRB, the Private Property Line shall be the common access manhole connected to the building's Telecommunication Room or direct to the building and Telecommunication Licensee manhole.

(c) The infrastructure inside the Private Property Line is under responsibility of the developer or owner. The developer or owner is responsible to ensure all required infrastructure is available as per AITI's requirement.

(d) Infrastructure outside the Private Property Line shall be under responsibility of the telecommunication licensee, except for the lead-in pipes and its associated manhole.

6.2.2 MANHOLE

(a) The manholes on the road side outside the building/compound must be prepared by the Developer or owner so that the telecommunication licensee can connect their underground manholes and ducts network.

(b) A manhole shall be constructed at every location where there is a change of direction (e.g. a 90º bend) in the underground ducting

(c) A minimum of one (1) manhole must be provided for every 200 m section length of underground pipes laid.

(d) For manhole reserved for connection of Drop Fibre, the manhole cover shall be made from fibre or any light material type which should be possible to be accessed by one (1) person only.

(e) The manhole cover must sustained loading and sustain up to twenty (20) years.

6.2.3 UNDERGROUND DUCT (LEAD-IN PIPES AND U/G PIPES)

(a) The developer or owner shall provide the underground ducting within the development to enable the telecommunication licensee to connect the development to the main point of presence (POP).

(b) The underground duct-ways are required to connect the road side manhole direct to the building. The number of the duct-ways depends on the size and types of the building and number of users.

(c) All underground ducting shall be made of unplasticised polyvinyl chloride (uPVC) material with a diameter of 100 mm, inclusive of the lead-in pipes to the building.

(d) The duct provision shall be made to accommodate the local line installation envisaged for the period of twenty (20) years.

(e) The duct routes must be as straight without sharp bends and not obstructed. The maximum allowable bending radius is twenty (20) times of duct diameter.

(f) Duct plugs or caps must be installed at both ends of every empty or unused duct inside every manhole or jointbox.

6.2.4 SUB-DUCT

(a) Sub-ducts are required for the construction of underground duct system for fibre optic in the telecommunication's outside plant network.

(b) Sub-ducts are intended to be installed as a sub-duct for every 100 mm GI or PVC pipe in each section between two (2) manholes.

(c) Every sub-ducts installed are to be accompanied by the pulling rope.

(d) The sub-ducts are intended for housing of fibre optic cables installed by traditional pulling techniques.

(e) Duct plugs or caps must be installed at both ends of every empty or unused sub-duct inside every manhole or jointbox.

6.2.5 MANHOLE AND UNDERGROUND DUCT ROUTE DESIGN FOR NRB

(a) The developer shall provide the access infrastructure manhole and the underground duct-ways to connect to the building Telecommunication Room. The size of manhole and the number of duct depend on the capacity of the building.

(b) Lead-in ducting shall be made of unplasticised polyvinyl chloride (uPVC) material with a minimum inside diameter of 100 mm.

(c) The lead-in duct shall be installed in a straight run from the manhole to the Telecommunication Room wherever possible. Any bends in the duct shall be a purpose made preformed uPVC duct bend with maximum bend of 90 degrees and a minimum bend radius of 400 mm. Figure 35. below shows the recommended size and allowable bending radius for the premise accessing duct.

(d) Developer to install a pulling rope in the 100 mm duct to facilitate the fibre installation.

(e) Duct plugs or caps must be installed at both ends of every empty duct inside every manhole or jointbox and inside of the Telecommunication Room.

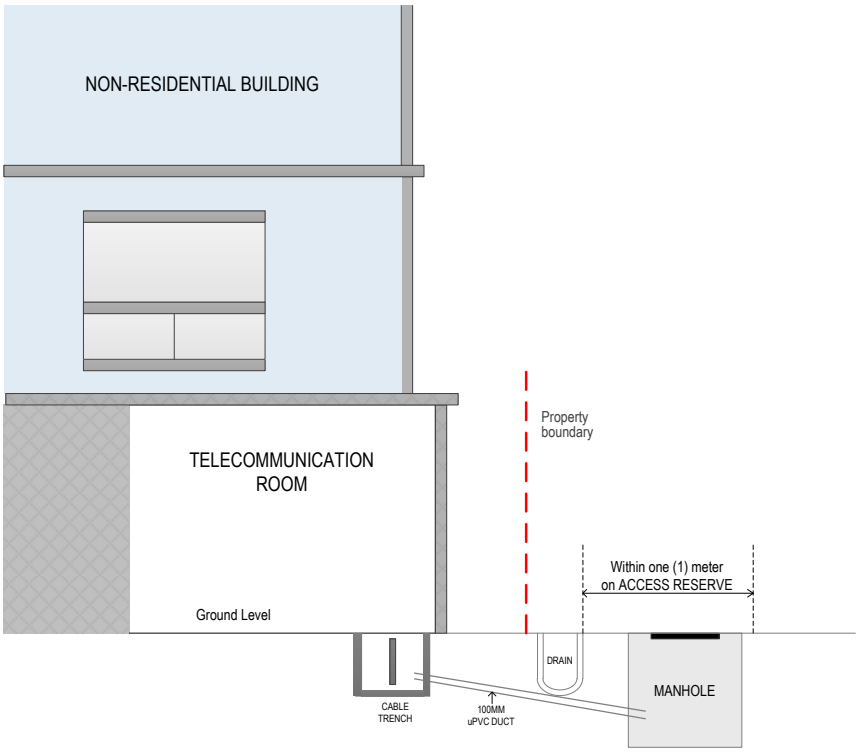


Figure 34: NRB manhole connection to building's Telecommunication Room

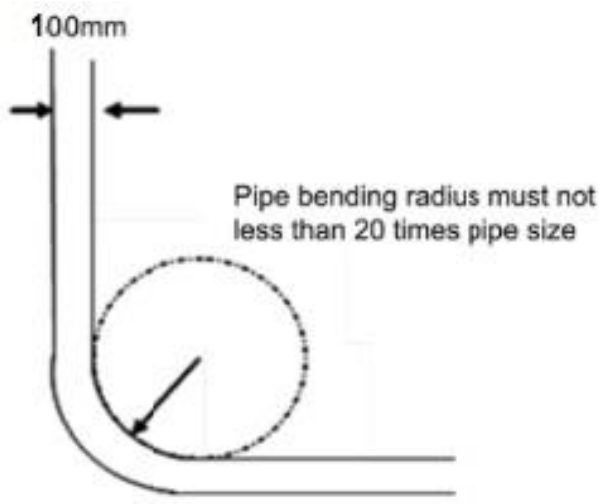


Figure 35: Design of premise's entering duct

6.3 INTERNAL INFRASTRUCTURE REQUIREMENTS

6.3.1 TELECOMMUNICATION ROOM

(a) A Telecommunication Room shall be provided in every non-residential building within the development.

(b) A dedicate room with security lock to locate all Fixed Network equipment and cables.

(c) The floor area required for the Telecommunication Room, inclusive of the Main Distribution Frame and termination equipment shall depend on the type and demand of the building:

i. For NRB with a total usable floor area up to and including 2,000 m^2, the Telecommunication Room's floor space will be of three (3) meters in length by two (2) meters in breath and by three and half (3.5) meters in height (3 m x 2 m x 3.5 m).

ii. For NRB with a total usable floor area of more than 2,000 m^2, the Telecommunication Room's floor space will be based on the total usable floor area of the NRB at stated in the table below.

Table 2: Telecommunication Room's floor space details

Total usable floor area in the development ('000 m^2)	Minimum total floor area of the telecommunication room (m^2)	Minimum height of the telecommunication room (m)
<= 2	6	3.5
> 2 to 5	12	
> 5 to 12	20	
> 12 to 25	30	
> 25 to 50	40	
> 50 to 75	60	
> 75 to 100	80	
> 100 to 125	100	
> 125 to 150	120	
> 150 to 175	140	
> 175 to 200	160	

(d) If the usable floor area of the relevant development exceeds 50,000 m^2, two (2) or more telecommunication room shall be provided. The total combined size of telecommunication room shall be no less than the minimum size based on the relevant usable floor area, and each telecommunication room shall be no smaller than 12 m^2.

(e) The Telecommunication Room shall be placed on the Ground floor area and connected to the access infrastructure manhole and underground duct, as well as connecting to the available Telecommunication Risers. Ducting, sewage pipes air condition pipes shall not pass through the Telecommunication Room and should be locate free from perceptible vibration.

(f) The Telecommunication Room shall be provided with electrical AC supply with solidly earth system. The type of AC supply and rating will be dependent on the expected load. An earth leakage circuit breaker shall be installed inside the room.

(g) Any Telecommunication Rooms under the development of non-residential building, irrespective of the size, a minimum number of three (3) by two (2) gang thirteen (13) A (3 x 2-gang 13 A) switch socket outlets shall be provided.

(h) The Telecommunication Room shall be equipped with daylight type fluorescent lighting that can provide a minimum of 300-Lux luminance at floor level. The earthing system shall be connected to the building main grounding.

(i) The Telecommunication Room shall be air-conditioned and be fitted with a ventilation fan system.

(j) The Telecommunication Room shall have no other opening except for the door, the ventilation and cable trays. The door dimension shall be of two and a half (2.5) meters by one (1) meter (2.5 m x 1 m). The room must be flood free. A 150 mm kerb across the doorway is required to prevent water from entering the room.

(k) Developer should observe all relevant ordinance and regulation, regarding the fire safety requirements during the design of the Telecommunication Room, by having:

i. Portable hand-operated fire extinguisher; and

ii. Emergency lighting connection to back up power supply.

6.3.2 TELECOMMUNICATION RISER, CABLE TRAY AND TRUNKING

(a) The riser duct should be placed centrally with respect to the distribution in which it is to serve to obtain maximum benefit from the distribution system.

(b) The distance or serving radius between the riser duct and the outlet point in the home unit should be kept as short as possible, that is less than forty (40) meters

(c) A 150 mm high kerb across the doorway is required to prevent water from entering the room and each Telecommunication Riser shall be labeled as “Telecom Riser” and numbered for easy identification.

(d) The size of the Telecommunication Riser shall minimum and is based on the type of building, based on the total usable floor area:

i. For NRB with a total usable floor area up to and including 2,000 m^2,

: Closet space (W x D) = 600 mm x 450 mm

ii. For NRB with a total usable floor area of more than 2,000 m^2 and including up to 75,000 m^2,

: Closet space (W x D) = 1100 mm x 800 mm

iii. For NRB with a total usable floor area of more than 75,000 m^2,

: Closet space (W x D) = 1600 mm x 800 mm

(e) For every floor opening in the telecommunication riser, a height of 150 mm and thickness of 100 mm kerb shall be constructed surrounding the floor opening.

(f) Every floor opening shall be sealed with fire resistant material, which can be easily removed and in compliance with the Director of Brunei Fire and Rescue Department requirement.

(g) Access to each Telecommunication Riser will be necessary on each floor and should always be available from a corridor or other common area. The riser shafts must be constructed in a direct vertical line throughout the building.

(h) The Telecommunication Riser shall have a hinged and locked door on every floor which can be fully opened outwards throughout the entire width and it is critical to be fire proof. If the width of the telecommunication riser exceeds 1.2 m, a double leaf door shall be provided. The specifications shall be at its minimum and in accordance with dimension specified below:

i. For NRB with a total usable floor area up to and including 2,000 m^2,

: Closet space (W x D) = 600 mm x 450 mm,

: Door Dimension (H x W) = 2100 mm x 500 mm.

ii. For NRB with a total usable floor area of more than 2,000 m^2 and including up to 75,000 m^2,

: Closet space (W x D) = 1100 mm x 800 mm,

: Door Dimension (H x W) = 2100 mm x 900 mm.

iii. For NRB with a total usable floor area of more than 75,000 m^2,

: Closet space (W x D) = 1600 mm x 800 mm,

: Door Dimension (H x W) = 2100 mm x 1400 mm.

(i) In the Telecommunication Riser, there will be a minimum of two (2) riser cable trays. The cable trays are affixed vertically and running across every level or floors, against the walls of the Telecommunication Riser. The cable trays are placed opposite facing each other in the Telecommunication Riser. Each cable tray will hold the telecommunication cables separately such as coaxial and non-coaxial cables.

i. For NRB with a total usable floor area up to and including 2,000 m^2,

: Width of cable trays (W x D) = 300 mm x 25 mm,

: Floor opening (W x D) = 400 mm x 180 mm.

ii. For NRB with a total usable floor area of more than 2,000 m^2 and including up to 75,000 m^2,

: Width of cable trays (W x D) = 450 mm x 25 mm,

: Floor opening (W x D) = 600 mm x 180 mm.

(j) Vertical cable trays in the Telecommunication Room can share with Broadcast Services, and other Telecommunications Services.

(k) In case of cable trays being installed from the telecommunication room to each telecommunication riser, a minimum of two (2) cable trays of 600 mm shall be provided. A minimum height of 300 mm opening shall also be provided in the wall of each telecommunication riser for cable trays to pass through.

(l) The trunking located outside the Telecommunication Riser at each floor, via Fibre Distribution Terminal (FDT) to the Access Termination Box (ATB) inside each individual unit of premise is referred to as the Horizontal Trunking. Horizontal Trunking must be provided in all NRB properties.

(m) Trunking is required for laying the cable inside the building and acts as the protection and cable guide.

(n) The size of Horizontal trunking along the corridor shall be according to the number of cables;

i. For number of cables less than ten (10), the size of trunking on ceiling will be one (1) number of 100 mm by 50 mm

ii. For number of cables from ten (10) to twenty (20), the size of trunking on ceiling will be two (2) number of 100 mm by 50 mm.

iii. For number of cables more than twenty (20), the size of trunking on ceiling needs to comply with the 50 % space factor.

(o) The bending radius of the trunking must be greater than 10 times of the trunking size to ensure that the fibre cable meet the minimum bending radius.

(p) The size of the horizontal trunking for the horizontal drop cable into the individual unit shall be using a PVC or harder type conduit of 20 mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to reduce the aesthetics within or outside the premise.

6.3.3 FIBRE DISTRIBUTION HUB (FDH)

(a) The Fibre Distribution Hub (FDH) serves as distribution and termination point of bulk fibre optic drop cables or multicore riser cables. The FDH also acts as the connection point between FCP's fibres and the in-building fibre cables via optical splitters.

(b) FDH should be installed with sufficient space around the cabinet to allow access to installation and maintenance. Its dimensions and type varies depending on the number of cables to be terminated.

