GUIDELINES

ON

TECHNICAL SPECIFICATIONS

FOR THE DEPLOYMENT OF INFRASTRUCTURE IN THE COMMUNICATIONS SECTOR IN NIGERIA

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PART I
SCOPE OF THE GUIDELINES

CHAPTER ONE

1. SCOPE

(1) These Guidelines provide standards to be adhered to by Communications services providers/operators, designers, fabricators and installers of Communications towers towards ensuring environmental safety and sound engineering practices.

(2) The Guidelines takes cognisance of types and constituents of tower structures and also provides a comprehensive data on wind speeds in Nigeria which may be used as reference material for engineers in the design of masts and towers.

(3) In these Guidelines, concerns about public safety, and safety of personnel and equipment are addressed and accordingly, the responsibilities of owners, designers and fabricators of Communications masts and towers relating thereto are set out.

(4) The demands of the local operating environment are also taken into consideration by the Guidelines alongside the need to achieve substantial conformity with applicable international best practices.

(5) Non-compliance with the mandatory provisions of these Guidelines shall be deemed to be an offence punishable under relevant provisions of the Nigerian Communications Act 2003 (the Act); the Nigerian Communications (Enforcement Process, etc.) Regulations 2019 and other applicable laws.

(6) This Guidelines provides minimum installation standards and technical specifications for Fibre Optic installations at the backbone Fibre networks, Metro Fibre network, Access points and In-building Physical Plant Installations in towns/cities of the Federal Republic of Nigeria.

(7) The Guidelines apply to all Fibre Optic installations in new developments and provide guidance on the mostly used materials specifications for Fibre Optic networks.

(8) This Guidelines shall not change any obligation imposed by other administrative authorities. Installations along roads and highways shall strictly comply with the requirements set by the relevant Government Agencies/Authorities having legitimate jurisdiction consistent with the Laws of the Federal Republic of Nigeria. Thus, the installations shall comply with all provisions and Guidelines established by these authorities.

PART II

TECHNICAL SPECIFICATIONS FOR INSTALLATION OF MASTS AND TOWERS

CHAPTER TWO- TYPES OF TOWERS AND MASTS

These Guidelines recognise the following types of communications towers, namely;

2 (1) <u>Monopole Towers or Post Masts</u>

(a) Monopole towers consist of tapered steel tubes that fit over each other to form a stable pole.

(b) A monopole tower should be guyed or self-supported and be fitted with climbing rungs where necessary. It should have the following features:

(i) Sections should be made from hollow, heavy duty, thick steel tubes, flanged steel tubes or low-alloy, high-strength steel.

(ii) Each shaft section should be a constant-tapered hollow steel section

(iii) Slip joints should be designed with a minimum of $1^1/_2$ times the pole diameter at the splice.

(iv) Pipe diameter should decrease from bottom to top

(v) Monopoles are to be made from galvanised hollow steel pipes or high strength steel and designed for a variety of multi-user configurations and finishes to meet local aesthetic requirements.

(vi) The pipes shall be tapered to ensure that one pipe base fits into the top of another until the desired height is achieved. A joint in the arrangement should have an overlay between the two adjacent pipes.

(vii) The depth of the overlay, the base width and the number of pipes in a particular monopole shall be determined by the expected height of a tower, the thickness of the pipe walls, the base diameter and whether the tower shall be guyed or not.

2 (2) <u>Guyed Towers</u>

(a) These are towers that are stabilized by tethered wires

(b) Guyed towers shall be designed and installed in the manner illustrated in Figures 2.16 to 2.18 of the First Schedule to these Guidelines and shall take cognisance of the following specifications and recommended practices:

(i) Guyed masts may be in lattice, triangular or square, tapered or straight, as well as monopole structural forms.

(ii) Guyed masts shall be supported and held in position by guy wires or ropes.

(iii) Mast Guy Ropes shall be made from pre-stretched steel only. For every mast, the specified minimum strength of the guy wire shall be the maximum tension likely to occur in the worst loading condition.

(iv) Guy wires must not be over tightened in the installation of guy towers in order to avoid excessive tension which may cause alignment problems, cable rupture and permanent wrapping of tower structural parts.

(v) All sections must be straight square sections to eliminate potential problems associated with twisting or the need to shim the legs.

(vi) Typical tower sections are to have brace configuration with horizontals (z, x or k) and pivot base sections. These tower-structures should be wholly of steel, modular and hot-dip galvanized.

(vii) Sections can be of the same face width but in the event that the tapered type is considered, the design should be with junction flanges.

(viii) Guyed towers should have tube or solid legs with solid bracing which increases the tower rigidity to allow for the twist and sway.

(ix) Guy wires are to be engineered with precision and a minimum safety factor of 2.0 applied to the design.

(x) The design, based on the load calculations would determine working load and the break strength required of the guy wire and ultimately the choice of the size and grade of the wire.

(xi) The choice of each guy earth screw anchor would be dependent on its holding power in the soil, which is a function of its diameter and length to be used to compute the minimum number of guys required.

(xii) As a general rule, guys should be planted in three directions at 120 ^{o} apart from each other. The distance from the base of the tower to the guy anchor base should be one quarter of the height of the tower.

2 (3) <u>Self-Supporting Towers</u>

(a) Self-supporting towers are free-standing lattice structures

(b) The use of self-supporting towers with tapered sections, and face width that vary according to height and load capacity is recommended when land availability is limited PROVIDED that it is technically feasible to install them.

(c) Self-supporting towers shall be designed and constructed as Lattice structures in the manner illustrated in Figure 2.1 to 2.13 of the First Schedule to these Guidelines and shall have the following features:

(i) Triangular or square structure

(ii) Tube legs, angle legs, lattice legs or solid round legs
(iii) Sections in steel angle steel or steel tubes
(iv) Steel angle cross bracing.
(v) Tapered sections
(vi) Face widths vary according to height and load capacity.
(vii) Rest platforms provided every 20 metres of height
(viii) Work platforms provided at all height where antennas are to be installed
(ix) Fitted with climbing ladder

Standard support forms for lattice structures are specified as follows:

(i) Lattice Leg
(ii) Angle Leg
(iii) Tube Leg / Solid Round Leg

2 (4) <u>Roof Mounts</u>

(a) Roof mounts are an inexpensive way of elevating signals above roof interference or any other obstruction.

(b) The design and installation of roof mounts illustrated in Figures 2.20 of the First Schedule to these Guidelines shall take cognisance of the following specifications and recommended practices:

(i) Structural checks must be made to ascertain the capability of a chosen roof to withstand the additional load being imposed on it by the structure and the entire antenna array it will support.

(ii) All roof mounted masts or towers must be certified by the building's structural engineer before installation.

(iii) As a general rule, roof mounts should be limited to light weight structures of low heights and support minimal dead and dynamic loads.

(iv) Roof mounts can be installed in the penetrating or non-penetrating modes and can be self-supported or guyed. However non- penetrating roof mounts are most suitable for flat surfaces.

2 (5) <u>General Features of Towers</u>

(a) In constructing tower legs, schedule 80 pipes or angle steel should be used although hollow aluminium pipes may be used for short towers.

(b) Bracings should be of angle steel construction or aluminium in case of aluminium towers.

(c) Mast sections, when made from steel pipes, should be joined to each other through joint plates welded to the base of each section. The width of the mast section joint plates should be double the width of the wall of the pipe they are supporting.

(d) Gussets should be used in the strengthening of the weld joint between the base plate and the tower section.

(e) Each plate should have four 20mm diameter holes drilled to accommodate four 18mm bolts, nuts and washers.

(f) When bolting sections together, bolts should be placed upside down with washers and nuts on topside of plates, the connecting face of plates should not be painted.

(g) Lock nuts shall be used but nuts on bolts may be clinched if lock nut is not utilized.

(h) Lock washers and lock nuts should be used on antenna support steel work and dish panning arms in order to avoid loss of signals.

(i) When a tower is made from angle steel, sections should be joined to each other through appropriately sized flanges, bolts, washers and lock nuts.

(j) There should be adequate application of bracing to prevent towers being exposed to torque that may result in loss of signal during strong winds speeds.

CHAPTER THREE

SITING, DESIGN AND CONSTRUCTION

3 (1) SITING OF TOWERS AND MASTS

(1) The siting of masts and towers shall take cognisance of provisions of the Act and be guided by provisions of the Collocation and Infrastructure Sharing Guidelines of the Commission in such a way as to minimise their number, protect and promote public safety, and mitigate adverse visual impacts on the community. To reduce the visual impact of towers and antennas structure, Stealth and/or camouflage design of towers and antennas are encouraged.

(2) All masts and towers sited in cities shall conform to the Guidelines and standards of the Commission concerning all matters on radio frequency

(3) All towers sited within residential areas must conform to the set back stipulated in the Guidelines under Subsection 5 below and Section 9 (9) to mitigate the effect of heat, smoke and noise pollution arising from generating sets.

(4) Communications towers above 25 metres in height would not be permitted within districts delineated as residential.

(5) Notwithstanding sub-paragraph (4) of this guideline, where towers in excess of 25 metres in height are permitted, they should be placed at a minimum setback of 10 meters distance to the nearest demised property, excluding the fence. Prior permission must be obtained from the Commission.

(6) Towers and masts sited in contravention of these Guidelines shall be removed and the owner of the tower shall bear the cost of such removal.

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3 (2) Design of Towers and Masts

(1) The design of towers illustrated in Figures 2.2 to 2.14 of the First Schedule to these Guidelines shall be in accordance with the specifications contained in Tables 2.1 to 2.13 thereof. In designing towers, due cognisance shall be taken of the following;

(a) Tapered steel and flanged steel poles feature designs that blend well into the environment and require minimum space for installation.

(b) Flanged steel poles are easy to handle and install.

(c) Connections shall be precision fitted to allow quick assembly of modular sections and the top platform, side arms or mounting frame.

(d) Pole sections shall be made with identical base flange plates to permit simplified modifications of mounting heights and antenna reconfigurations.

(e) Tapered steel poles have comparatively smaller base diameters and so demand minimal land space.

(f) Tapered poles can be installed quickly and offer an extremely efficient strength-to cost ratio.

(2) **Superstructure**

The following parameters shall apply to all superstructure of towers and masts.

(a) All steel materials to be used in the finishing of the superstructure shall be hot-dip galvanised and painted according to the Nigerian Airspace Management Agency (NAMA) paint schedule for obstructions.