(c) Free standing type FDH - This type of FDH cabinet is recommended for high rise and multi-storey buildings, shopping malls, hospitals, airports, large commercial establishments, etc. with more than one hundred (100) tenancies.

(d) Wall-mount type FDH - Low-rise buildings including complex of villas may use wall-mount FDH cabinet. This cabinet is recommended for less than one hundred (100) tenancies.

(e) The indoor FDH enclosure provides a vital cross-connect/interconnect interface for optical transmission signals at the MDU. The enclosure provides mechanical protection for cables, splices, connectors and passive optical splitters.

(f) The FDH shall be provided by the developer for every individual building in the Telecommunication Room, with Type-SC/APC output connector and adaptor for connection. The requirement of plinth construction shall be dependent on the dimension of the FDH structural design.

(g) The Fibre Distribution Hub (FDH) must be located at the nearest point leading to the internal riser.

6.3.4 FIBRE DISTRIBUTION TERMINAL (FDT)

(a) The Fibre Distribution Terminal (FDT) located at floor riser room acts as the connection point between the medium or low density fibre count distribution cables and individual Drop Fibre into the customer premise via optical splitters.

(b) The indoor FDT enclosure provides a vital cross-connect/interconnect interface for optical transmission signals at the MDU.

(c) The FDT shall be provided by the developer for every floor of the building in the Telecom riser room, with Type-SC/APC output connector and adaptor for connection.

(d) The indoor FDT enclosures are for indoor wall mount applications and provide complete access for maintenance and service provisioning.

6.3.5 ACCESS TERMINATION BOX (ATB)

(a) The Access Termination Box (ATB) is a termination point for the internal fibre cable from the Fibre Distribution Terminal (FDT) and provides the connection point for the Optical Network Terminal (ONT).

(b) The ATB shall be provided by the developer with SC/APC output connector for connection with ONT's patch cord. The ONT patch cord will be provided by the telecommunication licensee during the service activation.

(c) The ATB shall be placed at 0.3 m above the floor level and at the same height, with a distance of 0.3 m apart from the corner of the wall or from electrical points.

(d) A minimum of one (1) 13 A-AC electrical power socket shall be provided as the ONT requires main electricity connection.

(e) A minimum one unit of ATB must be provided by the developer in all premises.

(f) Further details on the location of ATB installation is described in "Internal Telecommunication Wiring" under "CABLING FOR NON-RESIDENTIAL BUILDING (NRB)".

6.4 CABLING FOR NON-RESIDENTIAL BUILDING (NRB)

6.4.1 CABLING FOR NRB

(a) Generally, premise internal cabling for non-residential building covers the elements and interconnections from the FDH, inside the Telecommunication Room to the individual premise's ATB.

(b) For non-residential building, FDH is referred to the distribution and termination point in the Telecommunication Room, whereas FDT is the connection point inside every floor of the Telecommunication Riser and ATB is the socket located inside each individual premise for connection with CPE or specifically, ONT.

(c) The internal fibre cable between FDH and ATB via FDT shall be provided by the developer.

(d) For each unit of non-residential building, at least two (2) core of Indoor Fibre cable must be provided inside each unit. However it can be multiple cores depending on Developer's design.

(e) Each unit of non-residential type of premise shall have only a single core of Internal Optical Fibre.

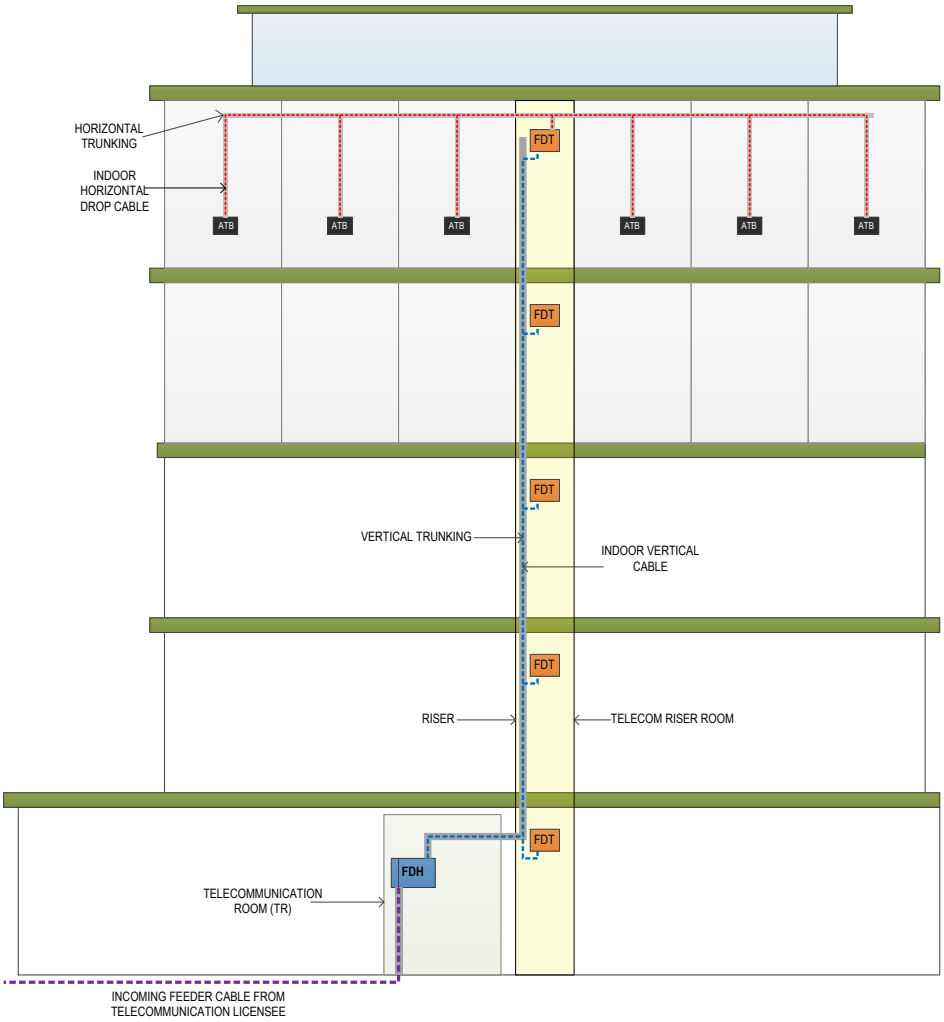


Figure 36: Non-Residential Indoor Fibre Cabling and Trunking

(f) Distance between the riser duct and the outlet point in the home, ATB unit should be kept as short as possible, generally must not exceed 40 m to ensure the power attenuation loss is within allowable range.

(g) All infrastructures inside the building and connection shall be made available by the Developer

6.4.2 INDOOR VERTICAL CABLE

(a) The Indoor Vertical Fibre Cable is referred to the cabling between the FDH in the Telecommunication Room, and FDT at each floor Telecommunication Riser in the same building. Indoor Vertical Cable must be provided by the Developer and must be approved during acceptance procedure.

(b) The Indoor Vertical Fibre Cable is laid onto a riser cable tray which runs across each level of the floor. The Indoor Vertical Cable can be laid using a normal fibre cable.

(c) For business type of NRB, the number of effective vertical fibre cable core must at least two (2) cores for each individual premise unit. However, it should depend on the numbers of potential resident in each premise unit.

(d) For the maintenance and future used purpose, it is highly recommended to have minimum 30 % spare cores for business and 10 % of spare core for residential building.

6.4.3 INDOOR HORIZONTAL DROP CABLE

(a) The Indoor Horizontal Drop Fibre Cable is referred to the cabling between the FDT at each floor of the Telecommunication Riser, and ATB inside each individual unit premise. Indoor Horizontal Drop Cable must be provided by the Developer and must be approved during acceptance procedure.

(b) The Indoor Horizontal Drop Fibre cable must be covered or protected with surface mounted PVC duct or concealed inside the wall, or using conduit through the ceiling. The Indoor Horizontal Drop Cable must be laid using a bend-insensitive fibre cable.

(c) Indoor Horizontal Drop Cable shall be laid separately with Indoor Vertical Cable and will be spliced and connected using adaptor inside the Telecommunication Riser's FDT. In this case, the core arrangement of Indoor Horizontal Drop Cable must follow the same sequence of premise numbering system, where premise with unit number one (1) must be connected with core number one (1).

(d) Number of effective core for each premise is two (2) cores for business building and one core for residential building.

(e) For the maintenance and future used, it is highly recommended to have minimum 20 % of spare cores for business and 10 % of spare cores for residential type in each of Indoor Horizontal Drop Cable.

6.4.4 INTERNAL TELECOMMUNICATION WIRING

(a) The Internal Telecommunication Wiring is referred to the cabling inside each non-residential unit, using an unshielded twisted pair cable.

(b) Under the presence of utility room/closet, in each non-residential unit :

i. The utility room/closet shall act as a centralized location for both active and passive components installation, such as Optical Network Unit (ONU), incoming access from Access Termination Box (ATB) and cable distribution to the open space in the unit.

(c) Whereas under the absence of a utility room/closet, in each non-residential unit :

i. Both active and passive components installation such as Optical Network Unit (ONU) and incoming access from Access Termination Box (ATB) shall be placed in a strategic location, preferably at the center of the non-residential unit, which shall allow the ease of cable distribution.

(d) Both end-to-end connections of the unshielded twisted pair cable shall be terminated with a similar outlet affixed against the wall. The RJ-11 outlet shall be

terminated with a Category 5 cable in accordance with TIA 568-A/B, while the RJ-45 outlet shall be terminated with a Category 6 cable in accordance with TIA 568-C.

(e) The number of telecommunication outlet termination of each residential unit shall be dependent on the presence of utility room/closet.

(f) If the active equipment is kept in the utility room/closet, there shall be a telecommunication outlet consisting of RJ-11 and RJ-45 installed and terminated, interconnecting to a strategic location at the center of the non-residential unit.

(g) If the active equipment is kept at a strategic location, in the absence of utility room/closet, the telecommunication outlet consisting of RJ-11 and RJ-45 outlet shall not be necessary.

(h) A minimum of one (1) 13A- AC power supply shall be installed, next to both active and passive components such as Optical Network Unit (ONU), Access Termination Box (ATB) and telecommunication outlets (RJ-11 and RJ-45).

APPENDIX 7 OPTICAL DISTRIBUTION NETWORK (ODN) PRODUCT SPECIFICATIONS

7.1 OBJECTIVE

7.1.1 The objective of this document is to define the infrastructure requirements and to identify suitable components and accessories that are to be use in the house or building deployment. It also provides the minimum technical specifications necessary for the in-building fibre cabling FTTP distribution system to function as required in buildings.

7.1.2 This document specifies the minimum technical requirements that have to be met by Optical Distribution Network (ODN) components and accessories in order to be considered for acceptance.

7.2 GENERAL REQUIREMENT

7.2.1 In general, all proposed products and solutions must be licensed. Unlicensed or counterfeit products and solutions shall be rejected. All associated products and its sub-components in this documentation must come from a renowned and reputable manufacturer.

7.2.2 Samples shall be required to be submitted for evaluation and verification. Any sample submitted without the proper test report shall be rejected.

7.2.3 The products and its sub-components must also come with a copy of the accreditation or/and quality assurance certificate along with the test report. Manufacturer's factory tested results in accordance with international standard, covering both reliability tests and mechanical tests.

7.2.4 If required, an independent body test report on the products and its sub-components shall be required to verify the manufacturer's factory tested results. All cost for the independent test shall be bear by the manufacturer or vendor.

7.2.5 All products and sub-components specifications and requirements in this documentation are only minimal. Developers are encouraged to offer a better solution to ease operation and maintenance for the future.

7.2.6 The proposed products and its sub-components shall be commercially available (in current production) and has been commercially deployed. A prototype and unproven product shall be disqualified. Developers to submit evidence to prove the products and sub-components are field proven and in current production.

7.2.7 Information brochures, catalogues, certificate, etc.; which describe the products offered shall be in English. The information shall be in hardcopy and softcopy (CD) and shall be submitted during tender submission. Developers shall provide support and expertise on the proposed products and solutions.

7.3 INDOOR MINIATURE CABINET (FDH)

7.3.1 STANDARDS

(a) The unit shall be compliant with Telcordia GR-449-Core for fibre routing and distribution

(b) The unit must adhere to IP65 level of IEC's standardized International Protection code System which is durable and fully adaptable to outdoor environment.

(c) The splitters shall meet or exceed the requirements of Telcordia GR-1209 and GR-1221.

(d) The unit must be designed to NEMA-12 specification.

7.3.2 AVAILABILITY

(a) The unit shall be rectangular in shape with convex shaped top panel to prevent accumulation of water on the top of the unit.

(b) The unit shall provide an interconnection point of routing between the distribution cable from the Fibre Concentration Point (FCP) and distribution of smaller cable to building's residential units, via Fibre Distribution Terminal (FDT).

(c) The unit shall possess the capability to cater different types of modular or cartridge-type splitters. Primarily, it shall be able to cater more than 8 times of 1:4 split ratio splitter depending on the number of customer's drops.

(d) Both optical splitters and splicing module must adopt a modular structure for easy installation, maintenance and configurable according to their capacity requirement.

7.3.3 MOUNTING CAPABILITIES

(a) All hardware supplied with the unit shall be stainless steel, aluminum welded or galvanized to limit the possibility of corrosion.

(b) The unit shall be capable of mounting to the wall of the telecommunication room with minimum dimensions matching the footprint of the unit.

(c) The unit shall be supplied with a mounting template to assist with pad mounting. The template shall have all dimensions labeled and shall be drawn to the actual size of the unit.

(d) The unit shall be supplied with a wall mounted bracket with pre-cast studs, a shim kit and rubber and a rubber mounting cushion, to be mounted and secure safely to the walls of the telecommunication room.

7.3.4 GENERAL CONSTRUCTION

(a) The unit shall be able to accommodate optical component modules allowing the unit to house splitters, WDMs, filters and other optical components.

(b) The units must provide a sealed cable ports for cables and interconnection cables and gaskets to protect against dust and water spray.

(c) The unit must be designed with anti-theft protection, equipped with security locks.

(d) The unit shall be able to provide strain relief for incoming cables with a standard cable grip kit.

(e) Separate compartment would be an advantage for storing loose tube, individual fibre slack, a splices and splitter devices.

(f) The unit must possess a proper cable management and routing limit bend radius to avoid strain to any incoming and outgoing fibre cable.

(g) Cable input splicing shall be contained in a segregated splice compartment designed primarily for that purpose.

(h) The unit shall be comprised of two tiers; the buffer tube storage area located in the bottom of the tray and fusion splice storage area which is accessible when the tray is opened.

(i) The splice storage area shall contain provisions for storing fibre splices protected with heat shrinkable fusion splice protectors.

(j) Both spliced fibres and buffer tubes inside the splice drawer shall conform to the bending requirement within international specifications. Spliced fibres shall not be subjected to a bend radius smaller than 30 mm (1.2 inch). Buffer tubes shall not be subjected to a bend radius smaller than 38 mm (1.5 inch).

(k) Each splice drawer shall be able to cater a maximum number of 12 fusion splices.

(l) The splice compartment shall be secured in the closed position via a latch and shall contain a laser warning label.

(m) The splice closure shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure.

(n) Splitter Module Mounting Compartment:

i. The unit shall provide a separate area for storage of splitter modules.

ii. The unit shall accommodate an assortment or combination of splitters ratio such as 1x1:2 , 2 x1:2, 1x1:4, 2x1:4, 1x1:8, 2x1:8 or above. The mounting area shall allow for modular storage of different splitter modules in the event that full utilization of different splitter ratio at time of deployment.

iii. The module mounting area shall incorporate a vertically arranged jumper management guide located beside the splitter module mounting area.

7.4 FIBRE DISTRIBUTION TERMINAL (FDT)

7.4.1 STANDARDS

(a) The unit shall be compliant with Telcordia GR-449-Core for fibre routing and distribution

(b) The unit shall possess an IP65 protection code for metallic design, whilst a non-metallic design shall possess an IP55 protection code. Both designs must be RoHS compliant.

(c) The splitters shall meet or exceed the requirements of Telcordia GR-1209 and GR-1221.

7.4.2 AVAILABILITY

(a) The FDT housing shall be metallic (stainless steel, aluminum welded or galvanized) or non-metallic. It shall be resistant to solvents, stress cracking and creep. The housing

materials shall also be compatible with chemicals and other materials to which they might exposed in normal applications.

(b) The unit should possess feature of splitter integration to accommodate different types of splitter ratio such as 1:2, 1:4, 1:8, 1:16 or more if applicable.

(c) The unit shall be capable of accepting any optical fibre cable used in interoffice, outside plant and building entrance facilities.

(d) Fusion splicing, termination and splitting functions are separated from each other, facilitating ease of operation and maintenance.

(e) The unit shall have a separate fibre slack storage for routing, protecting and storing buffer tubes or unused fibre.

(f) Ability to accept additional cables without disturbing existing cables or splices. The unit shall possess a clamping mechanism to prevent cable sheath slip or pullout.

7.4.3 MOUNTING CAPABILITIES

(a) The unit shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components. The cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than a #6 AWG.

7.4.4 GENERAL CONSTRUCTION

(a) The unit shall accommodate splice trays to manage single fibre and single fibre heat-shrink in a proper arrangement.

(b) Both spliced fibres and buffer tubes inside the splice drawer shall conform to the bending requirement within international specifications. Spliced fibres shall not be subjected to a bend radius smaller than 30 mm (1.2 inch). Buffer tubes shall not be subjected to a bend radius smaller than 38 mm (1.5 inch)

(c) The product must be designed for anti-theft performance with reliable security lock.

(d) Additional accessories of the product such as SC/APC adapter, pigtail with SC/APC connector and a Splice protection sleeve.

(e) The unit general specification shall be illustrated in the table below:

Table 3: General Requirement of Fibre Distribution Terminal (FDT)

Wall Mounted Fibre Distribution Terminal (FDT)	
Installation	Indoor, Wall Mounted
Function	Splitting
Splitter Configuration	Flexible in integrating 1:8, 1:16, 1:32 splitter
Connection Type	Using Connector
Connector Type	SC/APC ; Compliant with IEC 61754-4
No of Incoming Cable	1 or 2
Incoming Cable Type	Any Outdoor or Indoor Riser Optical Fiber cable
Outgoing cable	Depending on the number of splitter output
Outgoing Cable Type	Standard/ Low Friction Indoor Drop Cable
Main Body	Preferably stainless Steel, aluminum welded or Galvanised metal

7.4.5 PERFORMANCE REQUIREMENT

(a) A bond clamp shall remain firmly attached to the cable sheath while under a tensile load of 9-kg (20 lbf). Following removal of the load, there shall be no evidence of clamp loosening or damage to the cable sheath, or clamp that would reduce its current carrying capacity as required by the AC fault test.

(b) The electrically conductive path used for continuity and grounding of the metallic components shall be capable of withstanding an AC current of 1000 Amperes for 20 seconds.

(c) The cable clamping and sealing hardware used to terminate optical fibre cable shall not cause an attenuation change greater than ± 0.05 dB per fibre, when tested with a source operating at 1550 nm ± 20 nm.

(d) The unit shall be capable of safe and proper assembly at temperatures of 0 °C ± 2 °C (32 °F ± 3.6 °F) and 40 °C ± 2 °C (104 °F ± 3.6 °F) using materials and procedures specified by the manufacturer.

(e) The unit shall not exhibit any mechanical damage or corrosion following 30 days of severe temperature and humidity cycling from 65 °C ± 2 °C (150 °F ± 3.6°F) and 95 % relative humidity to –40 °C ± 2 °C (-40 °F ± 3.6 °F) and uncontrolled humidity. Additionally, at the midpoint of the temperature cycle, re-entry and re-assembly of the closure shall be done. If the closure has a hinged cover, it shall be flexed twenty-five (25) times.

(f) Samples of external, nonmetallic closure materials shall not have a reduction in tensile strength or elongation properties greater than 20 % of their original value, after being exposed to a UV-B type ultraviolet light source with a peak emission at 313 nm for 2,160 hours (90 days).

(g) The unit shall not support fungus growth when tested per ASTM G 21. A rating of 0 is required.

7.5 OPTICAL SPLITTER

7.5.1 STANDARDS

(a) All passive optical devices shall meet the requirements of Telcordia GR-1209, a standard designed to characterize components and their operation in order to facilitate efficient network design and construction. Testing shall include mechanical testing such as vibration, impact, side pull and cable retention along with a short-term damp heat and temperature cycling tests.

(b) All passive optical devices shall meet the requirements of Telcordia GR-1221, a standard writer to ensure long term performance and reliability of components. Testing shall include temperature cycling, damp heat, accelerated heat aging, low temperature storage, vibration, impact and cable retention.

7.5.2 FEATURES

(a) The splitter's input and output shall be distinguishable in the form of imprinted identification, tags or color coding, which is permanent or non-removable.

(b) All splitter types must be from renowned manufacturer or widely used brand and model. The types of splitters allocated inside the passive optical devices will be dependent on their design.

(c) Splitters shall be available with equal splits in two different wavelength range options.

(d) Splitters shall be available in a dual window wideband offering that includes a wavelength range of 1260 nm-1360 nm and 1480 nm-1580 nm.

(e) Splitter shall be available in a dual window narrowband offering that includes a wavelength range of 1300 nm-1320 nm and 1540 nm-1560 nm.

(f) Splitters shall be available with equal power outputs with 1 or 2 input ports and 2, 4, 8, 16 or 32 output ports.

7.5.3 SPECIFICATIONS

(a) The table below illustrates the optical performance of a PLC splitter without Connector state:

Table 4: Optical performance of a PLC splitter

Parameter	Unit	1:2	1:4	1:8	1:16	1:32	1:64
Insertion Loss (Max) S/P	dB	≤ 4.0/3.8	≤ 7.3/7.0	≤ 10.5/10.2	≤ 13.8/13.5	≤ 16.8/16.5	≤ 20.4/20.0
Uniformity (Max) S/P		≤ 0.5/0.5	≤ 0.6/0.5	≤ 0.8/0.6	≤ 1.0/0.7	≤ 1.2/1.0	≤ 1.5/1.5
PDL (Max) S/P		≤ 0.2/0.15	≤ 0.2/0.15	≤ 0.2/0.2	≤ 0.25/0.2	≤ 0.25/0.2	≤ 0.3/0.2
Optical Return Loss (ORL) S/P		≥ 60					
Operating Wavelength	nm	1260 - 1650					
Operating Temperature	°C	-40 - +85					

S: Standard Grade, P: Premium Grade

i. Mini Modular type*

(A) Mechanical Specification

**Note:* *The dimension is for information purposes only and may subject to change.*

Table 5: PLC splitter Mini Modular type dimensions

Parameter	1:2	1:4	1:8	1:16	1:32	1:64
Material	SUS (only with 900µm Loose tube)					
Dimension (L x W x H)mm	55 x 7 x 4	55 x 7 x 4	55 x 7 x 4	60 x 12 x 4	80 x 20 x 6	100 x 40 x 6

(B) Optical Fibre Type with APC Connector

Table 6: PLC splitter Mini Modular type optical fibre details

Parameter		Description
Input	900µm Tight Buffered tube	≤1.0 m
Output	900 µm Loose Tube	
Optical Fibre	Bend intensive G.657A2 fibre	
Furcation Tube	900µm Loose Tube	**Must be from renowned manufacturer**

Connector	APC Connector (Green)	≥ 60dB

(C) Sample diagram of a Mini Modular Type PLC Splitter

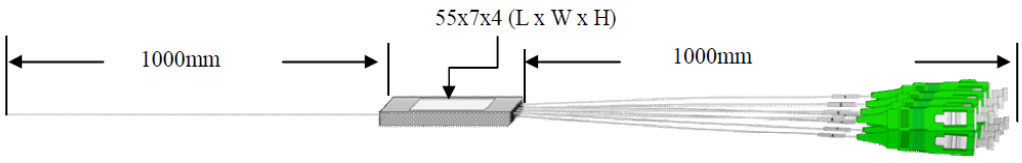


Figure 37: PLC splitter Mini Modular Type diagram

ii. Cascade Module type*

(A) Mechanical Specification

**Note:* *The dimension is for information purposes only and may subject to change.*

Table 7: PLC splitter Cascade Module type dimensions

Parameter	1:2	1:4	1:8	1:16	1:32	1:64
Material	Aluminum and ABS Plastic					
Dimension (L x W x H) mm	100 x 80 x 10					100 X 80 x 20

(B) Optical Fibre Type with APC Connector

Table 8: PLC splitter Cascade Module type optical fibre details

Parameter		Description
Input /Output	900µm Loose Tube or 2.0 mm cord PVC jacket	≤1.0 m
Optical Fibre	Bend intensive G.657A2 fibre	**Must be from renowned manufacturer**
Furcation Tube	900µm Loose Tube or 2.0 mm cord PVC jacket	
Connector	APC Connector (Green)	≥ 60dB

(C) Sample diagram of a Cascade Module Type PLC Splitter

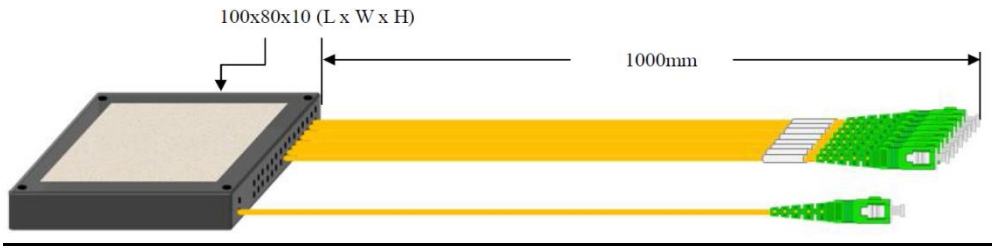


Figure 38: PLC splitter Cascaded Module type diagram

iii. Rack Mountable type

(A) Mechanical Specification

Table 9: PLC splitter Rack Mountable type dimensions

Parameter		Description
Package	Material	EGI (Electronic Galvanized Iron)

Dimension	ETSI standard require (custom Design based on cabinet rack design)
Splitter Ratio	1:2, 1:4, 1:8, 1:16,1:32

(B) Connector Specification

Table 10: PLC splitter Rack Mountable type optical fibre details

Parameter	Unit	Condition	Specification
Insertion Loss	dB	Mated Pair	≤ 0.3
Optical Return Loss (ORL)		APC	≥ 55
Ferrule Material	nm	Zirconia	

7.5.4 TEST REPORTS

(a) A test report shall be provided with each module including the following measured data in a paper document.

(b) Insertion Loss (Wavelength at 1310 nm and 1550 nm) at 25 ^{o}C.

(c) Uniformity (at 25 ^{o}C).

(d) Polarization Dependent Loss (PDL at 25 ^{0}C).

(e) Dimension of the protective case and length of pigtails.

(f) Visual inspection (Pass or Fail).

(g) Component packing dimensions (Pass or Fail).

7.6 OPTICAL FIBRE PIGTAIL WITH TYPE-SC/APC CONNECTOR

7.6.1 GENERAL REQUIREMENT

(a) The product shall be obtained from a renowned manufacturer.

(b) The fibre optic shall be a Single Mode Reduced Bend Sensitive (G.657.A2) type that is compliant with G.652.D when splicing.

(c) The pigtail must be 100 % optical tested with developed precision factory mounting

(d) Connector shall be a Type-SC/APC type with a green housing.

(e) Optical losses such as Insertion Loss (IL) and Optical Return Loss shall be minimal.

(f) The cable material must be a Low Smoke Zero Halogen (LSZH).

(g) The origin of the pigtail shall have imprinted information on the cable sheath such as brand, fibre cable types, etc. (*Preferable*)

(h) The product should meet the requirement of ITU-T G.657.A2, ITU-T G.652.D, ROHS, Bell core 326, EIA/TIA Standards.