(b) All aluminium materials shall have aluminium finish and be painted according to NAMA paint schedule for obstructions.

(3) **Painting**

(a) All skeleton type structures must be painted to International Civil Aviation Organisation (ICAO) stipulations on obstruction painting. ICAO stipulates that:

(i) For structures up to 212 metres, the structure shall be given seven equal bands of red and white paint or orange and white paint.

(ii) For structures above 212 metres, nine bands of paint in alternating red and white or red and orange.

(iii) In all cases the top and bottom of the mast or tower must be painted red or orange.

(iv) Paint shall be non gloss finish (matt).

(b) Mast and Towers shall in addition, be painted with base primer paint, one suitable under coat of red and white or orange and white followed by two coats of non gloss (matt) paint.

(4) **Obstruction Lighting**

(a) All mast and tower structures in Nigeria must conform strictly to ICAO / NAMA Guidelines with respect to obstruction lighting of tall structures as illustrated in Figure 2.21 of the First Schedule to these Guidelines and specified below:

(i) For every fifty metres of height above ground level, a tower shall have installed on it, one lamp on top and two lamps at the sides.

(ii) Obstruction lamps shall be maintained in a working condition at all times on all structures within 15 kilometres of an airport or helipad.

(b) Light intensity and colour specifications should be as provided hereunder:

Tower Height	Light Intensity	Light Colour
Below 45 m	not below 10 candelas	Red and fixed
Between 45 and 150m	not below 1600 candelas	Red and flashing
Greater than 150m	4,000 - 20,000 candelas	White Flashing

(5) **Substructure**

The following parameters are applicable to the substructure of towers and masts.

(a) Foundation and Anchors

(i) Foundations for tower and mast structures shall be designed to withstand the full expected dynamic loads namely; antennae, feeders, wind loading, etc.

(ii) The design shall take cognisance of the geo-technical investigation findings on soil and wind conditions at the installation site for purposes of determining bearing pressures (vertical and horizontal), other sub-surface conditions, the suitable foundation type (reinforced concrete blocks, standard pad and column, raft, preset rock anchors or piles), construction materials and installation method.

(iii) Engineers are to compute the weight of tower structure, antenna feeders and all associated steel work and then, calculate the effect of wind loads on the total surface.

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(iv) Worst case load design condition should always constitute the initial factor of safety against overturning for complete foundations or any part thereof.

(v) Standard foundation designs should be made for normal soils where however the need arises, it may be modified to suit the soil conditions at the installation site.

(vi) Normal soils for purposes of these Guidelines shall be defined as dry cohesive soils having:

a. an allowable net vertical bearing capacity of 192kPa

b. an allowable net horizontal pressure of 63kPa per linear metre of depth to a maximum of 192kPa.

c. unit weight of compacted soil greater than $16kNm^{-3}$

d. water table is at a depth greater than 2.5m below the surface

e. coefficient of passive earth pressure greater than 3.2

f. coefficient of active earth pressure of approximately 0.3

g. non acidic properties

h. no organic materials are present in the soil

(vii) Three basic physical forces shall be taken into consideration whilst designing tower and masts foundations. These are: - a. Vertical down load

b. Base shear

c. Uplift load

(viii) Proper soil borings shall be made by competent soil testing specialists and they must go deeper than the probable depth of the foundation to make sure of soil type consistency.

(ix) For guyed towers, borings shall also be taken at all guy locations and at the base per location since conditions can vary widely on the site.

(x) Foundations and Anchors shall be designed to support the structures and specified loads for specific soil conditions.

(xi) Pile, raft or specially designed foundations or anchors are to be considered in submerged, marshy or peat soil conditions. Foundation designs shall be made and certified by qualified and registered professional engineers.

(6) <u>Types of Foundations</u>

1. Standard Foundation

a. Standard foundations and anchors may be used for construction when actual soil parameters are the same as or exceed normal soil parameters.

b. Geo-technical investigation to verify that actual site soil parameters are the same as or exceed normal soil parameters shall be made before standard foundations and anchors are utilized in final designs.

c. Foundations and anchors shall be designed for the maximum structure reactions resulting from the anticipated worst loading conditions.

d. When non-standard foundations and anchors are to be used for construction, the soil parameters recommended by the geo-technical engineer shall incorporate a minimum safety factor of 2.0 against ultimate soil strength.

2. Raft Foundation

a. In determining the dimensions of the raft, consideration should be given to the pressure distribution under maximum design loads to ensure that tensile forces do not develop under a significant part of the raft area.

b. Raft foundations shall be designed by certified foundation engineers using geo-technical data for the site. Such design which shall be in the manner illustrated in Figure 2.23 of

the First Schedule to these Guidelines should conform to the specifications in Figure 2.27 and 2.29 thereof.

c. A name plate giving details of the designer and the builder shall be placed in a conspicuous location at the tower base.

3. *Piles*

a. Pile foundations are recommended in swamps and peat soils, in order to overcome catastrophic effects of uneven settlement in other types of foundation.

b. Pile foundations shall be designed by certified foundation engineers using geo-technical data for the site.

c. A name plate giving details of the designer and the builder shall be placed in a conspicuous location at the tower base.

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4. Drilled foundations

The design and construction of drilled foundations presents certain challenges to Engineers. Consequently, the engineers involved in the design process which is illustrated in Figure 2.24 to 2.25 of the First Schedule to these Guidelines should at all times take cognisance of the following:

a. Foundations can be drilled in any type of soil formation including sandy soils where drilling is however not straight-forward due to the likelihood of hole cave-in.

b. Where drilling is in sandy soil, a casing may be used and pulled out as the concrete is being placed so that the concrete is in contact with the sides of the hole.

c. Alternatively, drilling slurry could be used. The hole is filled with "mud" and as the concrete is pumped into the bottom of the hole, the mud is pumped out at the top. The concrete likewise makes immediate contact with the soil and the foundation provides the support that is required.

5. Foundation Drawings

a. Foundation drawings shall indicate structure reactions, material strengths, dimensions, reinforcing steel and embedded anchorage material type, size and location.

b. Every foundation that is designed for normal soil conditions shall duly be noted and every foundation design shall include site soil data as a footnote.

6. *Foundation in Swamps*

a. The erection of Guyed tower in swamps can be performed more quickly and efficiently, and less expensively with modified construction techniques and an alternative method for anchoring.

b. The 'simple marsh anchor' method which is a technology that employs square rods with screw helices at one metre intervals on the initial three to six metre length may be used.

c. Use of the screw anchors requires only the availability of an auger machine to screw the anchors into the ground thus avoiding the digging of holes, forming, and pouring concrete.

d. The anchors are simply screwed into the ground until a layer of earth is encountered that offers sufficient resistance to achieve the required installation torque.

e. In order to shorten the depth to which anchors are to be screwed, the use of multiple anchors with load-distributing linkages is advisable.

f. The advantage of this method is the ease with which extensions or additional anchors can later be added in the event that capacity needs to be increased for additional load requirements or for the addition of torque arms.

7. *Rock Anchors*

a. Rock anchors shall be designed to ensure long life and treated against corrosion to last longer than the design life-span of the tower.

b. Pre-stressed rock anchors are to have their upper terminating steel work in such a way as to have a steel-to-steel connection between the structure footing and the rock anchor tendon.

c. The upper end termination of rock anchors shall not be encased in concrete but shall be protected against corrosion so as to allow any subsequent checking of the tension in the tendons during the life of the structure.

8. *Anchor Bolts Template*

a. Templates which provide proper anchor bolt orientation at the time of foundation forming shall be used to eliminate problems associated with misalignment.

b. Templates shall be precisely fabricated and used in constructing tower foundations in accordance with design specifications.

c. A minimum of two anchor stirrups shall be provided around each leg of a tower and each stripe shall have a safe working load (SWL) of 100KN.

9. *Uplift*

a. Anchors must be dimensioned to provide sufficient safety against overturning.

b. A qualified geo-technical engineer shall design foundations especially when they are to be sited in non-standard soils and the application of prototype designs for normal soils becomes undesirable.

c. Standard foundations, anchors, or drilled and buried piers shall be designed to resist uplift forces by their own weight in addition to the weight of earth enclosed within an inverted pyramid or cone whose sides form an angle of 30^0 with the vertical.

d. The base of the cone shall be the base of the foundation if an undercut or toe is present or the top of the foundation base in the absence of the foundation undercut.

e. Earth shall be considered to weigh $16kN/m^3$ and concrete $24kN/m^3$.

f. Straight shaft drilled piers for standard foundations shall have an ultimate skin friction of 31 kPa per linear metre of depth to a maximum of 48kPa of shaft surface area for uplift or download resistance.

g. Non-standard foundations, anchors, and drilled piers shall be designed in accordance with the recommendations of a geo-technical report. A mat or slab foundation for a self-supporting structure shall have a minimum safety factor against overturning of 1.5.

h. The effects of the presence of water shall be taken into account in the design of non-standard foundations. In this regard, reduction in the weight of materials due to buoyancy and the effect on soil properties under submerged conditions shall be considered.

10. Concreting

(i) All loose material shall be removed from the bottom of any excavation, and the sides thereof shall be rough and free of loose cuttings before concrete placement.

(ii) Concrete shall be placed with the aim of preventing segregation of concrete material and any occurrence that may decrease the strength or durability of the foundation.

(iii) Concrete placement shall be continuous.

(iv) No construction joints shall be permitted.

(v) Weight of concrete mixture shall in all cases be $24kNm^{-3}$.

(vi) Concrete mixture must be such as to enable the concrete develop a minimum compressive strength of $30Nm^{-2}$ in 28 days.

(vii) Reinforcement steel shall be grade 50 deformed bars and shall be covered with concrete overlay of a minimum thickness of 75mm and Spacers shall be used to achieve this minimum cover on reinforcement.

(viii) Concrete shall always be thoroughly mixed prior to putting in place, and any water which seeps into excavation should be removed prior to placing concrete.

(ix) A concrete vibration machine shall be used until all concrete is in place.

(x) The concrete column of the foundation shall always be installed inside wood or steel formwork and left in place for 24 hours before removing.

(xi) When the formwork is removed, concrete shall be kept wet for the first seven days of drying in the south of the country whilst a ten-day period is recommended for the north.

(xii) Aggregate size shall be 20mm.