7.6.2 SPECIFICATIONS

(a) The table illustrates the Pigtail with SC/APC Connector specification:

Table 11: Properties of Optical Fibre Pigtail with SC/APC Connector

General Specification	
Cable type	Tight Buffered

Fibre Category	Single Mode bend insensitive (G.657.A2), compatible with G.652.D
Connector Type	Type-SC/APC
Ferrule Material	Ceramic
Housing color	Green
Housing Material	Composite
Polish	APC
Nominal Outer Diameter	900 µm (0.4 in)
Optical Return Loss (ORL) for APC	≤ - 60 dB
Maximum Insertion Loss (IL)	0.25 dB
Average IL (Random)	0.18 dB
Cable configuration	Simplex
Cable Length	3 m
Cable material	Low Smoke Zero Halogen (LSZH)
RoHS	Free of hazardous substances according to RoHS 2002/95/EG
Attenuation	1310 nm=0.38dB/km 1550 nm=025dB/km
Chromatic Dispersion (CD)	1310 nm = 3.0ps/nm x km 1550 nm = 18.0ps/nm x km
Guideline radius	=7.5 mm
Insertion Loss at 1550 nm,	15 mm radius and 10 turns = ≤ 0.03 dB 10 mm radius and 1 turns = ≤ 0.1 dB 7.5 mm radius and 1 turns = ≤ 0.5 dB

7.7 OPTICAL FIBRE ADAPTER-TYPE-SC/APC

7.7.1 GENERAL REQUIREMENT

(a) The Type-SC/APC adapter must be obtained from a renowned manufacturer.

(b) The adapter must emit a minimal insertion loss (IL) when mount with a APC connector

(c) The adapter must be durable to maintain a loss of ≤ 0.2 db at 500 mating.

(d) The SC Duplex Adapter must be compatible with housing, panel or face plate when utilized.

(e) The adapter must comply with the standard of Telcordia, ANSI,TIA/EIA, NTT and JIS

(f) The adapter must exhibit high precision alignment, low insertion and return loss, and flange options. It must have a compact design.

(g) The adapter shall come in simplex and are available in plastic, with or without flanges, and in horizontal and vertical mount styles.

(h) The adapter shall come with a choice of Zirconia split sleeves (diagonal or straight split options available), or with phosphor bronze straight split sleeves.

7.7.2 SPECIFICATIONS

(a) The general specifications of a Type-SC/APC Adapter are as below:

Table 12: Properties of Optical Fibre SC/APC Adapter

General Specification

Insertion Loss: Single Mode (SM)	0.2dB max
Adapter Type	Type-SC/APC
Housing Colour	Green
Insertion sleeves	Zirconia Ceramic or Phosphor Bronze
Durability (500 mating):	0.2 dB max
Operating Temperature	- 40 ^{o}C to 80 ^{o}C
Compliance	Telcordia, ANSI,TIA/EIA, NTT and JIS

7.8 OPTICAL FIBRE PATCH CORD WITH TYPE-SC/APC CONNECTOR

7.8.1 GENERAL REQUIREMENT

(a) The patch cord with Type-SC/APC connector must be obtained from a renowned manufacturer.

(b) The patch cord must be of simplex single mode (SM) fibre class (G.657.A2), which is Bend Insensitive.

(c) The patch cord and Type-SC/APC connector must be 100 % optical tested with developed precision factory mounting. It shall also emit minimal loss during installation.

(d) The patch cord must conform to a combination of TIA/EIA 568 B, ISO11801, EN50173.

(e) The product must also be ITU-T, RoHS and LSZH compliant.

(f) The patch cord shall exhibit a lower optical power loss under bend conditions while remaining compatible with conventional cabling.

(g) The patch cords shall maintain its quality, mechanical features and optical performance when subjected to bent or flexed.

(h) The patch cord must be compatible with other G.652D single mode fibre during installation.

(i) The origin of the patch cord shall have imprinted information on the cable sheath such as brand, fibre cable types, etc. (*Preferable*)

7.8.2 SPECIFICATIONS

(a) The general Specifications of a patch cord with SC/APC Connector are as below:

Table 13: Properties of Optical Fibre Patch Cord with SC/APC Connector

General Specification	
Type of patch cord	G657.A2 Reduced bend sensitive (RBS), simplex
Type of connectors	Type-SC/APC – Type-SC/APC
Ferrule material	Zirconia ceramic
Cable material	Low Smoke Zero Halogen (LSZH) with RoHS
Maximum Insertion Loss (IL)	0.25dB
Optical Return Loss (ORL)for APC	≤ 60dB
Mating durability	must be 500 mating
Fibre cable Attenuation	At1310 nm =0.38 dB/km At1550 nm=0.25 dB/km
Chromatic Dispersion (CD)	At 1310 nm = 3.0 ps/nm x km

	At 1550 nm = 18.0 ps/nm x km
Guideline radius	7.5 mm
Insertion Loss at 1550 nm	for 15 mm radius and 10 turns ≤ 0.03 dB for 10 mm radius and 1 turn ≤ 0.1 dB for 7.5 mm radius and 1 turn ≤ 0.5 dB

7.9 SPLICE PROTECTION SLEEVE

7.9.1 GENERAL REQUIREMENT

(a) The product must be from a renowned manufacturer.

(b) The product must be a pre-shrunk heat bonded assembly.

(c) The product shall only have a single opening for the fibre to prevent incorrect assembly.

(d) The splice sleeves and materials used shall comply with ISO9001:2008 accredited environment, Telcordia / Bellcore Certification and BT Approvals.

(e) All protection sleeves must be RoHS Compliant.

(f) The product shall be durable and provide lasting protection of single fibre splices in field installation.

(g) The strength member supporting the splice must be strong and durable to withstand any vibration to prevent any breakage to the fibre during installation. The strength member must be anti-rust proof.

7.9.2 SPECIFICATIONS

(a) The general specifications of Splice Protection Sleeve are as below:

Table 14: Properties of Optical Fibre Splice Protection Sleeve

General Specification	
Sleeve Length/ Diameter	40 mm/3.1 mm (max)
Outer Tube	Polyethylene
Inner Tube	Ethylene-Vinyl Acetate (Polyolefin Copolymer)
Strength Member	Stainless Steel
Operation Condition (after shrink)	-40 ^{o}C to 75 ^{o}C , 0 to 95 % RH (Non-dew)
Storage condition (before shrink)	-40 ^{o}C to 60 ^{o}C , Non-dew

7.10 OPTICAL FIBRE TERMINATION BOX (TB) and ACCESS TERMINATION BOX (ATB)

7.10.1 GENERAL REQUIREMENT

(a) The Termination Box / Access Termination Box must possess three (3) features such as good adaptability, user –friendly design, easy operation and maintenance and high reliability.

i. Good adaptability:

(A) The product should be able to accommodate more than once (1) core, to satisfy different capacity requirement. It can support wall mounted, thus saving installation space.

ii. User-Friendly Design and Easy Operation

(A) The unit must be convenient during installation and maintenance, with clear operating instructions thus minimizing installation time. It shall not be required to open the cover plate when plugging in and out the fibre connectors and it shall possess a diverse cable routing requirements.

(B) The fibre slack management route must maintain a radius of ≥ 30 mm to prevent further optical power loss. The design must have the provision to store and hold fusion splices separately in a proper order.

iii. Easy Maintenance and High Reliability

(A) The unit must have a complete instruction label to prevent incorrect operations. Clear and easily noticeable laser labels must be available to prevent eye injuries. The optical ports must be facing downwards to prevent direct contact with eyes during installation, operation or maintenance process.

(B) It must have a secured locking mechanism to prevent unauthorized access. The unit shall have an integrated heat shrink holder to secure the fusion splices in the designated position.

(C) The unit must adhere to IP65 level of IEC's standardized International Protection Code System which is durable and fully adaptable to outdoor environment. For indoor application, the unit shall conform to IP44 of IEC's standardized International Protection Code System. It shall be RoHS

(D) Additional accessories of the product such as Type-SC/APC adapter, pigtail with Type-SC/APC connector and a splice protection sleeve. An inventory list containing lists of components or parts supplied and the operation and installation manual shall be provided with each unit.

(E) Evidence such as certificate, letter of conformance, etc. from an authorized body shall be provided during approval process. Additional evidence to prove the unit are field proven and in current production is required to be submitted.

(F) Approved laser caution signs as per IEC 60825-1 Ed.2.0 requirements shall be provided as a standard for every unit.

7.11 OUTDOOR UNDERGROUND OPTICAL FIBRE CABLE

7.11.1 GENERAL REQUIREMENT

(a) The underground fibre optic cable shall be single-mode outdoor armored layered and shall be suitable for underground installation in pipes.

(b) The cable should be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

7.11.2 STANDARDS

(a) The cable shall conform to the following standards:

(b) ITU-T Recommendations G.652D and compatible with G.657A2 optical fibre cables when splicing.

(c) Electronic Industries Association, EIA/TIA 455-78A, 455-3A, 455-62A, 455-164A/167A/174, 455-168A/169A/175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.

(d) International Electrotechnical Commission standards, IEC60304, IEC60794-1-2, IEC60811-5-1. Bellcore GR-20

(e) The Optical Fibre shall conform to the requirements specified in the table below:

Table 15: General Specification of Underground Optical Fibre Cable

Characteristics	Conditions	Specified Values	Units
Optical Characteristics			
Attenuation	At 1310 nm	≤ 0.36	dB/km
	At 1383nm	≤ 0.35	
	At 1550 nm	≤ 0.22	
	At 1625nm	≤ 0.24	
Attenuation Variation with wavelength	1285 nm – 1330 nm	1310 ± 0.05	dB
	1525 nm – 1575 nm	1550 ± 0.05	
Attenuation at Water Peak	At 1383 nm	≤ 2.1	dB/km
Dispersion coefficient	1285 nm– 1340 nm	≥ -3.0 ≤ 3.0	Ps/(nm – km)
	1550 nm	≤ 18	
	1625nm	≤ 22	
Zero dispersion wavelength		≥ 1302 ≤ 1322	nm
Chromatic Dispersion; Maximum	At 1550 nm	20	Ps/(nm x km)
	1288 nm– 1339 nm	3.5	
	1271 nm – 1360 nm	5.3	
Zero dispersion slope		≤ 0.091	Ps/(nm^2 – km)
Polarization Mode Dispersion			
PMD Maximum Individual Fibre		≤ 0.2	Ps/√km
PMD Design Link Value		≤ 0.08	Ps/√km
Fibre Cutoff Wavelength		≥ 1180 ≤ 1330	nm
Cable Cutoff Wavelength		≤ 1260	nm
Mode Field Diameter (MFD)	At 1310 nm	9.2 ± 0.4	µm
	At 1550 nm	10.4 ± 0.8	µm
Group index of refraction (Typical)	At 1310 nm	1.466	
	At 1550 nm	1.467	
Backscatter characteristics 1310 nm, 1550 nm			
Step (mean of bidirectional measurement)		≤ 0.05	dB
Irregularities over fibre length and point discontinuity		≤ 0.05	dB
Difference backscatter coefficient (bidirectional measurement)		≤ 0.03	dB/km
Attenuation uniformity		≤ 0.01	dB/km
Geometrical Characteristics			
Cladding diameter		125.0 ± 1.0	µm
Cladding non-circularity		≤ 1.0	%
Coating diameter		242 ± 7	µm
Coating/cladding concentricity error		≤ 12.0	µm
Coating non-circularity		≤ 6.0	%
Core/cladding concentricity error		≤ 0.6	µm
Curl (radius)		≥ 4	m
Delivery length		≥ 2.1 ≤ 50.4	km/reel
Environmental Characteristics 1310 nm, 1550 nm			

Characteristics	Conditions	Specified Values	Units
Temperature dependence Induced attenuation	-60 °C to +85 °C	≤ 0.05	dB/km
Temperature-humidity cycling Induced attenuation	-10 °C to +85 °C, 90 %R.H	≤ 0.05	dB/km
Damp heat dependence Induced attenuation	85 °C, 8 5% R.H... 30days	≤ 0.05	dB/km
Water soak dependence Induced attenuation	20 °C for 30 days	≤ 0.05	dB/km
Mechanical Characteristics			
Proof test	Offline	≥ 9.0 ≥ 1.0 ≥ 100	N % KPSI
Bending Dependence Induced Attenuation	1550 nm 1 turn, 32 mm diameter	≤ 0.50	dB
	100 turns, 60 mm diameter	≤ 0.05	dB
Coating Strip force	Typical average force	1.7	N
	Peak force	≥ 1.3 ≤ 8.9	N
Dynamic stress corrosion susceptibility parameter (typical)		≥ 27	

7.11.3 GENERAL CONSTRUCTION

(a) The optical cable shall consist of a central fibre optic unit protected by one or more layers of helically wound anti-hygroscopic tape or yarn.

(b) The central fibre optic unit shall be designed to house and protect the fibres from damage due to forces such as crushing, bending, twisting, tensile stress and moisture, wide temperature variations, hydrogen evolution etc.

(c) The fibre shall be of loose tube construction. The fibres, 250 µm, are positioned in a loose tube made of a high modulus plastic. The tubes are filled with a water-resistant filling compound.

(d) A Fibre Reinforced Plastic (FRP) locates in the center of core as a non-metallic strength member. The tubes (and fillers) are stranded around the strength member into a compact and circular core.

(e) An aluminum Polyethylene Laminate (APL) is applied around the cable core. Then the cable core is covered with a thin flame retardant inner sheath to protect it from water ingress. After corrugated steel tape armor is applied, the cable is completed with a flame retardant outer sheath.

(f) Water-blocking material is one means of protecting the fibres from the ingress of water or moisture. A dry powdered filling compound/swelling powder, swelling tape, or a combination of materials may be used.

(g) The interstices of the central fibre optic unit and cable shall be filled with a suitable dry powdered filling compound to prohibit any moisture ingress or any longitudinal water migration within the fibre optic unit or along the fibre optic cable. Whereas inside the buffer or loose tube containing optical fibres, it shall be filled with gel compound for water protection. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC60794- 1-2-F5.

(h) The sheath shall be black, smooth, concentric, and shall be free from holes, splits, blisters and other surface flaws. The sheath shall be extruded directly over the central fibre optic unit and shall also be non-hygroscopic.

(i) The cable sheath design shall permit easy removal without damage to the optical fibres or fibre units. The sheath shall be made from good quality of weather resistant polyethylene compound (Black High Density Polyethylene- HDPE) and thickness shall be > 1.8 mm.

(j) The sheath shall be marked with the manufacturer's name, sequential meter, month and year of manufactured, fibre count and fibre type. The marking shall be in contrasting colour to the cable sheath. The preferred marking colour shall be white.

(k) A circular jacket of not less than 0.65 mm Polymide-12 (Orange Nylone-12) material should be applied over the sheath as an outer jacket. The outer jacket shall have smooth finish and shall be termite resistant.

(l) Suitable rip cord(s) shall be provided to open the outer sheath of the cable. The rip cord(s) shall be properly waxed to prevent wicking action and shall not work as a water carrier.

(m) The cable to be supplied should have been type tested either as per the requirement specified in this section or relevant TEC specifications including latest amendments. The fibre should have been type tested as per relevant International standards.

(n) Illustration of the cable construction of 144-Core Underground Optical Fibre Cable

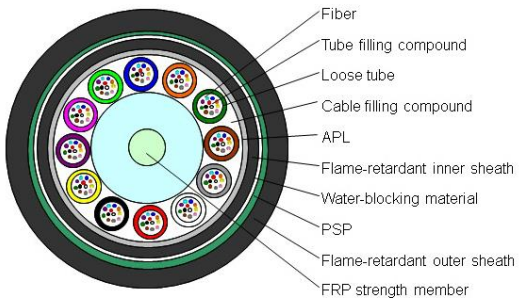


Figure 39: Construction Diagram of 144-Core Underground Optical Fibre Cable

Table 16: Construction Properties of Underground Optical Fibre Cable

Items		Description
Optical Fibre		Optical Fibre ITU- T G.652D 144 Core =12 fibre core per tube / 12 tubes *For other cable design:* 72 Core= 12 fibre core per tube / 6 tubes 48 Core=12 core per tube / 4 tubes 24 Core= 12core per tube/ 2 tubes 12 Core = 12 core per tube / 1 tube 2 / 6 Core = 1 tube
Central Strength Member	Material	FRP, Fibre Reinforced Plastic
	Diameter	Nominal: 2.8 mm sheathed to 7.4 mm
Loose Tube	Material	PBTP
	Diameter	Nominal: 2.4 mm outside
Sheath	Material	PE
	Diameter	Nominal: 1.8 mm

(o) Individual optical fibres within a fibre unit, and shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme. The colour coding system shall be discernible throughout the design life of the cable.

Table 17: Colour Coding and Fibre Identification Details Optical Fibre Cable (TIA/EIA-598)

Loose Tube	No	1	2	3	4	5	6
	Colour	Blue	Orange	Green	Brown	Grey	White
	No	7	8	9	10	11	12
	Colour	Red	Black	Yellow	Purple	Pink	Aqua
Fibre in Tube	No	1	2	3	4	5	6
	Colour	Blue	Orange	Green	Brown	Grey	White
	No	7	8	9	10	11	12
	Colour	Red	Black	Yellow	Purple	Pink	Aqua

7.12 INDOOR RISER OPTICAL FIBRE CABLE

7.12.1 GENERAL REQUIREMENT

(a) The mechanical design and construction of the indoor riser fibre optic cable shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

7.12.2 STANDARDS

(a) The cable materials shall possess the properties of RoHS compliant, flame retardant and OFNR.

(b) The cable must meet the requirements of the National Electric Code (NEC).

(c) Non-Plenum Applications - Applicable Flame Tests: UL 1666. All-dielectric cables shall be listed OFNR.

(d) Finished cables shall conform to the applicable performance requirements of the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).

(e) The indoor riser optical cable shall comply with ITU-T G.652D and G.657.A2 when performing splicing works and Telcordia GR-409 and GR-20 CORE standards.

(f) Electronic Industries Association, EIA/TIA 455-78A, 455-3A, 455-62A, 455-164A/167A/174, 455-168A/169A/175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.

(g) The Indoor Riser Optical Fibre Cable shall conform to the requirements specified in the table below:

Table 18: General Specification of Indoor Riser Optical Fibre Cable

Characteristics	Conditions	Specified Values	Units
Optical Characteristics			
Attenuation	At 1310 nm	≤ 0.36	dB/km
	At 1383nm	≤ 0.35	
	At 1550 nm	≤ 0.22	
	At 1625nm	≤ 0.24	
Attenuation Variation with wavelength	1285 nm – 1330 nm	1310 ± 0.05	dB
	1525 nm – 1575 nm	1550 ± 0.05	
Attenuation at Water Peak	At 1383 nm	≤ 2.1	dB/km
Dispersion coefficient	1285 nm– 1340 nm	≥ -3.0 ≤ 3.0	

Characteristics	Conditions	Specified Values	Units
Zero dispersion wavelength	1550 nm	≤ 18	Ps/(nm – km)
	1625nm	≤ 22	
		≥ 1302 ≤ 1322	nm
Chromatic Dispersion; Maximum	At 1550 nm	20	
	1288 nm– 1339 nm	3.5	Ps/(nm x km)
	1271 nm – 1360 nm	5.3	
Zero dispersion slope		≤ 0.091	Ps/(nm^2 – km)
Polarization Mode Dispersion			
PMD Maximum Individual Fibre		≤ 0.2	Ps/√km
PMD Design Link Value		≤ 0.08	Ps/√km
Fibre Cutoff Wavelength		≥ 1180 ≤ 1330	nm
Cable Cutoff Wavelength		≤ 1260	nm
Mode Field Diameter (MFD)	At 1310 nm	9.2 ± 0.4	µm
	At 1550 nm	10.4 ± 0.8	µm
Group index of refraction (Typical)	At 1310 nm	1.466	
	At 1550 nm	1.467	
Backscatter characteristics 1310 nm, 1550 nm			
Step (mean of bidirectional measurement)		≤ 0.05	dB
Irregularities over fibre length and point discontinuity		≤ 0.05	dB
Difference backscatter coefficient (bidirectional measurement)		≤ 0.03	dB/km
Attenuation uniformity		≤ 0.01	dB/km
Geometrical Characteristics			
Cladding diameter		125.0 ± 1.0	µm
Cladding non-circularity		≤ 1.0	%
Coating diameter		242 ± 7	µm
Coating/cladding concentricity error		≤ 12.0	µm
Coating non-circularity		≤ 6.0	%
Core/cladding concentricity error		≤ 0.6	µm
Curl (radius)		≥ 4	m
Delivery length		≥ 2.1 ≤ 50.4	km/reel
Environmental Characteristics 1310 nm, 1550 nm			
Temperature dependence Induced attenuation	-60 °C to +85 °C	≤ 0.05	dB/km
Temperature-humidity cycling Induced attenuation	-1 0°C to +85 °C, 90 %R.H	≤ 0.05	dB/km
Damp heat dependence Induced attenuation	85 °C, 85 % R.H.. 30days	≤ 0.05	dB/km
Watersoak dependence Induced attenuation	20°C for 30 days	≤ 0.05	dB/km
Mechanical Characteristics			
Proof test	Offline	≥ 9.0	N
		≥ 1.0	%
		≥ 100	KPSI
Bending Dependence Induced Attenuation	1550 nm 1 turn, 32 mm diameter	≤ 0.50	dB
	100 turns, 60 mm diameter	≤ 0.05	dB
Coating Strip force	Typical average force	1.7	N
	Peak force	≥ 1.3 ≤ 8.9	N
Dynamic stress corrosion susceptibility parameter (typical)		≥ 27	

7.12.3 GENERAL CONSTRUCTION

(a) Optical fibres shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 2.5 mm. Each buffer tube shall contain up to twelve (12) fibres.

(b) Each fibre shall be distinguishable by means of color coding in accordance with TIA/EIA-598, "Optical Fiber Cable Color Coding." as in Table 17. The fibres shall be colored with ultraviolet (UV) curable inks.

(c) Buffer tubes containing fibres shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm. The buffer tubes shall be resistant to kinking.

(d) Table below show the properties of cable construction:

Table 19: Construction Properties of Indoor Riser Optical Fibre Cable

Items		Description
Optical Fibre		Optical Fibre ITU- T G.652D 144 Core =12 fibre core per tube / 12 tubes *For other cable design:* 72 Core= 12 fibre core per tube / 6 tubes 48 Core=12 core per tube / 4 tubes 24 Core= 12core per tube/ 2 tubes 12 Core = 12 core per tube / 1 tube 2 / 6 Core = 1 tube
Central Strength Member	Material	FRP, Fibre Reinforced Plastic
	Diameter	Nominal: 2.8 mm sheathed to 7.4 mm
Loose Tube	Material	PBTP
	Diameter	Nominal: 2.4 mm outside
Sheath	Material	PE
	Diameter	Nominal: 1.8 mm

(e) Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm in outer diameter.

(f) The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent buckling of the cable. The GRP rod shall be coated with a thermoplastic, when required, to achieve dimensional sizing to accommodate buffer tubes/fillers.

(g) Water-blocking material is one means of protecting the fibres from the ingress of water or moisture. A dry powdered filling compound/swelling powder, swelling tape, or a combination of materials may be used.

(h) Inside each buffer or loose tube containing fibres shall be filled with water blocking element such as gel-filled compound, to prevent water ingress. The gel-filled compound shall be non-nutritive to fungus, electrically non-conductive, and

homogenous. It shall also be free from dirt and foreign matter. This element will preclude the need for other water-blocking material.

(i) Two (2) polyester yarn binders shall be applied contra helically and with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.

(j) The cable shall contain at least one ripcord under the sheath for easy sheath removal.

(k) A flame-retardant tape may be applied to provide additional resistance to flame propagation.

(l) Cables shall be sheathed with flame-retardant polyvinyl chloride (PVC). Jacketing material shall be applied directly over the tensile strength members. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

(m) Cable jackets shall be marked with the manufacturer's name or file number, month and year of manufacture, sequential meter or foot markings, fibre count, and fibre type, flame rating and listing marking. The actual length of the cable shall be within -0/+1 % of the length markings. The marking shall be in a contrasting color to the cable jacket.

(n) The maximum pulling tension shall be 2700 N (600 lbf) during installation (short term) and 810 N (180 lbf) long term installed. The cable shall be all-dielectric.

(o) The cable to be supplied should have been type tested either as per the requirement specified in this section. The fibre should have been type tested as per relevant International standards.

7.13 INDOOR HORIZONTAL OPTICAL FIBRE DROP CABLE (LOW FRICTION)

7.13.1 GENERAL REQUIREMENT

(a) The cable must be of low weight, small volume and high flexibility. The mechanical design and construction of each unit shall be inherently robust and rigid under all condition of operation, adjustment, replacement, storage and transport.

(b) The cable must cover the design requirements and performance standards for the supply of bending insensitive, low water peak, single-mode optical fibre and tight jacket Duct FRP cable.

(c) The sheath of material must possess excellent abrasion-resistant and low friction property, as well as the cable must be of Low Smoke Zero Halogen (LSZH).

(d) It shall emit minimal macro-bending loss at very low radii ≤ 15 mm and has minimal effect on the attenuation ranging from 1310 nm to 1650 nm wavelength.

7.13.2 STANDARDS

(a) The cable materials shall possess the properties of RoHS and flame retardant compliance.

(b) The cable must meet the requirements of the National Electric Code (NEC).

(c) Finished cables shall conform to the applicable performance requirements of the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Indoor-Outdoor Optical Fibre Cable (ICEA S-104-696).

(d) The drop cable shall comply with ITU-T G.652D and G.657.A2 standards upon splicing together of both cables.

(e) Electronic Industries Association, EIA/TIA 455-78A, 455-3A, 455-62A, 455-164A/167A/174, 455-168A/169A/175A, 455-176, 455-59, EIA/TIA 598, EIA 455-104.

(f) International Electro technical Commission standards, IEC60304, IEC60794-1-2, IEC60811-5-1, IEC 60332-1, Bellcore GR-20

(g) The Optical Fibre shall conform to the requirements specified in table below:

Table 20: General Specification of Indoor Horizontal Optical Fibre Drop Cable (Low Friction)

Characteristics	Unit	Fiber Type (ITU-T G.657.A2)
Geometrical Characteristics		
Mode Field Diameter at 1310 nm	µm	8.6 ± 0.4
Cladding diameter	µm	125 ± 0.7
Core concentricity error	µm	≤ 0.5
Cladding non-circularity	%	≤ 1.0
Primary coating diameter (including color layer)	µm	250 ± 15
Coating-cladding concentricity error	µm	≤ 12.5
Fiber curl radius	m	≥ 4
Transmission Characteristics		
Attenuation at 1310 nm	dB/km	≤ 0.40
Attenuation at 1383nm	dB/km	≤ 0.35
Attenuation at 1550 nm	dB/km	≤ 0.30
Macro bending loss		
ϕ 30 mm, 10 turns, 1550 nm		≤ 0.03
ϕ 30 mm, 10 turns, 1625nm		≤ 0.10
ϕ 20 mm, 10 turns, 1550 nm	dB	≤ 0.10
ϕ 20 mm, 10 turns, 1625nm		≤ 0.20
ϕ 15 mm, 10 turns, 1550 nm		≤ 0.50
ϕ 15 mm, 10 turns, 1625nm		≤ 1.0
Cut-off wavelength (λ)	nm	1260
Chromatic dispersion at 1310 nm	Ps/nm.km	≤ 3.5
Chromatic dispersion at 1550 nm	Ps/nm.km	≤ 18
Zero dispersion wavelength	nm	1300 – 1324
Zero dispersion slope	$Ps/nm^2.km$	≤ 0.092
Mechanical Characteristics		
Proof stress level	%	1.5

7.13.3 GENERAL CONSTRUCTION

(a) Optical fibres shall be placed inside a Low Smoke Zero Halogen Sheath. The nominal outer thickness will be 1.0 mm thick. Under the LSZH sheath, it will consist of two (2) optical fibres.

(b) The fibres shall not adhere to the inside of the LSZH sheath. Each fibre shall be distinguishable by means of color coding in accordance with TIA/EIA-598, "Optical Fibre Cable Color Coding."

(c) The fibres shall be colored with ultraviolet (UV) curable inks. The colors shall be stable across the specified storage and operating temperature ranges, and not

subject to fading or smearing onto each other. Colors shall not cause fibres to stick together.

(d) Under the LSZH sheath, there will be two Fibre Reinforced Plastic in-parallel with the optical fibre to improve the crush resistance to protect the fibre.

(e) The sheath material must possess low friction property, abrasion-resistant property and reliability. The sheath shall be made from good quality of weather resistant polyethylene compound (Black High Density Polyethylene- HDPE) and thickness shall be > 1.0 mm.

(f) Cables shall be sheathed with Low Smoke Zero Halogen jacket. Jacketing material shall be applied directly over the tensile strength members. The LSZH sheath shall contain carbon black or a UV stabilized colored compound to provide ultraviolet light protection and shall not promote the growth of fungus.