(xiii) Mechanical vibration shall be used in concrete making to eliminate honeycombs and voids. Welding and splicing is prohibited on reinforcement steel and embodiments.

(xiv) Concrete curing time should be 28 days.

(xv) The surface level of mast foundation, guy anchor and tower foundation blocks shall be between 150mm and 300mm above the highest point of the existing ground level.

(xvi) When separate blocks of foundation for each leg of tower are employed, the upper surface of each leg must be at the same level.

(xvii) The upper surfaces of all foundations are to be given a gentle slope to ensure that water run off and shall be further painted with bituminous paint to avoid dampness around the foundation bolts, sole plates and guy attachment steel works.

(xviii) Structural backfill shall be compacted in 225mm maximum layers to 95% of maximum dry density at optimum moisture content. It must have a minimum compacted weight of $1.6kNm^{-3}$.

(xix) The Top of the foundation shall be sloped to drain with a floated finish. Exposed edges of the concrete shall be chamfered.

(xx) If power cables, feeders, grounding tape must pass through concrete base, appropriately sized diameter plastic or asbestos pipe shall be imbedded in concrete works.

(xxi) Where land for structure is limited, grounding tapes and rods may be placed below or to the side of foundation.

11. Reinforcement

a. Main reinforcement bars shall have a minimum concrete cover of 75mm and sufficient auxiliary reinforcement shall be included to minimize the occurrence of cracking while the integrity of the foundation remains intact.

b. Reinforcement in block type foundations shall be for the purpose of ensuring that the total weight of concrete is fully utilized to give the specified resistance to uplift forces.

12. Factors of safety

a. In all cases, the factors of safety for foundations and any component thereof against overturning shall be made for the worst design load condition.

b. In the case of guy anchor blocks, a safety factor of 2 shall be applied to the maximum design guy tension.

c. In calculating the resistance to shear (for the foundation only) the friction between the bottom face of the concrete and the soil shall be taken into account.

d. In the case of guy anchor blocks, the earth resistance in the direction of the horizontal force may be assumed to be utilized, in which case the soil shall be checked against the possibility of shear-friction failure.

e. The soil surrounding the foundation shall not be included in the calculation of resistance to uplift and overturning.

3 (3) EARTHING AND LIGHTNING PROTECTION OF TOWERS AND MASTS

(1) *General*

(a) All masts shall be grounded and the earth resistance measured at the earth terminal block shall be less than 2 ohms.

(b) A lightning air terminal (Faraday Rod) shall be mounted on mast top and a vertical copper earth wire or tape run down the side of one mast leg to ground and connected to the earth at the terminal box.

(c) Due cognisance should be taken of the fact that the most important factor in getting a good earthing is the use of good quality materials for installation. Care should be taken to ensure that the earthing and lightening protection design and methods illustrated in Figure 2.33 and 2.34 of the First Schedule to these Guidelines are followed.

(2) *Earthing*

(a) Earthing and Lightning protection shall be provided in all completed towers sites to protect equipment from damage and personnel from harm which may result from excessive voltages during a lightning strike.

(b) The arrangement shall be such that lightning discharge current shall be prevented from entering equipment rooms.

(c) Equipotential conditions shall be maintained throughout the site by bonding.

(d) Due cognisance shall be taken of the following:

(i) that the resistance achievable in an earth installation is directly proportional to the resistivity of the soil at the depth to which the earth rod has been driven.

(ii) When the soil resistivity of a site is not known it can be measured without excavation by using a direct reading metre and earth spikes.

(iii) It can also be read out from tables if soil type is accurately known.

(iv) Resistivity at any depth is related to the diameter of the earth rod, the target resistance and the depth to which the earth electrode is driven into the soil by:

$$R = (p / 275L) \times \log_{10}(400L / d)$$

Where R is the target resistance p is the resistivity of the soil
L is the length of electrode in metres
d is the diameter of electrode in cm

(v) An accurate assessment of the soil resistivity should be made around the tower base using a direct reading resistance metre to determine amongst other things the appropriate depth to drive in the copper earth rods, the number of rods and the need for an earth mat, amongst other things. Table 2.14 of the First Schedule to these Guidelines contains the Resistivity Values for different soil types.

(3) Lightning Protection

(a) Separate down conductors shall be installed from each air terminal (lightning spike) and in addition, the structure shall also be a return path to the earth.

(b) These two systems shall be bonded together and Lightning spikes shall be long enough to give 45^0 cone of protection over all aerials.

(c) Air terminations shall be made of copper rod, hard or medium – hard drawn, 12mm in diameter and Down conductors shall be made from 25mm by 3mm soft annealed copper strip.

(d) The earth termination shall be independent of the foundation reinforcement.

(e) Where rods are used as earth electrodes they shall be driven into the ground to a depth of at least 2.4m in normal soil or the depth predetermined for the site from measurements.

(f) Longer lengths shall, when necessary, be built up of 1.2m lengths screwed onto each other with internal screw and socket joints.

(g) Where one earth electrode cannot obtain the specified resistance, additional electrodes should be connected in parallel and such additional electrodes may be those provided for other down conductors.

(h) The distance between any two driven electrodes shall be equal to their driven length.

(i) All connections between earth conductors and steelwork shall be via sacrificial legs or brackets where copper would be in contact with concrete and painted with bitumen or separated from the concrete with itemized paper.

(j) Earth conductor runs shall be straight as far as is practicable and where bends are unavoidable shall be smooth and of maximum radius.

(k) The resistance to ground of the earth system shall be below 2 ohms.

(4) Construction of an Earth

The Construction of an Earth shall conform to the following specifications:

(a) Lightning rod shall be clamped to the highest point on the mast.

(b) Ground wire shall be connected to the lightning rod and shall preferably be one continuous piece down to the earth ground rod.

(c) Where, the antenna type does not permit the use of a lightning rod point, the ground wire shall be taped or wire-tied to the mast as far up as practicable.

(d) Ground wire shall run from the tip of the mast and shall be connected to the tower, and then run all the way to the ground.

(e) Copper bond earth rods made up of copper electrolytically bonded onto a high tensile steel core shall be driven into the ground to varying depths dictated by earth resistivity measurements.

(f) Several lengths of the rod may be driven into the ground and each length coupled to the next through coupling threads.

(g) The rod is driven in by hammering on the driving high tensile steel head and each leg of a mast or tower shall have at least one earth rod driven into the ground beside it.

(h) The leg of the mast shall be tied to the earth rod through a flat copper tape.

(i) The number of earth rods driven into the ground at the optimum depth shall be such that is necessary to achieve a suitably low resistance.

(j) Where good grounding cannot be obtained at a reasonable depth, a three metre pit shall be dug and partly filled with layers of carbon, salt and manure and backfilled firmly.

(k) The maximum permissible resistance to earth shall be 2 ohms.

(5) Protective Grounding

(a) Structures shall be directly grounded to a primary ground.

(b) A minimum ground shall consist of two, 1.2 metre long, 16 mm diameter galvanized steel ground rods driven not less than 2.4 metres into the ground, 180° apart and adjacent to the structure base.

(c) The ground rods shall be bonded with a lead of not smaller than 5 mm tinned bare copper connected to the metal base of the structure of each leg of a tower.

(d) A similar ground rod shall be installed at each guy anchor and connected to each guy at the anchor in case of guyed towers.

(e) Self-supporting towers exceeding 1.5 m in base width shall have one ground rod per tower leg.

(f) All the earth rods shall be tied together to maintain an equipotential condition all over the structure while top and bottom ground straps are to be bonded at both ends.

(g) All equipment on a structure such as antennas, antenna supports and warning safety lights shall be connected by a secondary ground.

(h) The earth of the tower shall be bonded to the general earth of any adjoining equipment room and all shall form a single earth.

(i) The maximum permissible resistance to earth shall be 2 ohms.

3 (4) SAFETY DEVICES FOR TOWERS AND MASTS

(1) Safety devices shall be installed on every tower above the height of 45 metres. Safety devices shall comprise of the following:

(a) fall arrest systems
(b) climbing ladders or step bolts
(c) guard rails
(d) work / test platforms
(e) rest platforms
(f) (f) anti-climb systems.

(2) Fall arrest systems

(a) A complete fall arrest system shall consists of the rail and the trolley. The Trolley

(i) Is a locking brake pawl attached to the harness of a climber.

(ii) Moves freely along the Safety Rail with climber in normal climbing position

(iii) In case of a slip trolley brakes remain locked until the force is removed. Falls are instantly arrested when a sudden downward motion is applied to the Trolley. Trolley remains stationary once disconnected from the harness.

(3) *Anti Climb Shields*

(a) Anti Climb shields consist of metal sheets bolted to tower legs. These are constructed to prevent unauthorized persons from climbing a tower. It is ideal for tower sites around schools and public areas where public safety is a concern.

(4) *Climbing Facilities*

(a) *Access Ladders*

(i) Access ladders shall be made from hot dip galvanized steel or aluminium sections mountable on all tower types and monopoles amenable to inside or outside mounting.

(ii) Climbing ladders shall be of steel or aluminium depending on tower material and shall be provided with Safety cages, Landing places (rest and work platforms) and Protective finishes.

(iii) Ladders shall be attached to the tower structure.

(iv) The lowest point on the ladder shall be at a height of 3m to 4.5m above ground level and it shall run all through to the top of the structure.

(v) The ladder shall be so located that a clearance of at least 150mm at the rear of the ladders exists between the ladder and the structure.

(vi) Anti-climbing devices shall be provided on the structure to prevent access except from the climbing ladder.

(vii) The vertical separation between rest platforms shall be 20m.

(viii) Work and test platforms shall be located at those points where antennas are to be installed.

(b) *Platforms – Work / Rest / Test*

(i) All platforms shall be readily accessible from the climbing ladder.

(ii) The access to all platforms and walkways from the vertical climbing ladder shall be from one direction only.

(iii) Platforms and walkways shall be designed to carry a point load of 150kg at any point without a deflection exceeding 6.0mm.

(c) *Guard-rails*

(i) Guard-rails shall be of a height range between 0.9m and 1.1m and shall be provided on all platforms, stairways and horizontal members used as walkways.

(ii) They shall have an intermediate rail at half this height and a toe board not less than 150mm high.

(iii) The distance between any toe-board and the lowest guard – rail above it shall not exceed 750mm.

(iv) Widths of walk-ways and platforms shall not be less than 650mm.