(g) Illustration of the cable construction of 2-core Indoor Fibre Drop Cable:

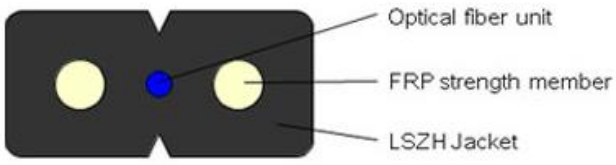


Figure 40: Construction Diagram of 2-core Indoor Horizontal optical Fibre Drop Cable (Low Friction)

(h) Details on the dimension of Indoor Horizontal Optical Fibre Drop Cable (Low Friction) construction:

Table 21: Properties of two (2)-Core Indoor Horizontal Optical Fibre Drop Cable (Low Friction)

Items		Description
Optical Fibre		Optical Fibre ITU- T G.657A2 2 Core only
Central Strength Member	Material	FRP, Fibre Reinforced Plastic
FRP	Diameter	Nominal: 0.5 mm
Sheath	Material	LSZH, Low Smoke Zero Halogen, Low Friction
	Diameter	Nominal: 1.0 mm

(i) Individual optical fibres within a fibre unit, shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme.

(j) Table below illustrates the Colour Coding and Fibre Identification for Indoor Horizontal Optical Fibre Drop Cable (Low Friction):

Table 22: Colour Coding and Fibre Identification Details of two (2)-Core Indoor Horizontal Optical Fibre Drop Cable

Loose Tube	No Colour	1 Blue	2 Orange

(k) Cable jackets shall be marked with the manufacturer's name or file number, month and year of manufacture, sequential meter or foot markings, fibre count, and fibre

type, flame rating and listing marking. The actual length of the cable shall be within -0/+1 % of the length markings. The marking shall be in a contrasting color to the cable jacket.

(l) The cable to be supplied should have been type tested either as per the requirement specified in this section. The fibre should have been type tested as per relevant International standards.

7.14 HDPE CORRUGATED SUB-DUCT

7.14.1 GENERAL REQUIREMENT

(a) Sub-ducts are intended for housing of fibre optic cables installed by traditional pulling techniques.

(b) The structure must possess greater flexibility which does not spiral and has lower friction when cables are pulled through difficult and confined environment.

(c) This specification covers the minimum standards and requirements for the construction, properties and testing of High Density Polyethylene (HDPE) Corrugated Sub-Duct.

(d) HDPE Corrugated Sub-Duct is used for the construction of underground duct system for fibre optic in the telecommunication's outside plant network. They are intended to be installed as a sub-duct for every 100 mm GI or PVC pipe in each section between two manholes. Every HDPE Corrugated Sub-Duct installed is to be accompanied by the pulling rope.

(e) The materials used to manufacture the sub-ducts shall be non-toxic and environmental friendly.

(f) The HDPE Corrugated Sub-Duct shall be designed and manufactured so that physical, transmission and operation and maintenance characteristics shall not degrade when exposed to the environmental conditions. The environment conditions may include ambient air temperature variations from -10 ^{o}C to +55 ^{o}C.

(g) Any imprinted identification or label shall not fade over time under prolonged UV exposure and corrosive agents present underground.

7.14.2 STANDARDS

(a) The HDPE Corrugated Sub-Duct is produced in accordance with EN50086 2-4 (DIN 16961, NFC 68-171), i.e. EN 13476 standards.

7.14.3 DESIGN REQUIREMENT*

(a) The HDPE Corrugated Sub-Duct shall be supplied according to the requirements specified.

Table 23: HDPE Corrugated Sub-Duct Specification Details

Parameter	Description		
HDPE Corrugated Sub-Ducts *This is for general references purposes only. Actual dimension may varies upon cable size used in actual deployment*	OD (mm)	ID(mm)	Corrugation Thickness (mm)
	32.0	25.0	3.5
	40.0	31.0	4.5
	50.0	43.0	3.5
Colour	Orange for telecommunication		

Bending	Maximum permissible bend radius 30 times OD in temperature 20 ^{o}C
Cuttings	Can be cut using either a specialized cutter, or a sharp knife or a metal or woodworking saw.
Labeling	The following information shall be clearly marked on the duct at the intervals of 1 meter throughout the whole length of the duct. The marking shall be durable, clear and distinct to the naked eye from a minimum distance of 50cm.

7.14.4 **TECHNICAL REQUIREMENT**

(a) The HDPE Corrugated Sub-Duct shall be compatible with the latest installation standards and operation and maintenance practices for the telecommunication's duct system.

(b) Any alternative proposals for Type and Acceptance Testing will be subject to technical evaluation by ABCi with regards to satisfactory compliance with the material and product qualities implied by this specification.

(c) The HDPE Corrugated Sub-Duct supplied empty or with built-in sub-ducts or inner-ducts, shall be flexible and easy to install.

(d) The HDPE Corrugated Sub-Duct shall have inner and outer surfaces that are clean and free from grooves, cracks, blisters, shrink holes or any other defects or foreign matters, which might impair the performance of the ducts in service.

(e) The HDPE Corrugated Sub-Duct shall be acceptably rounded. They shall be supplied with its ends neat, smooth and cut cleanly at right angles or perpendicular to the axis of the ducts.

(f) The HDPE Corrugated Sub-Duct shall last semi-permanently, have resistance against all kinds of corrosive liquids, aggressive media and chemicals usually found in the ground.

(g) The HDPE Corrugated Sub-Duct shall be light weight, flexible and shall contain correct type of carbon black protection against Ultra Violet (UV) degradation.

(h) The HDPE Corrugated Sub-Duct and its accessories shall be unaffected by all kinds of corrosive liquids and other compounds which exist in the underground system.

(i) All material used in the Corrugated Sub-Duct shall be non-toxic and dermatologically safe.

(j) The manufacturer shall be ISO certified in accordance with the ISO9000:2008 for quality management system.

(k) The HDPE Corrugated Sub-Duct shall meet all the material properties and test requirements as required based on per relevant international standards.

APPENDIX 8 OPTICAL DISTRIBUTION NETWORK (ODN) TESTING GUIDELINES

8.1 INTRODUCTION

8.1.1 One of the first tasks to perform when designing fibre-optic networks is to evaluate the acceptable budget loss in order to create an installation that will meet the design requirements. The total loss measured during network deployment should not exceed the total loss budget allowed by the system design.

8.1.2 The steps for this stage are:

(a) inspecting and cleaning connectors and connections

(b) qualifying the loss, optical return loss (ORL), and distance of the link, using an optical time domain reflectometer (OTDR) and a loss test set (OLTS).

8.2 CONNECTORS AND CONNECTIONS CARE

8.2.1 MAINTAINING CONNECTORS

(a) Connectors are key elements that interconnect the different components of a network; failing to inspect them and clean them as needed can lead to network failure. A single particle mated into the core of a fibre can cause significant back reflection (also known as return loss), insertion loss, and equipment damage. Visual inspection is the only way to determine if fibre connectors are truly clean.

(b) By following a simple practice of proactive visual inspection and cleaning, poor optical performance and potential equipment damage can be avoided.

8.2.2 WHAT COMPONENTS NEEDS TO BE INSPECTED AND CLEANED?

(a) The following network components should be inspected and cleaned:

i. all panels equipped with adaptors where connectors are inserted in one or both sides.

ii. test patch cords.

iii. all connectors mounted on patch cables or pigtails.

8.2.3 WHEN SHOULD A CONNECTOR BE INSPECTED AND CLEANED?

(a) The very first step to fibre testing is connector inspection, connectors should be checked as part of an inspection routine to prevent costly and time consuming fault finding later.

(b) These stages include:

i. after installation.

ii. before testing.

iii. before connecting.

iv. Connectors should be cleaned only if they are proven dirty after completing the inspection.

8.2.4 HOW TO CHECK A CONNECTOR?*

(a) To properly inspect the connector's end face, a microscope designed for the fibre optic connector end face is recommended.

(b) The many types of inspection tools on the market fall into two main categories: fibre inspection probes (also called video fibrescopes) and optical microscopes.

(c) A fibre inspection probe comes with different tips to match the connector type: angle-polished connectors (APC) or flat-polished connectors (PC, SPC or UPC).

*Note: Never use a direct magnifying device (optical microscope) to inspect live optical fibre.

8.2.5 INSPECTION INSTRUCTIONS

(a) Visual fibre interconnect inspection is the only way to determine the cleanliness of the connectors prior to mating.

(b) A video microscope magnifies an image of a connector's end face for viewing on a laptop or a portable display, depending on the product used.

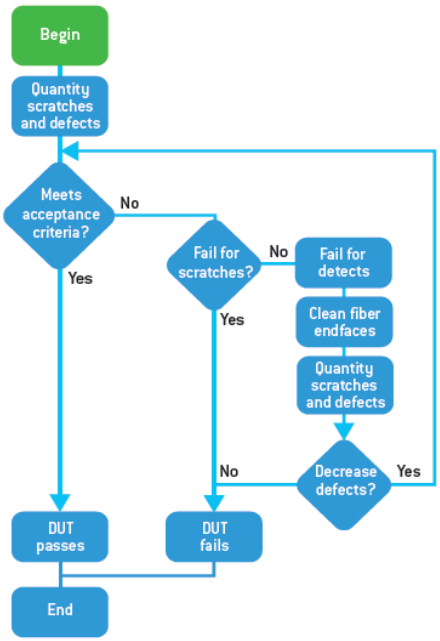


Figure 41: Connector inspection flow

INSPECT

1. Select the appropriate tip for the connector/adaptor you are inspecting.
2. Inspect both connector end faces (patchcord/bulkhead/ pluggable interface) using the microscope.

IS IT CLEAN?

CLEAN No – upon inspection, if defects are found on the end-face, clean the connector using a designed-for optics cleaning tool.

CONNECT Yes – if non-removable non-linear features and scratches are within acceptance criteria limits according to operator's thresholds or standards, the fibre interfaces can be connected.

8.2.6 RECOMMENDATIONS WHEN MANIPULATING OPTICAL FIBRE CABLES

(a) When testing in a patch panel, only the port corresponding to the fibre being tested should be uncapped—protective caps should be replaced immediately after testing.

(b) Lifespan of a connector is typically rated at 500 mating.

(c) Test jumpers used in conjunction with test instruments should be replaced after a maximum of 500 mating (refer to EIA-455-21A).

(d) If using a launch cord for OTDR testing, do not use a test jumper in between the OTDR and launch cord or in between the launch cord and the patch panel. Launch cords should be replaced or returned to manufacturers for re-polishing after 500 mating.

(e) Do not allow unmated connectors to touch any surface. Connector ferrules should never be touched other than for cleaning. Unused caps should be kept in a small plastic bag.

(f) Clean and inspect each connector using a fibrescope or, preferably, a videoscope, after cleaning or prior to mating.

(g) Test equipment connectors should be cleaned and inspected (preferably with a videoscope) every time the instrument is used.

8.3 TESTING ODN DURING CONSTRUCTION

(a) During network construction, some testing occurs in the optical distribution network (ODN). When fibre is laid down new splices have to be done and tested using an OTDR. For accurate measurements, bidirectional OTDR measurements should be performed.

(b) For acceptance testing, it is important to test each segment of the construction.

(c) Emphasize the importance of having documentation on the system before testing and troubleshooting.

8.3.1 METHOD #1: USE OF OPTICAL LOSS TEST SETS (OLTS)

(a) This first method involves using an optical loss test set (OLTS), comprising two test sets that share data to measure insertion loss (IL) and optical return loss (ORL). First, the two units should be referenced prior to measuring IL.

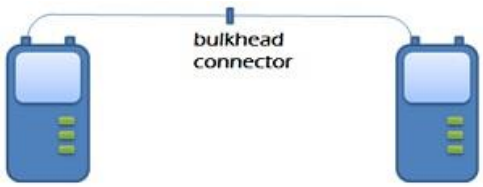


Figure 42: OLTS referencing

Test sets should be referenced prior to measurement.

(b) Next, ORL sensitivity is set by calibrating the minimum ORL that the units can measure.

(c) Follow the manufacturer's instructions to set the ORL sensitivity on both units and to reference the source and the power meter.

(d) Now ready to perform measurements on the *end-to-end network or any individual installed segment*

(e) The purpose of the test is to identify whether there are any transposed fibres, and measure the IL and ORL to make sure that the loss budget has been met.

(f) The intended wavelengths to be tested are 1310 nm, 1490 nm and 1550 nm; and all three wavelengths are to be test for Insertion Loss (IL) and Optical Return Loss (ORL).

(g) Losses should be measured with OLTS at all wavelengths and bi-directionally to check all operational modes - similar to how the transmission equipment will use the fibre.

(h) The following table illustrates the expected ORL values for the network:

Table 24: ORL values conditional details

Length (meters)	1310 nm (dB)	1490 nm (dB)	1550 nm (dB)
50	53	56	57
300	46	50	50
500	44	47	48
1000	41	45	46

8.3.2 METHOD #2: USE OF OPTICAL TIME-DOMAIN REFLECTOMETER SETS (OTDR)

(a) Unlike an OLTS, the OTDR can identify and locate the position of each component in the network.

(b) The OTDR will reveal splice loss, connector loss and reflectance, and the total end to end loss and ORL.

(c) All fibres between connections may be tested to characterize the loss of each splice and locate macro bends.

(d) The test can be conducted to cover both directions. Post-processing of the results will be required to calculate the real loss of each splice (averaged between each direction).

(e) The loss due to the splitter and the cumulative link loss, as well as identifying whether any unexpected physical event has occurred before, or after, the splitter.

(f) Construction testing can significantly reduce the number of problems that occur after subscriber activation by certifying end-to-end link integrity.

(g) Characterizing each fibre with an OTDR, verifying fibre attenuation, termination losses and reflectance and splice quality are greatly needed and highly recommended.

(h) In this step, both loss and fibre attenuation of the ODN elements must be measured to ensure that they meet supplier specifications, as well as the link loss budget.

(i) Since the fibres are being used bi-directionally and connector or splice loss may be different in each direction if the fibre core diameter (mode field diameter for SM fibre) is different, testing in both directions is important too.

(j) OTDR traces should be filed for future reference.

8.4 NETWORK DESIGN LINK LOSS BUDGET

(a) One of the first tasks to perform when designing fibre-optic networks is to evaluate the acceptable loss budget in order to create a product that will meet application requirements, based on ITU G.984.2.

(b) The loss budget calculation should be one of the first things verified prior to any deployment, and it should be mandatory to ensure that the class of the system selected is compatible with the topology that will be deployed.

(c) Therefore, the total loss measured during network deployment should not exceed the total loss budget allowed by the system design, and it should have enough of a buffer to allow for any loss fluctuation that could occur during the lifecycle of the system.

8.4.1 PARAMETERS AND THRESHOLD LEVELS OF MATERIAL AND COMPONENT

(a) Type of optical fibre: **SM 9/125, G652.D and G657.A2**

i. Optical fibre attenuation at 1310 nm and 1550 nm

Table 25: Optical Fibre attenuation details

Type of optical fibre	Attenuation at 1310 nm	Attenuation at 1550 nm
G652.D	0.36 dB/km	0.22 dB/km
G657.A2	0.38 dB/km	0.25 dB/km

(b) Type of optical connector**: Type-SC/APC** (IEC 61751-4)

Table 26: Optical Connector attenuation details

Type of optical connector	Attenuation loss (mating)	Optical Return Loss
SC/APC	0.3 dB	60 dB

(c) Type of joint termination**: Fusion splicing**

Table 27: Fusion splice attenuation details

Type of termination	Max. allowable insertion loss
Fusion splicing	<0.1 dB

(d) Type of optical splitters**:**

Table 28: Optical splitters attenuation details

Type of optical splitter	Typical attenuation loss
1:4 split ratio	7.2 dB
1:8 split ratio	10.5 dB

(e) Type of optical patchcords**: SC/APC – SC/APC SM, G657.A2**

Table 29: Optical patchcords attenuation details

Type of optical patchcords	Attenuation loss (patch)	Optical Return Loss
SC/APC – SC/APC	0.25 dB	60 dB

8.4.2 OPTICAL LINK LOSS CALCULATION

(a) ODN (Access) optical link loss calculation guideline as below:

Table 30: Optical Link Loss details

LINK LOSS BUDGET =	*(TOTAL FIBRE LOSS) + *(TOTAL CONNECTOR LOSS) + *(TOTAL SPLICE LOSS) + *(TOTAL PATCHING LOSS) + *(TOTAL OPTICAL SPLITTER LOSS)

(b) TOTAL FIBRE LOSS = (Total cable distance x Loss per km)

(c) TOTAL CONNECTOR LOSS = (Connector pair mating loss x Number of connector pairs)

(d) TOTAL SPLICE LOSS = (Individual splice loss x Number of splices)

(e) TOTAL PATCHING LOSS = (Patching loss x Number of patching)

(f) TOTAL OPTICAL SPLITTER LOSS = (1^{ST} stage splitter loss + 2^{nd} stage splitter loss)

**Note:* *Where applicable*

8.5 TESTING GUIDELINES FOR SINGLE-DWELLING UNIT (SDU)

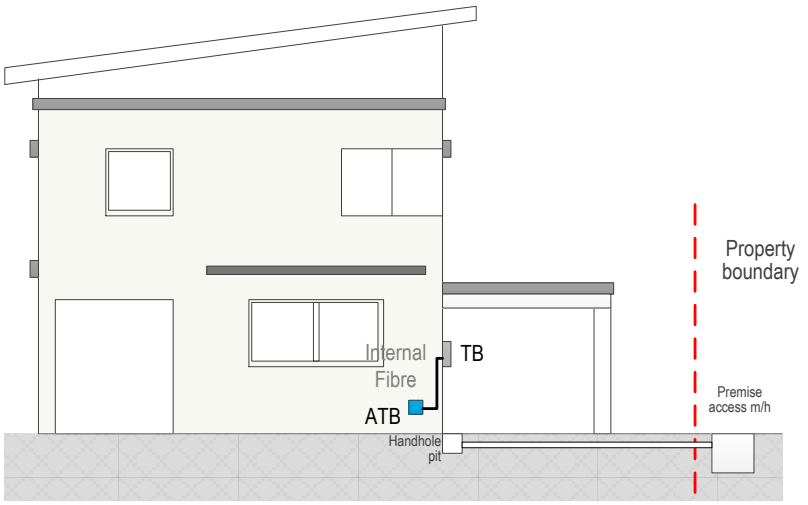


Figure 43: Testing for SDU cabling

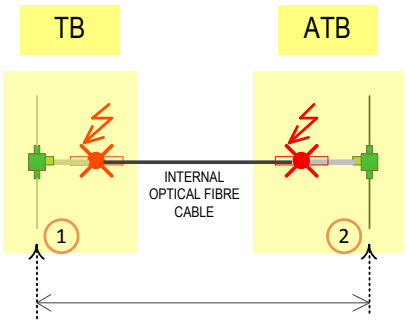


Figure 44: ODN testing diagram for SDU

8.5.1 For SDU, ODN testing is required between the TB and ATB of the building for both external underground cabling and aerial cabling.

8.5.2 The cable installation and termination must be tested between the TB, located at the outside wall, and the ATB located inside the premise.

8.5.3 Testing requirements for SDU:

(a) OLTS:

i. Bi-directional (2-way) test from point (1) to (2), and vice versa.

ii. Either on 1310 nm or 1550 nm wavelength, or both where necessary.

8.5.4 What to test and expected results?

(a) Cable continuity test, to ensure the installed and terminated cable is within the stated insertion loss and good condition of both connectors.

(b) The total loss should not exceed the link loss budget for the connection.

8.5.5 Parameters to take into account are:

(a) Total fibre (cable) loss;

(b) Total connectors loss;

(c) Total splice loss.

8.6 TESTING GUIDELINES FOR SINGLE-DWELLING UNITS (SDU) – SHOP LOTS

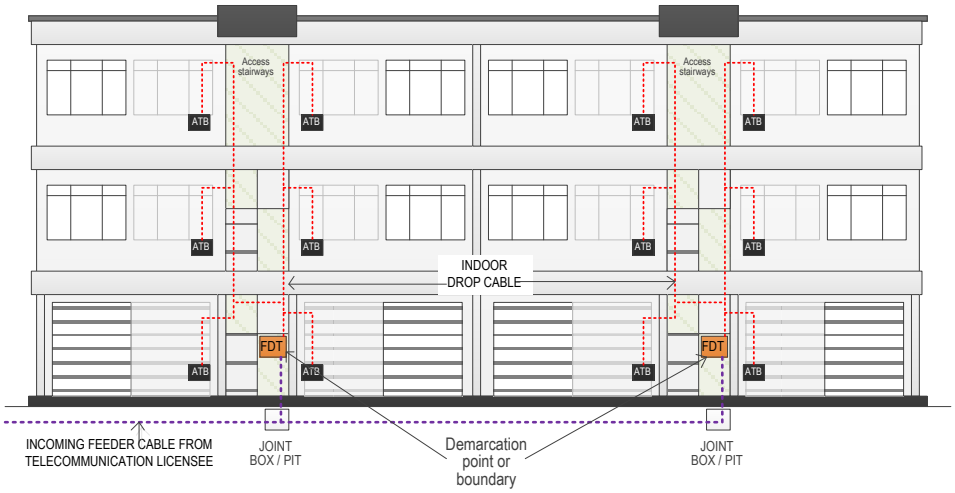


Figure 45: Testing of SDU's shop lots cabling

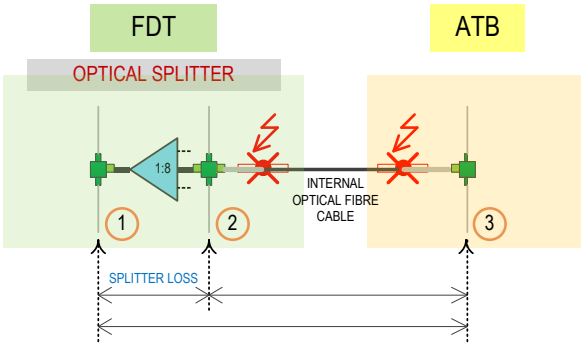


Figure 46: ODN testing diagram for SDU's shop lots

8.6.1 For SDU's shop lots, ODN testing is required between the FDT and ATB of access stairways of the building.

8.6.2 The cable installation and termination must be tested between the FDT, located at the ground floor of the access stairways, and the ATB located inside the premise.

8.6.3 The optical splitter is located inside the FDT, for the distribution of the individual indoor drop fibre cable to each premise.

8.6.4 Testing requirements for SDU's shop lots:

(a) OLTS:

i. Bi-directional (2-way) test from point (1) to (2), and vice versa to test the optical splitter's condition and losses.

ii. Bi-directional (2-way) test from point (2) to (3), and vice versa to test the internal optical fibre cable's condition and losses.

iii. Bi-directional (2-way) test from point (1) to (3), and vice versa to test the link from FDT to ATB.

iv. All the tests above will be either on 1310 nm or 1550 nm wavelength, or both where necessary.

8.6.5 What to test and expected results?

(a) Cable continuity test, to ensure the installed and terminated cable is within the stated insertion loss and good condition of both connectors.

(b) The total loss should not exceed the link loss budget for the connection.

8.6.6 Parameters to take into account are:

(a) Total fibre (cable) loss;

(b) Total connectors loss;

(c) Total splice loss;

(d) Total optical splitter loss.

8.7 TESTING GUIDELINES FOR MULTI-DWELLING UNITS (MDU) and NON-RESIDENTIAL BUILDINGS (NRB)

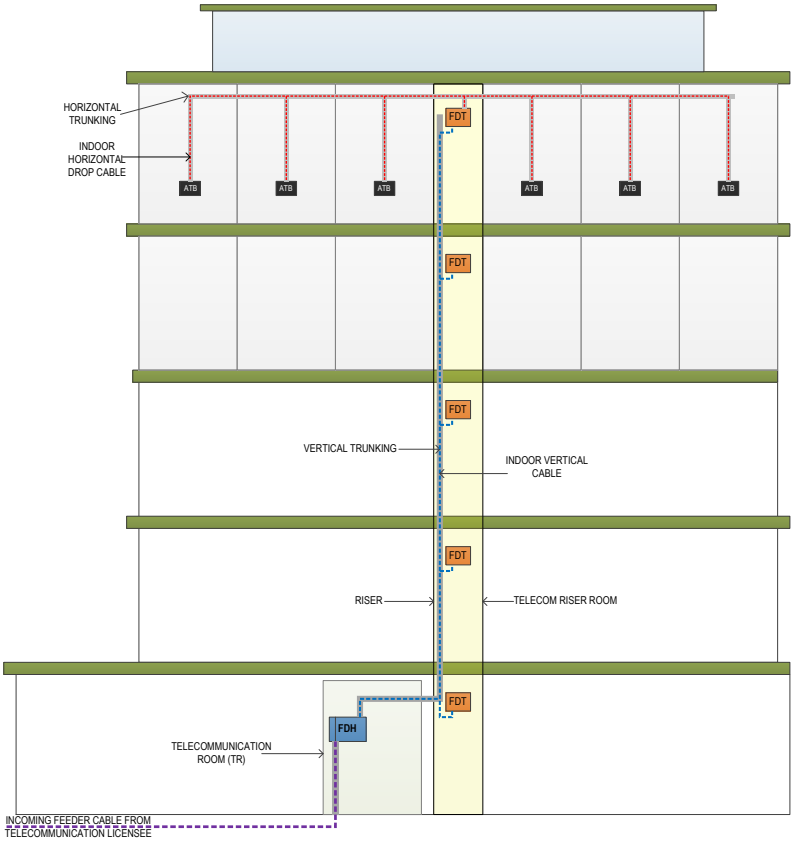


Figure 47: Testing for MDU and NRB

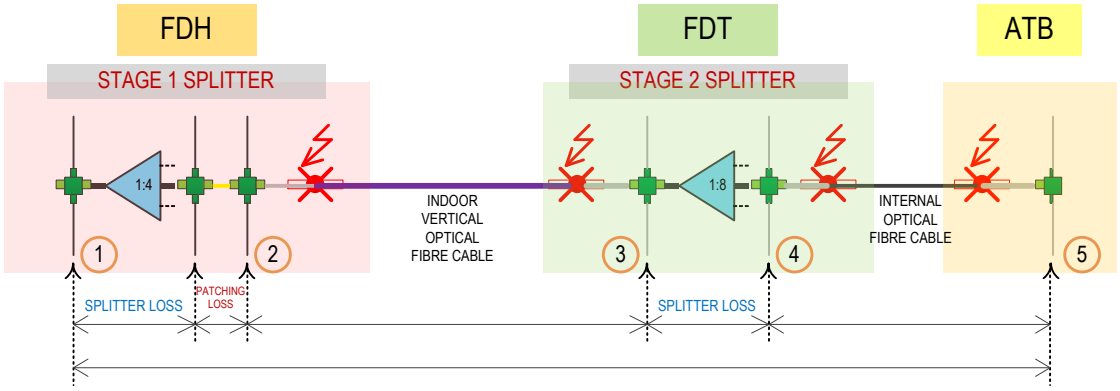


Figure 48: ODN testing diagram for MDU and NRB

8.7.1 For MDU and NRB, ODN testing is required between the FDH and ATB via the FDT in the building.

8.7.2 The cable installation, components and termination must be tested between the FDH, located in the telecommunication room; to the FDT, located in the telecommunication riser and till the ATB located inside the premise.

8.7.3 The optical splitter is located inside the FDH for the first stage splitting and FDT for the second stage splitting.

8.7.4 Testing requirements for MDU and NRB:

(a) OLTS:

i. Bi-directional (2-way) test from point (1) to (2), and vice versa to test the first stage optical splitter's condition and losses, as well as for the patching losses.

ii. Bi-directional (2-way) test from point (3) to (4), and vice versa to test the second stage optical splitter's condition and losses.

iii. Bi-directional (2-way) test from point (1) to (5), and vice versa to test the link from FDH to ATB via FDT

iv. All the tests above will be either on 1310 nm or 1550 nm wavelength, or both where necessary.

(b) OTDR:

i. Bi-directional (2-way) test from point (2) to (3), and vice versa to test the indoor vertical optical fibre cable's condition and losses, as well as termination losses.

ii. Bi-directional (2-way) test from point (4) to (5), and vice versa to test the internal optical fibre cable's condition and losses, as well as termination losses.

iii. Uni-directional (1-way) test from point (5) to (1) to test and characterize the link for each ATB back to the FDH.

iv. All the tests above will be both on 1310 nm or 1550 nm wavelength.

8.7.5 What to test and expected results?

(a) Cable continuity test, to ensure the installed and terminated cable is within the stated insertion loss and good condition of both connectors.