(v) Walk-ways and surface used as working platforms or traversed to gain access to platforms or traversed to gain access to working positions shall be provided with anti-slip surface.

(vi) Guard rails and toe boards shall be attached at each stanchion and secured to prevent rotation.

(5) Safety Enhancement

(a) Safety in the installation and use of masts and towers are enhanced by the following practices which shall be mandatory for all tower owners and installers.

(i) Tower assembly parts shall be standardized e.g. fasteners for the main structure shall be of only one size, length and material.

(ii) Manual handing over of parts or tools between installers during tower construction is prohibited.

(iii) All parts shall be labelled in detail especially where the method of assembling is not obvious.

(iv) Towers shall be structurally designed for simple assembly by the promotion of ease in fittings and elimination of small loose parts.

(v) On-site welding and riveting is prohibited. Owners and installers of mast and towers who engage in these practices shall be liable to pay a penalty to the Commission of a sum amounting to 15% of the cost of the tower.

(vi) All site connections shall be by bolt and nut with a means provided for locking the nut against loosening by vibration.

(vii) All nuts, bolts and washers shall be galvanized for easy assemblage

(viii) Taper washers shall be used whenever the steel section shape requires their use.

(ix) Bolt lengths shall be such that with the locking device in place, a minimum of one complete thread shall protrude beyond the nut.

(x) Bolt threads shall protrude inside the structure only.

CHAPTER FOUR
GENERAL SPECIFICATIONS

4 (1) <u>Towers and Masts</u>

(a) The following specifications apply to communication lattice towers and masts constructed and installed in Nigeria.

(i) The predominant load on tower structures shall be wind load.

(ii) Each structure shall be made of hot dip galvanized steel sections.

(iii) Masts may be guyed or free standing.

(iv) The height of free standing masts shall not exceed 150 metres.

(v) Masts and towers may be installed on a property with the written consent of the owner of the property.

(vi) Mast and towers above 30 metres in height may only be installed with a clearance certificate issued by the Nigerian Airspace Management Authority (NAMA),

(vii) No masts or towers (irrespective of the height) may be installed within 15 kilometres of any airport, or within the proximity of helicopter pads and their approaches without prior approval and permits from NAMA.

(viii) The Armed Forces of the Federal Republic of Nigeria may be exempted from strict compliance with paragraph (vii) above, in times of war. At the cessation

of hostilities, any structures erected under this waiver shall be submitted for reassessment and approval.

(ix) The open space available at the site of a proposed mast or tower installation, shall be, at least three times the space required by the base of the structure.

(x) Each completed mast or tower shall have a name plate bolted to each of its legs on which the following particulars of the fabricator, owner, operator and installer are detailed:

a. Name, address and telephone numbers of the owner, fabricator, operator and installer
b. Permit Number issued by the Commission for erection of the Mast at the location.

(xi) The antenna of each mast or tower shall contain the following particulars:

a. Date of erection
b. Height
c. Number of antenna
d. Operating Frequencies
e. Location address

f. Geographical coordinates
g. Name of operator and licensee
h. Effective Isotropic Radiated Power
i. A log book showing inspection dates and types of inspections performed and detailed particulars of the inspector.

(xii) A permit from and registration with the Commission shall be required for the erection of any Masts or Towers whose height exceeds 20 metres.

4 (2) <u>The Superstructure</u>

(a) Members' Sizes

(i) The sizes of members in compression shall be such that the maximum slenderness ratios are:

Ladder	120
Bracing members	150
Subsiding members	180

(ii) No load-carrying angle bar/lattice shall be smaller than 50 x 50 x 6mm.

(iii) The minimum thickness of gussets and similar plates on the main structure shall be 8mm.

(b) Intersecting Bracings

(i) Where a gusset plate connects bracings that cross, at least one of the bracings shall be continuous between the main members to which it connects.

(ii) Towers and Masts shall be manufactured from the following materials

Steel with hot dip galvanized finish

Stainless Steel with # 4 or # 7 finish
Aluminium - polished, anodized and painted finish

(c) Lattice Structures

(i) Legs -Tubular
-Angular
-Solid Round Leg

(ii) Members -Tubular pipes
-Angles

(iii) Bracing -Angles
-Tubular pipes
-Steel rods

(d) Monopole Structures

(i) Sections -hollow, heavy duty, thick steel pipes
-hollow, heavy duty, flanged steel pipes

(e) Guys

(i) Wires -Extra High Strength stainless steel or galvanised steel cable.

(ii) Earth Screw Anchor -Galvanised steel or stainless steel.

(iii) Thimble -Galvanised steel or stainless steel.

(iv) U-Bolt -Galvanised steel or stainless steel.

(v) Turnbuckle -Galvanised steel or stainless steel.

(vi) Both lattice and monopole structures shall be made from steel for tall, heavy load bearing towers or aluminium for lightweight light duty towers.

(vii) Tower components shall be of the following classification: -

a. All steel members shall be fabricated from Grade 50 or 42, A36 or A 572-50.
b. All steel tubes shall be fabricated from Grade 43C.
c. All structural pipes shall be fabricated from Grade 42 or Grade C steel.
d. Anchor rods shall be fabricated from Grade B7 steel.
e. Rebar shall be fabricated from Grade 400 steel.
f. Diagonals shall be fabricated from Grade 43A steel.
g. Structural Bolts fabricated from Grade A325 steel.
h. Steel angles shall have a minimum strength of 56ksi for tower legs and 36ksi for tower members.
i. Round legs shall be fabricated from schedule 40 pipes.
j. Braces shall be fabricated from Grade A36 or A 572-50 steel

(viii) Guying materials should always conform to the sizes, mechanical strength and capabilities as shown in Figure 3.10 and Tables 3.1 to 3.4 of the First Schedule to these Guidelines.

4 (3) <u>Concrete</u>

(a) Ordinary cement shall be used.

(b) Cement of different types may not be mixed.

(c) High Alumina (HA) cement may not be used for concrete mixing.

(d) Additives that hasten the setting of cement or give a denser concrete shall not be used.

(e) All sand shall be clean, sharp, gritty, and free from loam earth, salt and other impurities like humic acids.

(f) Sand shall not contain more than 15% clay or silt. The sand shall contain grains from the finest sizes up to 4.75 mm. Grains smaller than 0.25 mm in size shall not constitute more than 15% of the total weight of the sand to be used.

(g) Aggregate shall be clean screened river ballast gravel, graded in size and free from dirt, floury stone dust, loam or earth or any other impurities. The maximum size of aggregate to be used shall be 19 mm.

(h) Water to be used for concrete mixing shall be free from oil, salt, and organic substances.

(i) Cement shall have a mixture of 1:2:4.

(j) The concrete shall be thoroughly mixed by machine.

4 (4) <u>Earthing and Lightning Protection Installation Materials</u>

(a) Air Terminals shall be made from copper.

(b) Saddles (ridges, flat, light duty or heavy duty) shall be made from gunmetal or aluminium.

(c) Clamps shall be made from gunmetal or aluminium. Bi-metallic clamps shall be employed when joining aluminium earth rods to copper earth conductors.

(d) Earth bars shall be made from high conductivity copper.

(e) Copper Earth rods shall be made from:

(i) High tensile steel core with copper film electrolytically bonded to it to a minimum thickness of 0.25mm.

(ii) Solid copper earth rods for extremely high corrosive environments U-bolts could be of copper but with gunmetal back plates.

(f) The earthing and lightening protection installation materials referred to above shall conform to the illustrations in Figures 3.1 to 3.9 of the First Schedule to these Guidelines.

4 (5) <u>Metals and Galvanising</u>

(a) The following metals and alloys shall be used in tower fabrication, construction and for foundation reinforcement: -

(i) Magnesium
(ii) Zinc
(iii) Aluminium
(iv) Lead / Tin
(v) Brass / Copper / Bronze
(vi) Silver
(vii) Graphite

4 (6) Antenna Mounting Frames

(a) Frames for mounting antennas on towers or masts shall be designed upon consideration of the type of tower structure and the type, weight and size of the antenna.

(b) The frames shall be made from galvanised steel, stainless steel or aluminium and care shall be taken to ensure that there are no welded parts, and that bolts and nuts are not used for implementing joints.

(c) The basic designs for some tower structural forms and the frames for mounting antennas shall be as illustrated in Figures 3.11 to 3.16 of the First Schedule to these Guidelines.

CHAPTER FIVE
MAINTENANCE AND TESTING

5 (1) First Line Maintenance

(a) When carrying out first line maintenance, due cognisance shall always be taken of the following factors:

(i) The worst case scenario of a total mechanical failure is assumed in tower design.

(ii) Mechanical failure can be caused by stress, extreme overload, use of defective and poor quality materials, fatigue, corrosion, poor workmanship, insufficient maintenance, sabotage, as well as any combination of these factors.

(iii) Every design must attempt to foresee all possible combinations of these that can occur in the installation environment and incorporate protective answers to them in the design.

5 (2) Hot Dip Galvanization

(a) For all purposes of maintenance, due consideration shall be given to the followings facts:

(i) Unprotected steel can be seriously damaged due to environmental factors including rain, salty/humid air and extremes of temperature.

(ii) Corrosion transforms steel back to its natural state of iron, a transformation which is unsuitable for structures like towers. The best way to avoid this is through "hot dip galvanization" which is the process of dipping steel in melted zinc at 450°C allowing an alloy to form where pure zinc prevails to the outside.

(iii) The difference of electrochemical potential between zinc and steel (cathodic protection) ensures that a zinc coating protects steel in such a way that slight exposure of surfaces as a result of cutting, scratching or piercing is protected against corrosion.

(iv) That the greatest effect is produced by silicon in concentrations higher than 0.12%.

(v) Most steels can be galvanized: high-strength steel, low-carbon steel, low-alloy steel, and steels with as much as 0.20% copper content; the most appropriate being low-carbon steels.

5 (3) <u>Tower Maintenance</u>

(a) In the maintenance of towers, attention shall be given to the following best practices:

(i) Towers require regular maintenance for purposes of early detection of deterioration and as a mandatory measure to prevent breakdowns and the attendant consequences.

(ii) Regular maintenance is especially important for the purposes of public safety, network availability, environmental aesthetics and life time quality of the structures.

(iii) Maintenance and inspection of steel towers and antenna supporting structures should be performed by the owner on a routine basis.