(b) Cable length and macro bending detection, for OTDR test.

(c) The total loss should not exceed the link loss budget for the connection.

8.7.6 Parameters to take into account are:

(a) Total fibre (cable) loss;

(b) Total connectors loss;

(c) Total splice loss.

(d) Total optical splitter loss.

(e) Total patching loss.

8.8 TEST EQUIPMENT SET-UP

8.8.1 TESTING USING OTDR*

***Note:** All OTDR testing is mandatory to use the Launch Cable with the OTDR.

(a) Example of OTDR testing from point A to point B (Bi-directional)

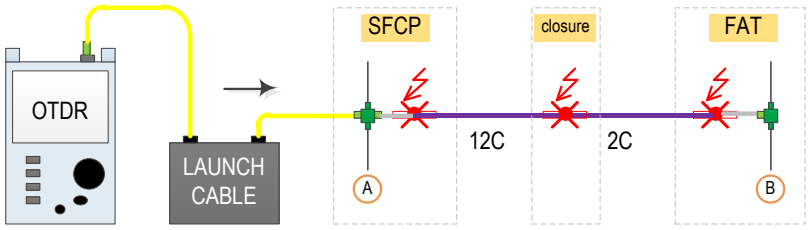


Figure 49: OTDR Bi-Directional Test Setup from A to B diagram

(b) Example of OTDR testing from point B to point A (Bi-directional)

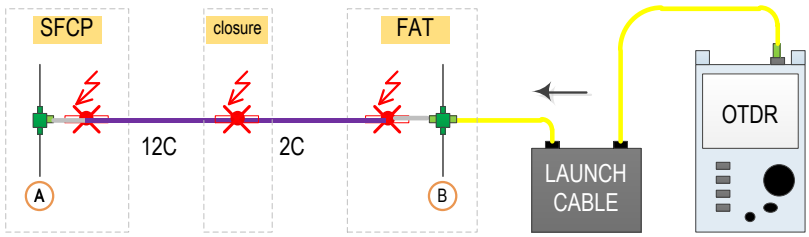


Figure 50: OTDR Bi-Directional Test Setup From B to A Diagram

(c) Example of OTDR testing for End-to-End (E2E) (Uni-directional)

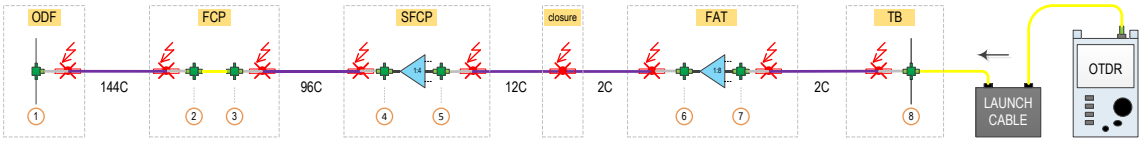


Figure 51: OTDR Uni-Directional E2E Test Setup Diagram

8.8.2 TESTING USING OLTS

(a) Example of OLTS testing for End-to-End (E2E) (Bi-directional)

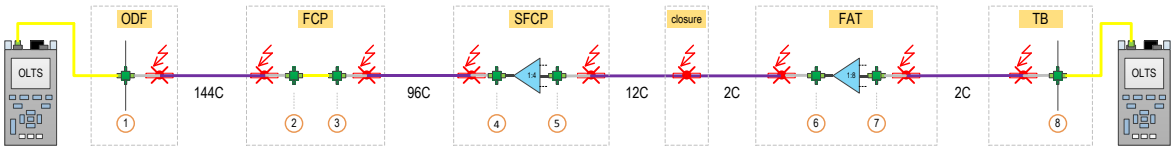


Figure 52: OLTS Bi-Directional E2E Test Setup Diagram

APPENDIX 9 CORE ASSIGNMENTS AND LABELING FOR INTERNAL FIBRE

9.1 SINGLE-DWELLING UNITS (SDU) – SHOP LOTS

9.1.1 All the internal fibre optics cabling for SDU's shop lots must have core assignments assigned, labeling convention tagged properly for easier maintenance and connection with the telecommunication licensee's cable during the service activation and during restoration process.

9.1.2 All cables need to be inventoried and one (1) copy of the inventory information must be submitted to the authority or/and telecommunication licensee during cabling approval process. All information of the cabling inventory must be placed and indicated clearly inside the FDT for reference. The building owner or the building management must update the information whenever there are changes to the inventory.

9.2 CORE ASSIGNMENT FOR SDU's SHOP LOTS

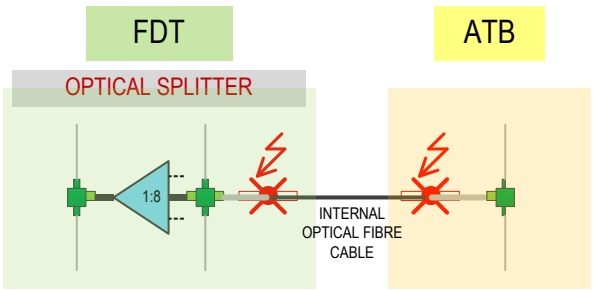


Figure 53: ODN schematic diagram for SDU's shop lots

9.2.1 Based on a single end-to-end connection as shown in **Figure 53**, the core assignment for the Single-Dwelling Unit's shop lots is shown in **Table 32** below.

Table 31: Core assignment tale for SDU's shop lots

FDT							ATB	
INCOMING CABLE		FDT ID.	SPLITTER INFO		OUTGOING CABLE			
CABLE ID.	CORE #		SPLITTER ID.	OUTPUT PORT #	CORE #	CABLE ID.	FLOOR #	UNIT #
XXXXXXXXXXXX xxxC O.F.C.	xx	Txx	yySPxx	xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				yy	xx	FDxxxx xxC O.F.C	xx	XX
XXXXXXXXXXXX xxxC O.F.C.	xx	Txx	yySPxx	xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				xx	xx	FDxxxx xxC O.F.C	xx	XX
				yy	xx	FDxxxx xxC O.F.C	xx	XX
LEGEND:	XXX.	- ALPHANUMERIC INPUT						
	xx.	- NUMERIC INPUT ONLY						
	yy	- OPTICAL SPLITTER SPLIT RATIO						

9.2.2 Incoming cable ID and core no. - Telecommunication licensee's optical fibre cable details.

9.2.3 FDT no. – The number allocated or assigned to the FDT.

9.2.4 Splitter ID and output port no. – The type of splitter's distribution and output port allocation.

9.2.5 Outgoing cable ID and core no. – The Internal Drop optical fibre cable information.

9.2.6 ATB location – the premise's unit number and floor level.

9.3 LABELING AND TAGGING FOR SDU's SHOP LOTS

9.3.1 The labeling convention for the Internal Drop Optical Fibre Cable is recommended to follow the following standard as shown in Table 33.

Table 32: Labeling for Internal Drop cable for SDU's shop lots

ITEM	FDT INFORMATION					CABLE INFORMATION				PREMISE		
	FDT ID.		SPLITTER INFO			INTERNAL O.F.C.				ATB		
			SPLITTER ID.		OUTPUT PORT #	CORE #		CABLE ID		FLOOR #		UNIT #
CODE	Txx	-	yySPxx	-	xx	xx	-	FDxxxx	-	xx	-	XX
EXAMPLE	T01	-	08SP01	-	02	01	-	FD0013	-	01	-	05

(a) FDT no. – The number allocated or assigned to the FDT.

(b) Splitter ID and output port no. – The type of splitter's distribution and output port allocation.

(c) Outgoing cable ID and core no. – The Internal Drop optical fibre cable information.

(d) ATB location – the premise's unit number and floor level.

9.3.2 All the Internal Fibre cable must be tagged properly and all tag must be stated clearly and sealed with transparent material for easy reading.

9.3.3 Tagging must be placed at the FDT at the ground floor of the stairways access.

9.3.4 All tagging must be placed by the housing developer or owner initially and the record must be updated by the building management upon any changes to it.

9.4 MULTI-DWELLING UNIT (MDU) and NON-RESIDENTIAL BUILDINGS (NRB)

9.4.1 All the internal fibre optics cabling for MDU and NRB must have core assignments assigned, labeling convention tagged properly for easier maintenance and connection with the telecommunication licensee's cable during the service activation and during restoration process.

9.4.2 All cables need to be inventoried and one (1) copy of the inventory information must be submitted to the authority or/and telecommunication licensee during cabling approval process. All information of the cabling inventory must be placed and indicated clearly inside the Telecommunication Room for reference. The building owner or the building management must update the information whenever there are changes to the inventory.

9.5 CORE ASSIGNMENT FOR MDU and NRB

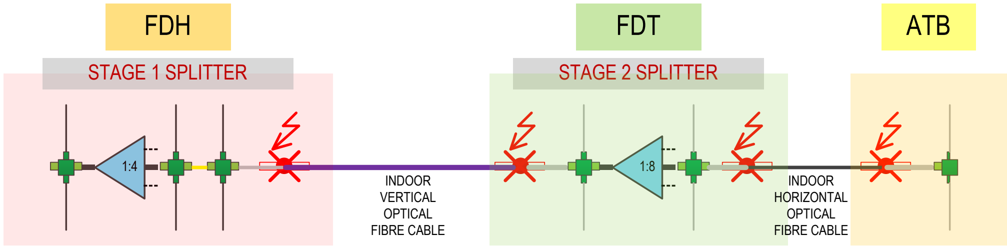


Figure 54: ODN schematic diagram for MDU and NRB

9.5.1 Based on a single end-to-end connection as shown in Figure 54, the core assignment for the MDU and NRB is shown in Table 34 below.

Table 33: Core assignment table for MDU and NRB

FDH							FDT						ATB	
INCOMING CABLE		FDH ID.	SPLITTER INFO		OUTGOING CABLE		INCOMING CABLE	FDT ID.	SPLITTER INFO		OUTGOING CABLE			
CABLE ID.	CORE # (TRAY #)		SPLITTER ID.	OUTPUT PORT # (TRAY #)	CORE # (TRAY #)	CABLE ID.	CORE #		SPLITTER ID.	OUTPUT PORT #	CORE #	CABLE ID.	FLOOR #	UNIT #
XXXXXXXXXXXX xxxC O.F.C.	xxx (XX)	Hxx	yySPxx	xx (XX)	xx (XX)	FVxxxx xxC O.F.C	xx	Txx	yySPxx	xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										yy	xx	FHxxxx xxC O.F.C	xx	XX
				xx (XX)	xx (XX)	FVxxxx xxC O.F.C	xx	Txx	yySPxx	xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										yy	xx	FHxxxx xxC O.F.C	xx	XX
				xx (XX)	xx (XX)	FVxxxx xxC O.F.C	xx	Txx	yySPxx	xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										yy	xx	FHxxxx xxC O.F.C	xx	XX
				yy (XX)	xx (XX)	FVxxxx xxC O.F.C	xx	Txx	yySPxx	xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										xx	xx	FHxxxx xxC O.F.C	xx	XX
										yy	xx	FHxxxx xxC O.F.C	xx	XX

LEGEND: XXX. - ALPHANUMERIC INPUT
xx. - NUMERIC INPUT ONLY
yy - OPTICAL SPLITTER SPLIT RATIO

(a) Incoming cable ID and core no. - Telecommunication licensee's optical fibre cable details.

(b) FDH no. – The number allocated or assigned to the FDH.

(c) FDT no. – The number allocated or assigned to the FDT.

(d) Splitter ID and output port no. – The type of splitter's distribution and output port allocation for both 1st stage (FDH) and 2nd stage (FDT).

(e) Indoor Vertical cable ID and core no. – The Internal Vertical optical fibre cable information.

(f) Indoor Horizontal cable ID and core no. – The Internal Horizontal optical fibre cable information.

(g) ATB location – the premise's unit number and floor level.

9.6 LABELING AND TAGGING FOR MDU and NRB

9.6.1 The labeling convention for the Indoor Vertical Optical Fibre Cable is recommended to follow the following standard as shown in Table 35.

Table 34: Labeling for Indoor Vertical cable for MDU and NRB

ITEM	FDH INFORMATION				CABLE INFORMATION			FDT INFORMATION	
	FDH ID.		SPLITTER INFO		INDOOR VERTICAL O.F.C.			FDT ID.	SPLITTER INFO
			SPLITTER ID.	OUTPUT PORT # (TRAY #)	CORE #	CABLE ID			SPLITTER ID.
CODE	Hxx	-	yySDxx	xx (XX)	xx (XX)	FVxxxx	-	Txx	yySPxx
EXAMPLE	H03	-	04SP05	03 (2A)	07 (3A)	FV0013	-	T04	08SP11

(a) FDH no. – The number allocated or assigned to the FDH.

(b) Splitter ID and output port no. – The type of splitter's distribution and output port allocation for 1st stage splitter.

(c) Indoor Vertical cable ID and core no. – The Internal Vertical optical fibre cable information.

(d) FDT no. – The number allocated or assigned to the connected FDT.

(e) Splitter ID (2nd stage) – the type of splitter's distribution in the FDT connected to.

9.6.2 The labeling convention for the Indoor Horizontal Optical Fibre Cable is recommended to follow the following standard as shown in Table 36.

Table 35: Labeling for Indoor Horizontal cable for MDU and NRB

ITEM	FDT INFORMATION				CABLE INFORMATION			PREMISE	
	FDT ID.		SPLITTER INFO		INDOOR HORIZONTAL O.F.C.			ATB	
			SPLITTER ID.	OUTPUT PORT #	CORE #	CABLE ID		FLOOR #	UNIT #
CODE	Txx	-	yySPxx	xx	xx	FHxxxx	-	xx	XX
EXAMPLE	T04	-	08SP11	07	01	FH0025	-	07	15

(a) FDT no. – The number allocated or assigned to the FDT.

(b) Splitter ID and output port no. – The type of splitter's distribution and output port allocation for 2nd stage splitter.

(c) Indoor Horizontal cable ID and core no. – The Internal Horizontal optical fibre cable information.

(d) ATB location – the premise's unit number and floor level.

9.6.3 All the Internal Fibre cable must be tagged properly and all tag must be stated clearly and sealed with transparent material for easy reading.

9.6.4 Tagging must be placed at the FDH inside the Telecommunication Room and FDT in the Telecom Riser.

9.6.5 All tagging must be placed by the housing developer or owner initially and the record must be updated by the building management upon any changes to it.