(iv) Major inspections shall be performed at least once in every 3 years for guyed towers and every 5 years for self-supporting towers PROVIDED that the first thorough check of the structure should be carried out 6 months after its installation and erection.

(v) Shorter inspection intervals of 2 years for guyed towers and three years for self-supporting towers shall be obligatory for structures in coastal salt water environments, in corrosive atmospheres, and in areas that are prone to vandalism.

(vi) Ground and aerial procedures should be performed only by authorized personnel, experienced in climbing and tower adjustments.

(vii) All structures shall be inspected immediately after severe wind conditions like tempest, hurricane, tornado, and after the installation of an additional load like antennas on the structure loading conditions.

(viii) At every tower site, the owner shall keep a maintenance log book in a thick cellophane folder. The folder shall be readily accessible to inspectors from the Commission or any duly authorised person and shall contain the following information: -

a. Installation Date
b. Inspection due dates
c. Painting due dates

d. Minor Maintenance due dates
e. Major Maintenance due dates
f. Name and address of Inspector

(ix) For each of the due dates, the log shall show that the inspection or the maintenance was carried out and by whom.

5 (4) <u>Routine Checks</u>

(a) The following routine checks shall be carried out during the service life of the Structure.

(i) *Main structure*

a. Check that there are no structure components missing.
b. Check that bars are neither warped, holed nor spitted and replace all defective parts.
c. Check structure components for corrosion.
d. Check that draining holes on pipe leg members, pipe lattice parts are not blocked.
e. Check the climbing facilities, platforms, catwalks for integrity

(ii) *Tower Base Foundation*

a. Check for settlements or movements
b. Check for erosion
c. Check general site condition (standing water, drainage, trees etc.)
d. Check bolts, nuts and lock nuts for tightness
e. Grout condition

(iii) *Guy wires*

a. Check that each cable that is part of the guy wire is neither broken nor warped
b. Measure the tension of each guy wire using a strand dynamometer and compare result with the installer's stated values.
c. Check guy wires condition (corrosion, breaks, nicks, kinks, etc)
d. Check that the guy wire tightening system is properly greased.
e. Check for loose or missing fasteners
f. Check base for settlement, movement or earth cracks
g. Check backfill heaped over concrete for water shedding
h. Check anchor rod condition below earth
i. Check for signs of corrosion and take remedial timely steps
j. Ensure anchor head is clear of earth

(iv) *Bolting parts*

a. Check that no bolts or nuts or any bolting part like washers, pins, etc is missing. Replace these immediately.

b. Check bolts tightening.
c. Check bolts, nuts and bolting parts for corrosion.
d. Check anchorage rod in the concrete.

(iv) *Verticality*

a. Check with the appropriate devices such as theodolite that the structure stands in a vertical position.
b. There shall be no tilts. Take two measurements in two different planes with a 90° angle difference.

(v) *Antennas and Accessories*

a. Check antennas and antenna supports
b. Check coaxial cables
c. Check fixing clamps.

(vi) *Safety components*

a. Check that access ladder is in good condition
b. Check rest and work platforms for defects, wear and tear
c. Check that all safety components are existing and complete
d. Check the correct functioning of the fall arrestor system
e. For a fall arrestor system with cable, check that the cable has not been over tightened.
f. Check that the anti climbing door is functioning.

(vii) *Lightning and Earthing system*

a. Check that all lightning and Earthing components are existing and complete including lightning arrestor, copper strip, connection plate,
b. Check the Earthing connection of coaxial cables,
c. Measure the resistivity of the Earth and confirm conformity to expected values.

(viii) *Aviation Safety Lights*

a. Check that all components are in place,
b. Check condition and proper functioning of components (Light bulb, energy cables, fixing parts, photoelectric cell, connections)
c. Check earthing of the light wiring.

(ix) *Anti corrosion protection*

a. Check all galvanised members for integrity
b. Check paint condition.
c. Check for signs of corrosion on the structure, of the bolts, bolting accessories, harnesses, antenna supports, etc.
d. For guyed masts, check for corrosion on the entire guy assembly.

(x) *Salty environment*

a. Wash the structure and accessories with clean water once every six months to eliminate residue salt particles which may not be washed away by rain.

(xi) *Concrete blocks*

a. Check the good condition of above ground concrete block parts.
b. There must not be any water collection, cracking or splitting, chipped or broken concrete.
c. Check the condition of anchor setting in the concrete block.
d. Check anchor-bolt corrosion.

(xii) *Tower loading*

a. Check types, numbers and installed heights of all antennas currently on the structure and confirm that the loading does not exceed structure design load.

5 (5) <u>Annual Preventive Maintenance Checks</u>

(a) The following Annual Preventive Maintenance Checks shall be carried out during the service life of the Structure.

(i) *Structure*

a. Tension of Guy wires using a dynamometer.
b. Geometry of the structure.
c. Re-tighten main structure and accessories bolted parts (10%)
d. Geometry of the Bars.
e. Rigidity of Antennas and Accessories.

(ii) *Safety*

a. Ensure that anti climb door can open and close. Clean and grease all hinges.
b. Ensure the work platform's trap can open and close. Clean and grease all door hinges.
c. Check the fall arrestor system
d. Check tower ladder for any signs of weakness, re-tighten all bolts
e. Check the riggers' safety gear, take inventory and record it
f. Check the positioning and installation of safety components.
g. Test the fall arrestor system with individual equipment.

(iii) *Earthing*

a. Check the physical condition of the lightning rod and lightning arrestor
b. Check the physical condition and installation of the copper strip

c. Check the connection of the concrete block copper belting onto the copper strip the connection of coaxial cables earthing onto the copper strip
d. Check the connection between the bottom coaxial cable earthing and the collection Copper bar fixed on the concrete block
e. Check the tightening of the brass bolts of the lightning protection electrodes
f. Check the resistivity of the lightning protection electrodes
g. Earth resistance

(iv) *Aviation Safety Lights*

The following checks should be carried out:

a. Functionality of controllers, flashers, alarms and photo control
b. Condition of electrical wires, connectors and earthing
c. Condition and fixing of energy cables
d. Conduit, junction boxes, and ensure fasteners are weather tight and secure
e. Bulb condition - change all bulbs at the same time immediately before the rated service hours are achieved.
f. Condition and fidelity of the power supply systems

(v) *Coating*

a. To prevent discrepancies in galvanization
b. Paint coating. Repaint every three years
c. Rust and/or corrosion conditions
d. ICAO / NAMA Colour marking conditions
e. Water collection in members - unplug drain holes, etc.

(vi) *Log Book*

a. A Log Book shall be maintained in which all maintenance checks made will be documented.
b. The contents of the Log Book shall include: date of checks, what was checked, observations of the check, and name and signature of the personnel that conducted the check.
c. The Log Book shall be made available to the Commission or its due representative on demand.
d. Failure to keep or make a Log Book available to the Commission as above shall constitute an offence.

5 (6) <u>Testing</u>

(1) <u>Measurement of Guy Tension</u>

The following best practices should be observed in the measurement of guy tension.

(a) Tension should be measured when wind is relatively still given that Measurements in wind velocity above 25 m/s (90km/h) will yield misleading results.

(b) Tension results can be considered satisfactory if they fall within 15% of the tension value stated by the manufacturer and/or installer.

(c) Excessive tension may cause alignment problems, cable rupture and may even cause permanent wrapping of tower structural parts.

(b) There are two basic methods of measuring guy tensions in the field:

2. The Direct Method

a. A dynamometer (load cell) with a come-along (length adjustment device), is attached to the guy system by clamping onto the guy just above the turnbuckle and onto the anchor shaft below the turnbuckle, thus making the turnbuckle redundant. The come-along is then tightened until original turnbuckle begins to slacken. At this point the dynamometer carries the entire guy load to the anchor, and the guy tension may be read directly off the dynamometer dial.

b. This method is used to set the correct tension by adjusting the come along until the proper tension is read on the dynamometer.

c. Two control points are marked, one above the clamping point on the guy and one on the anchor shaft, and the control length is measured. The dynamometer and come-along are then removed, and the original turnbuckle is adjusted to maintain the control length previously measured.

d. The measurement of guy tension under the direct method shall be in the manner illustrated in Figure 4.1 of the First Schedule to these Guidelines.

3. The Indirect Method

a. Where guy initial tension is to be measured by the indirect method, two common techniques - the pulse or swing method (vibration) illustrated in Figure 4.2 of the First Schedule to these Guidelines, and the tangent intercept method illustrated in Figure 4.3 of the First Schedule to these Guidelines may be used.

CHAPTER SIX

ENVIRONMENTAL REQUIREMENTS

6 (1) Height

(a) The maximum height for a communications tower shall not exceed 150 metres.

(b) Notwithstanding sub-paragraph (a) above, a tower, exceeding 150 metres in height, may be approved by the Commission if it is satisfied that the increased height of the tower:

(i) Will not be detrimental to public health, safety or general welfare.
(ii) Will not have negative effect on the neighbourhood.
(iii) Is in conformity with the plan of the particular area and the general plan of the community.
(iv) Will not impair compliance with any other applicable laws or Guidelines.

6 (2) <u>Space requirements.</u>

(a) The siting of towers shall conform to the following space requirements:

(i) Any tower site shall be served by a parking/loading space.

(ii) Any tower site lying 50 metres or less from a paved road shall be paved.

(iii) Where a tower site is more than 50 metres from a paved road, hard-surfacing of the parking/loading spaces and driveways shall not be required for those portions of the site lying more than 50 metres from any paved road.

6 (3) <u>Screening</u>

(a) The screening of communications masts and towers shall in all cases conform to the following:

(i) The base of all communications towers shall be surrounded by an opaque screen of at least 2.5 metres in height.

(ii) The screening shall also include landscaping provisions for any portions of the development visible from adjacent residential or used property or right of way.

(iii) The use of barbed wire or other security fencing material may be allowed.

(b) Screening requirements provided above, may be waived if the design of the tower is found to be compatible with the adjacent land uses.

6 (4) <u>Removal of abandoned towers</u>

(a) A tower that has not been used for a continuous period of three years may be deemed to have been abandoned.

(b) Where the issue of abandonment is in issue, the Commission may request appropriate documentation from the owner/operator to determine the effective date of abandonment.

(c) Upon the determination of abandonment, the Commission shall issue a removal notice to the owner, whereupon the owner shall dismantle and remove the tower from the property within 90 days of the receipt of notice from the Commission.

(d) An abandoned tower that is not removed within the 90 day period may be removed by the Commission and the removal costs as well as a minimum penalty of two hundred and fifty thousand naira shall be paid by the owner to the Commission.

6 (5) Inspections

(a) All towers shall be subjected to inspection at least once in every six months, to assess the structural condition of the tower and support equipment by a qualified tower inspection service provider engaged by the Commission.

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(b) Owners of towers which fail to meet the required inspection standards will be notified and required to remedy the situation within 30 days failing which the owner shall pay to the Commission a penalty of 20% of the cost of the tower.

6 (6) Authorization

All towers and masts shall be erected and operated in compliance with such Guidelines as may from, time to time, be prescribed by the Nigerian Communications Commission and Nigerian Airspace Management Authority.

6 (7) Shared Use of Towers and Masts

(a) The design, construction and installation of towers over 25 metres, shall be done in such a way as to accommodate a minimum of three service providers using the same structure.

(b) Owners of Towers shall in furtherance to sub-paragraph (a) above, provide written certifications to the Commission that such towers are available for use by other communications service providers on a reasonable cost and non-discriminatory basis, and modalities and conditions for such shared usage.

(c) Where any serious disagreement or dispute arises that threatens the shared use of facilities, the Commission shall arbitrate over the dispute and any decision so reached by the Commission shall be final.

(d) For the avoidance of doubts, the sharing of towers and masts in these Guidelines shall be subject to the provisions of the Collocation and Infrastructure Sharing Guidelines of the Commission.

6 (8) Fencing

(a) Security fencing, where installed, shall be a wrought iron, barbed wire, or steel chain link fence with evergreen hedge or a masonry wall not less than 1.8 metres in height.

(b) The exterior of equipment buildings and/or metal equipment cabinets visible from residential areas or public right of way, shall be painted to reflect the colour and character of adjoining structures or blend with adjacent landscaping and other surroundings.

6 (9) Setbacks

(a) All towers as well as guys and guy anchors shall be located within the build-able area of the property and not within the front, rear, or side building setbacks.

(b) All towers in excess of 150 metres in height shall be set back by a minimum of 50 metres from the right of way of all controlled access, federal and state roadways designated as freeways, in order to provide unobstructed flight paths for helicopters.

(c) In all other cases, the distance for setbacks shall be as follows:

(i) 10 metres from any demised property excluding the fence

(ii) the distance specified as a potential hazard area by the designer of the structure.

(iii) Guy wire anchors and accessory structures shall not encroach into the mandatory setbacks listed above.

6 (10) Signage

(a) No signage, lettering, symbols, images, or trademarks in excess of 1200 cm^2 shall be placed on or affixed to any part of a tower, mast, antenna or antenna array fencing other than as required by the Commission for the purposes of identifying the operator.

(b) No adverts shall be allowed on any of the communications structures stated in sub-paragraph (a), above.

(c) Adverts placed contrary to sub-paragraph (a) and (b) above shall be removed by the Commission and the cost of removal shall be borne by the owner of the tower.

6 (11) Lighting

(a) Towers shall only be illuminated as required by NAMA and/or the International Civil Aviation Organisation (ICAO).

(b) No signals, lights or illumination of any kind shall be permitted on or directed towards any tower unless as required by the NAMA or any other appropriate public authority.

(c) Security lighting around the base of a tower must be shielded so that no light is directed towards adjacent properties or rights-of-way.

6 (12) Obstruction Lighting

(a) purpose of obstruction lighting and marking is to ensure that an obstruction to air navigation remains visible at a range sufficient to permit a pilot to take appropriate action in order to avoid the obstruction by not less than 305m vertically within a horizontal radius of 610 metres from the obstruction. A typical obstruction lighting kit shall include the following:

i. Light with bulbs of a minimum of 10,000hrs service life
ii. Junction box
iii. Photo sensor
iv. Power cable (in conduit and armoured)
v. Weather proof Light flasher. Flash rates of 40/min are allowable typical values.

vi. Assembly hardware such as U-bolts and connection bolts

(b)The obstruction light must be supplied with uninterruptible power supply in form of battery, solar energy or any other technology to ensure that lights are on during mains power outage and from 6pm to 7am. Aviation lighting gear should be designed to have minimal serviceable components so as to reduce the problems associated with regular climbing of towers to service lamps.

(c) Owners of mast and towers who do not comply with sub-paragraph (a) to (c) above, shall be liable to pay compensation for accidents occurring as a result of such omissions.

6 (13) <u>Tower to Tower Spacing</u>

(a) The minimum spacing between two or more towers in excess of 55 metres in height shall be 1 (one) kilometre.

6 (14) <u>Nearness to Power Lines</u>

(a) No tower or mast shall be installed in close proximity to High Voltage electrical power transmission lines. The nearest distance of a tower to a High Voltage electrical power transmission line shall be the equivalent of 120% of the height of the mast.

(b) Owners of mast and towers installed in contravention of the above specifications shall bear the cost of removal of such towers.

6 (15) <u>Alternative Mounting Structures</u>

(a) Alternative Mounting Structures 30 metres or less in height may be permitted in residential areas. However, Alternative Mounting Structures in excess of 30 metres in height may be permitted in non-residential areas.

(b) Alternative Mounting Structures must be similar in colour, scale and character to adjoining buildings or structures or blend with the landscaping and other surroundings immediately adjacent to them so as to generally avoid the creation of unique visual objects that stand out in the environment.

6 (16) <u>Antenna Mounts</u>

Antenna mounts must have structural integrity so as to guarantee public safety. To this end, the following specifications shall be strictly adhered to;

(a) Whip and Panel Antenna Mounts

(i) Individual communications antennas may be permitted on existing low tension electric utility poles, light standards, and towers in excess of 12

metres in height, provided that the total length of any antenna does not exceed 15 percent of the height of the existing structure.

(ii) Communications antennas and arrays are not permitted on existing high tension electric transmission towers.

(iii) Panel and whip antennas may be permitted on billboard structures.

(b) Dish Antenna Mounting Standards

(i) Ground mounted dish antennas in excess of 1.5 metres in height shall be screened from roadways and adjacent property by a minimum of 1.8 metre high screening fence.

(ii) Building and roof mounted dish antennas of one (1) metre or less in diameter, are permitted in all areas. No permits are required for this category

(iii) The Commission may permit building/roof mounted dish antennas in excess of one (1) metre in diameter, to be placed on buildings on the certification of a structural engineer to the effect that the building can withstand the additional load.

CHAPTER SEVEN

APPLICATION TO THE COMMISSION FOR PERMITS

7 (1) Any person erecting a communications mast or tower which height exceeds 20 meters shall be required to obtain a permit from the Commission before such mast or tower is erected.

(2) Applications to the Commission for permits required under sub-paragraph (1) above shall be accompanied by the following documents:

a. A Site Plan showing the location of the proposed structure in relation to adjoining structures.

b. Evidence of ownership of the property on which the structure is to be installed or a written consent of the owner.

c. The geographical coordinates of the proposed location of the structure and that of the nearest airport, heliport or helipad or alternatively, a permit issued by the NAMA for the erection of the structure in the proposed location.

d. A design of the structure showing its effective height, foundation, guys (where used), members, ladders, rest and work platforms, earthing, lightning protection and aviation lighting.

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e. Detailed information on the software package used in the design to enable easy verification of the fidelity of the design of the structure.

PART III

TECHNICAL SPECIFICATIONS FOR THE DEPLOYMENT OF FIBRE

CHAPTER EIGHT

8 (1) General requirement for Network Design and Planning

a. The design shall take into consideration the connection of all buildings within a New Development with public networks. The design shall be based on a customer demand forecast that takes into account the various types of occupants of the New Development and the services they may require.
b. The design process shall consider both, the short term and long term requirements of the New Development including lot density, terrain and site usage (e.g. residential, commercial, industrial, or governmental use). All infrastructures shall be based on demand forecasts of not less than 10 years to reduce delays in provision of service to customers and to avoid future disturbance to the public.
c. The requirements for reserve capacity must be adhered to, so that sufficient duct capacity is constructed for current and the future service requirements.
d. Due consideration shall be given at the planning stage to the location of existing underground infrastructure and to the planned provision of other underground utilities to ensure the safety of both the public and other utility providers' infrastructures.
e. All civil works route designs shall consider future developments in the area to avoid the need for any additional digging. This includes the needs of neighboring New Developments and extending routes to the boundaries of the New Development to connect to other future New Developments.
f. The figure below shows a schematic diagram of a typical network and the demarcation points between the backbone network, Metro Fibre network (including feeder and distribution), Access network and In-building Physical Infrastructure (IPI):

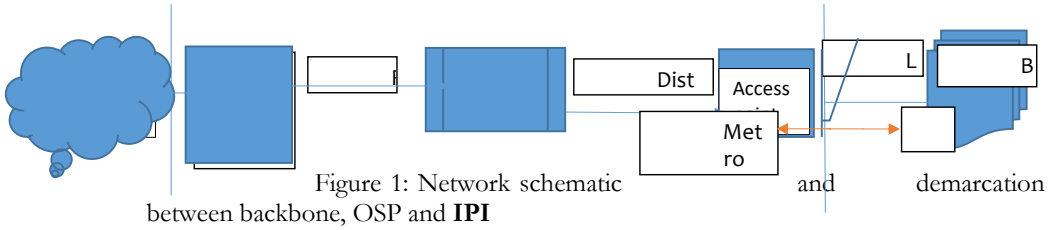

Figure 1: Network schematic and demarcation between backbone, OSP and **IPI**

8 (2) Passive Network Components

(a) Passive Network Components in Fibre optic installation shall enable the construction of, and facilitate the integration of existing, networks in new developments that can be used to connect customers to the public communications networks. Only future-proof technical solutions shall be implemented in order to provide for services like High-speed Broadband Internet or Multimedia Services. The network shall be designed and constructed in accordance with this national standards as well as recognized international standards.

b) In the event reference is made to international specifications (ITU-T, ISO/IEC, etc.), the latest version shall apply.

8 (3) Fibre Optic Standards

The following features shall be taken into consideration when selecting Fibre Optic Cables:

a. All Fibre Optics Cables (FOCs) must meet the requirements of ITU-T Recommendations: Performance specifications for standard single mode Fibre Optics (ITU-T G.652) or improved internationally accepted standards.
b. Each Fibre Optic Cable must be distinguishable from other Fibre Optic Cables in the same duct by means of color coding ink or non-removable label visible throughout the design life of the cable.
c. Each cable shall have traceability of each optical Fibre back to the original Fibre manufacturers serialized Fibre number and measured Fibre parameters.
d. Fibre Optics chosen shall have a high level of splice compatibility with Fibre Optics from other manufacturers.

8 (4) Fibre Optic Cable Standards

a. The FOC must be circular in cross section and free from pinholes, joints, repairs and other defects.
b. Materials used in the construction of the FOC shall not affect the physical or optical properties of the Fibres. All materials used shall be compatible with each other.
c. FOCs shall be marked and labelled at each Manhole and at all entry and end points of the Fibre Optic Cables.
d. Regarding bend-insensitiveness of single-mode Fibres for distribution networks and customer premises, ITU-T G.657 shall be followed.
e. Upon installation, Optical Time Domain Reflectometer (OTDR) measurements shall be performed.

The following minimum numbers of Fibres per Fibre Optic Cable shall be used for all

new metro Fibre installations:

Table 1: Minimum number of Fibres

Feeder	Distribution	Lead-in
48 Fibres	12 Fibres	4 Fibres per unit

8 (5) Slack

a. The slack on the drop cables may be about 7m in Manholes. Cables that span the inside of buildings between distribution frames are recommended to have about 7m slack at each end.
b. Depending on the local situation, the final length of the slack shall be subject to the specific project design that shall guarantee sufficient slack.

8 (6) Duct Standards

a. The standard ducts, Corrugated Optic Duct (hereafter called "COD") and bends shall be made from material consisting of High Density Polyethylene (HDPE) in accordance with internationally recognized standards. The ducts shall be ribbed inside.
b. The standard sub-ducts including micro COD shall be made from High Density Polyethylene (HDPE), in accordance with internationally recognized standards. The sub-ducts shall be ribbed or silicone coated inside and shall be capable of accommodating Fibre Optic Cables or act as lead-ins to buildings/customer premises.
c. The outer corrugate ducts and inner ducts must be bonded so that the inner ducts do not separate from the exterior when temperature changes.
d. The ducts shall be marked and labelled at each manhole and at all entry and end points.
e. The following minimum size of ducts as contained in Table 2 below shall be used for all new metro Fibre installations:

Table 2: Sub-duct Sizes

Duct Type	Feeder	Distribution Until Access Point
Dimension (inner diameter)	50 mm	20 mm
Thickness (mm)	+/-3.25	+/-2.00
COD Dimension (inner diameter)	28mm, 32mm, 36mm, 50 mm	10mm,12mm,14mm, 20 mm
COD Thickness (mm)	3.0mm +/-0.5	2.0mm+/-0.5

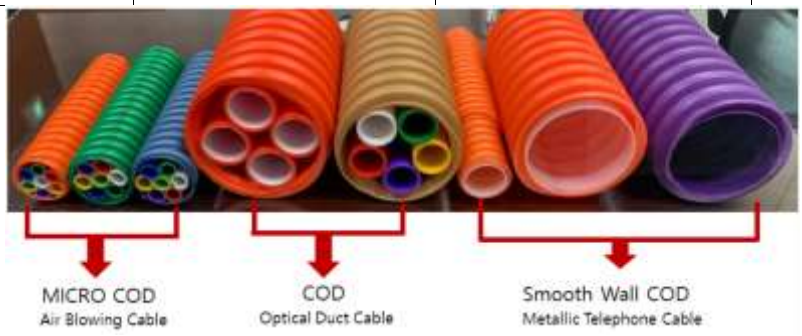

Figure 2: COD standard shape

f. The ducts and bends shall be suitably marked at an interval of not more than one meter with the duct number.
g. The duct laying shall be done in accordance to the technical standards in this Guidelines.
h. The line of ducts installed in the ground shall be straight and parallel to the center line of the road. Where it deviates, a proper bending radius shall be provided in line with the specification of duct bending see 2.2.2 (h) and (2.2.7(d). All bending in duct shall be cold formed, without use of artificial heat.
i. All ducts shall be sufficiently flexible to provide a minimum bending radius. The minimum bending radius shall be 20 x outer diameter of the duct or 25 x outer diameter of the COD or according to manufacturer's specification. Prefabricated bends shall have bend radii in accordance with paragraph 2.2.7 (d).
j. The duct formation shall be maintained between manholes. The use of bundles, flatliners, sub-ducts may support maintaining the duct formation and save space.
k. Sub-ducting systems may be used to increase the utilization of primary ducts and to improve the protection provided to individual cables. Different colors shall be used to identify each sub-duct running in a primary duct.
l. Duct size coupler may be used. In one duct span, maximum one coupler shall be used. A proof of air tightness shall be made.

8 (7) Duct Numbering and Colour Coding

a. The numbering of ducts shall start from top left to bottom right. Sub-duct numbering shall be from bottom to top.

b. Where sub-ducts or pre-formed duct bundles are used, they shall conform to a uniform colour code. Sub-ducts or duct bundles shall have the following colours as indicated in Table 3 below:

Duct	Colour
1	Black
2	Red
3	Purple
4	Grey
5	Blue
6	Green
7	Orange
8	Yellow
9	White
10	Pink
11	Brown
12	Light Green

Table 3: Duct colours

c. Subsequent sub-ducts shall have stripes or all colours
d. Figure 3 below shows examples of the numbering scheme and colour code for sub-ducts or duct bundles.

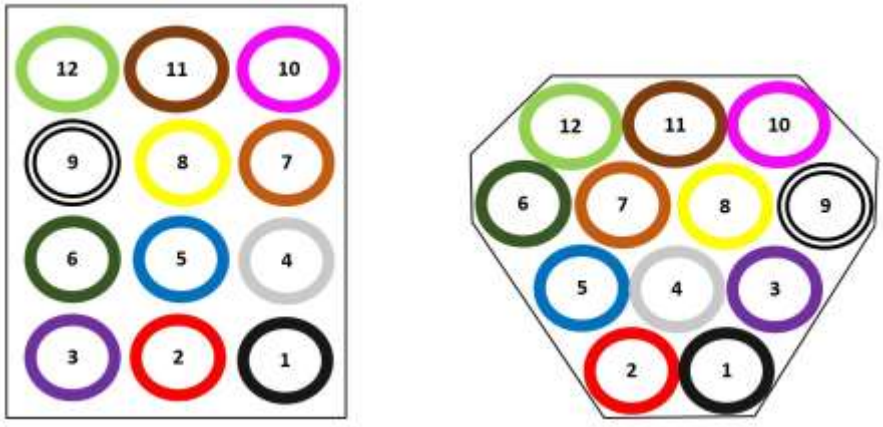

Figure 3: Duct colour

f. Cables placed in ducts shall be racked in the manhole in a sequential order from the floor up. Lower joint locations shall be used first.

8 (8) Ducts & COD Laying

a. HDPE (insert full meaning) ducts are typically delivered on cable drums or coil roll and are fitted with a connector or socket at one end to join the lengths. Each duct length has a socket at one end that will accept the barrel of the duct.
b. Suitable collar ducts may also be used to connect short lengths of duct which have no socket.
c. Ducts shall be placed in the center of the trench and shall be straight and in correct alignment.
d. Ducts may be laid as a single duct or in a multi-duct formation. Multi-ducts shall be laid in rectangular formation.
e. When multi-duct formations are installed in one trench, the largest ducts shall be installed at the bottom of the trench.
f. Ducts length shall be measured precisely on site between the two manholes and shall be cut to required sizes on site.
g. When pulling sub-ducts, the lowermost outside available primary duct should be selected. The sub-ducts should be extended 10 cm beyond the primary duct into the manhole.
h. For empty lots on a route, ducts shall be laid up to the property boundary and shall be properly closed with an identification marker placed over them. The ducts shall be extended to the customer wall or to the communications room when the lot is developed.
i. The Developer providing the metro Fibre infrastructure shall coordinate the location of the ducts at the property boundary and the placement of the lead-in ducts with the owner of the property.

Figure 4: Field trenching and installing

Commented [p7]: Confirm from TSNI if table is necessary

8 (9) Laying and Jointing

1. *Single Ducts*

b. The duct sections shall be jointed together in compliance with the manufacturers jointing system and shall result in a continuous smooth internal surface free from sharp edges and protrusions. The duct shall be laid on the trench bottom and the spigot end and the inside of the socket of the ducts to be jointed shall be thoroughly cleaned.

c. The spigots and sockets of a duct are so designed that, taking into account all manufacturing tolerances, the spigot will start to engage with the socket at a point between 1/3 and 2/3 of the socket depth. Two spigot markings are provided on the duct to show the maximum and minimum insertion depths. The minimum marking must be at least level with the socket.

Commented [p8]: The minimum marking must be at least level with the socket. Confirm from TSNI.

d. When jointing short lengths of duct together with a collar duct the spigot ends shall be given a liberal coating of a suitable sealing compound and then fitted into the collar so that they butt together at the midpoint.

2. Multi-way

a. The jointing of ducts, sub-ducts and duct bundles shall be as outlined in paragraph 2.2.5.1 above.

b. The first layer of ducts (or duct bundles) shall be laid on the prepared trench bottom so that their outer surfaces touch each other. The ducts may be at a distance of 2metres for ducts and 5 or 10meters for COD.

c. Concrete or earth free from stones shall be placed to fill the spaces between the ducts and the next layer of duct when the latter is bedded down.

3. Alternative Method of Jointing and Laying

Ducts may be joined above ground and fed into the trench from one end, provided space permits.

4. Pre-formed Duct Bends

a. All bends shall be of the same material as the duct or duct bundles to which they connect.

b. Pre-formed bends shall be used for all types of short run ducts and the short run may be bent with less than 10 degrees only, while pre-formed duct bends shall only be used at the end of duct lengths for building or manhole entries or house lead-ins.

c. Pre-formed duct bends may be used for duct routes between manholes.

d. No more than two ninety (290) degree (or equivalent) bends shall be installed in the duct between any two manholes.

Commented [p9]: Contact (HIT)TSNI to confirm the 290 degrees

e. The minimum curve bend radii for ducts between two manholes are indicated Table 4 below:

Table 4: Duct Curve

Duct Type	Long Run (> 100 m)	Short Run (< 100 m)
100 mm	500 mm	800 mm
50 mm	800 mm	300 mm
25 mm	not applicable	300 mm

f. To change the direction of a 100 mm duct in a long run, combinations of bends with angles of: 30° x 5m radius or 45 ° x 5m radius may be used.

8 (10) Protection against Entry of Material

A suitable plug shall be inserted at the end of each bore (or "way") of a duct to prevent the ingress of water and/or other foreign matter. The plugging mechanism or material shall be readily removable to allow for future sub-duct or cable installation.

8 (11) Cleaning and Testing

a. On completion of the duct line or bundles (including compaction of the backfill and prior to surface reinstatement like asphalting) between any two manholes, or sites thereof, a cylindrical brush followed by a UPVC mandrel shall be passed once through each "way" to test the installed duct and to remove any foreign matter that may have entered.

Commented [p10]: To get full meaning

b. The mandrel shall have a minimum diameter of 80% of the internal duct diameter.

c. Where any defect is discovered during the cleaning and testing, it shall be repaired forthwith.

d. After all operations are completed, including the repair of the duct where necessary, the joints of all ducts shall be tested to ensure that they form an effective seal (e.g. air tightness test, foam sponge, mandrel, pressure tests). Any such defects shall be repaired forthwith.

8 (12) Draw Rope

The use of draw ropes is an option to support future deployment of FOC or sub-ducts by pulling. Where draw ropes are used, they shall conform to the following specifications:

a. Draw ropes shall be threaded through and left in every bore (duct way) with sufficient surplus to enable future cabling or sub-ducting operations and may be jointed together to make up the necessary length between jointing chambers/manholes.
b. For lead in ducts, the rope shall be attached to the duct seal rope anchor or the plug pressure anchor eye.
c. It is prohibited to fit a rope through a duct seal.
d. Draw rope for any duct shall be rated at a minimum of 550 kg.

8 (13) Duct Seal

a. Ducts (including sub-ducts and duct bundles) shall be sealed within each manhole/handhole, so as to prevent the ingress of water between the outside of the duct and the manhole/handhole and the ingress of gas, water and vermin through the ducts.
b. Breakthrough into a building/customers' premises shall be performed carefully, in compliance with good engineering practices and any conditions or specifications regarding right of way or works instructions issued.
c. All duct sections between a building and the first manhole shall be gas-tight and watertight.
d. Lead-in ducts into customer premises shall be sealed at the end within the manhole and building / customers premises.
e. Uncabled ducts ending in a street cabinet shall have a suitable plug.

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2.2.12 Pulled Joints

Figure 5: Duct accessory

Where a duct joint or joints has pulled apart, short lengths of ordinary or split duct may be inserted in the duct line to establish satisfactory joints.

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8 (14) Minimum Number of Ducts and Fibres

a. The final design shall take into account the specific needs of residential, governmental, commercial, industrial, or special purpose New Developments.
b. The following minimum requirements shall be met in any case:
    i. At least 2 x 2 ducts or 1 x 4 ducts (two of them being reserve capacity) shall be installed in the feeder and distribution networks.
    ii. Fibre Optic Cable with 144 Fibres each may be used in the design and only one (1) Fibre Optic Cable will be installed in one duct. Where more than one (1) cable is to be installed in one duct, sub-ducts or duct bundles may be used.

CHAPTER NINE

FIBRE BACKBONE INSTALLATION

9 (1) General requirement for Fibre backbone installation

a. The optical Fibre shall be installed on a 20 to 50 cm strip at a distance of between 0 and 5m from the edge of the carriageway, thus remaining strictly within the right of way on all the Nigerian Highway road sections carrying optical Fibre.
b. The requirements for reserve capacity must be adhered to, so that sufficient duct capacity is constructed for current and the future service requirements.
c. All civil works route designs shall consider future developments in the area to avoid the need for any additional digging. This includes the needs of neighboring New Developments and extending routes to the boundaries of the New Development to connect to other future New Developments.
d. Backbone and metro Fibre cable installers shall adhere strictly to the "Dig Once," rule. A Fibre cable installers who is the first to dig up rights-of-way installs excess conduits or ducts for future cable plant installation. A minimum of 4 ducts or conduits is required.
e. The standards to-be followed for selection of cables for backbone network shall be, ITU-T G.652.D.
f. Infrastructure Sharing- The telecom infrastructure shall be built from a futuristic perspective, service providers shall opt for sharing of laid infrastructure so that it results to reduction in cost.
g. Fibre backbone infrastructure shall be designed to support speeds of 100 Gbps.
h. The minimum number of Fibre Optic Cable core capacity shall be 96 cores.
i. During planning, Right of Way (RoW) approval should be obtained from the requisite authorities.

Commented [p15]: Note requirements for reserve capacity

Commented [p16]: Need to find the Dig Once Policy/Federal High way Guidelines/ They should comply with DIG Once policy of the permit authorities across the different levels of government.

Commented [p17]: Refer to Federal Highway Guidelines on Dig-once

9 (2) Technical requirements

1. Trench

b. Digging and trenching works are regulated by local authorities and the specifications issued by these authorities shall be complied with.
c. Trench excavations shall start only after determination of the location of the manhole/handhole.
d. The trench shall be cleaned by removing stones and loose material. The bottom surface shall be levelled and compacted before installing ducts and manholes/handholes.
e. Trenches in the Backbone network will be 1500 mm from depth of ground level for ducts and min.600mm max.1000 mm depth from ground level and width of minimum of .200 and maximum of .300mm for COD. Backfilling and reinstatement of the surface shall comply with the regulations and standards of local authorities and as required by the necessary permits.

Figure 6: Manhole and Hand hole

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9 (3) **Duct Type and Size**

1. *Duct type*

Commented [p19]: Align with the Federal Highway Guidelines

ii. The standard ducts, Corrugated Optic Duct (hereafter called "COD") and bends shall be made from material consisting of High Density Polyethylene (HDPE) in accordance with internationally recognized standards. The ducts shall be ribbed inside.

iii. The standard sub-ducts (microducts) and COD sub-ducts including micro COD shall be made from High Density Polyethylene (HDPE), in accordance with internationally recognized standards. The sub-ducts shall be ribbed or silicone coated inside and shall be capable of accommodating Fibre Optic Cables or act as lead-ins to buildings/ customer premises, in accordance with internationally recognized standards.

iv. Following trench excavation, 40mm HDPE duct with outer diameter, 35mm and inner diameter, 29mm shall be laid at a depth of 1500mm for standard ducts and minimum of .600mm and maximum.1000mm for the COD.

v. At bridge crossing a Ø 50mm - Ø 100mm COD or GI pipe shall be used to protect the FOCs that will be installed as illustrated in Figure 3).

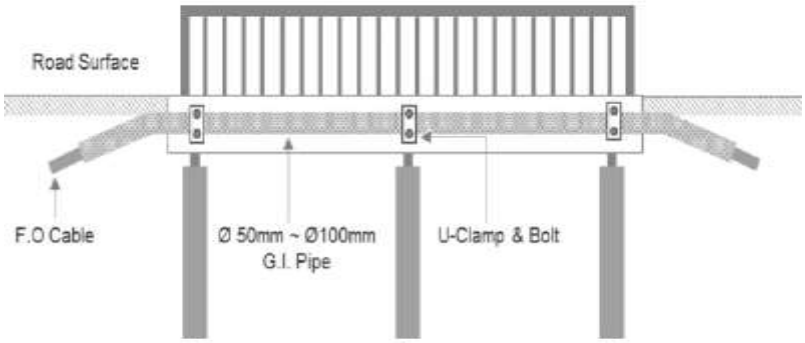

Figure 7: Bridge crossing

vi. The table below gives the specification for Fibre backbone ducts and Fibres

Table 5: Specification for Backbone duct and core

Quantity	Backbone	Feeder
Ducts	Minimum 5 (+ 20% of total installations shall remain reserve capacity = 2 reserve)	Minimum 2 (+ 50% of total installations shall remain reserve capacity = 2 reserve)
Fibres	144 Fibres	96 Fibres

Commented [p20]: Align table numbering

9 (4) Marker Tapes

a. A coloured plastic tape measuring a minimum of 0.1 mm thickness and a minimum width of 300mm shall be laid in a continuous manner above each duct structure at a depth of 300mm below ground level.
b. The tape shall be continuously and indelibly marked in English with appropriate wording (such as: CAUTION, TELECOM CABLE, Contact Number: XYZ ABC MNO)
c. The lettering shall be in a reasonable font size and colour.
d. Complete continuity of such tape shall be ensured and any displacement of the tape during backfilling is not permitted.

9 (5) Manhole and Handhole Installations

a. Manhole distance in a straight stretch (Duct) shall be 2Km.
b. The distance between manhole and handhole shall be 500m or 1Km.

c. The installation of manhole and handhole shall be carried out in accordance with the specifications given in paragraph 4.0 below.

9 (6) Metro Fibre Installation

1 Manholes / Handholes Standards

a. Manholes/Handholes shall be capable of shared access for more than one communications Network.
b. Manholes/Handholes shall be covered by a flat lid having a lock with unique head.
c. The load carrying capacity of the lid and the manhole shall not be less than 40 tons or defined in the project design taking into account the road classification.
d. Manhole/handhole lids will be labeled with the name of the owner of the Network.
e. Any Fibre Optic Cable joint shall be housed inside a manhole.
f. Where the cable is pulled in, the pulling of the cable shall be hand assisted at each manhole or handhole. Irrespective of the installation technique, the cable shall not be crushed or forced around a sharp corner. Sufficient slack shall be left at each end of the cable to allow proper cable termination as shown in figure 2.2.1.
g. All manholes shall have access shafts not less than 1200mm in height from the finishing surface to the top of the manhole roof. Manholes shall have a width of not less than 1200 mm and a length of not less than 1200 mm. The opening size of the access shaft shall be at least 600 x 600mm or 600 mm diameter.
h. Handholes shall be made in concrete or reinforced plastic (GRP) and provided with access shafts not less than 800mm in height from the ground surface to the top of the handhole roof. The measurement shall be a width of 600mm and a length of 600mm for concrete and a width of 580 mm and a length of 630 mm for GRP. The opening size of the access shaft shall be at least 600mm x 600mm for concrete and 580 x 580mm for GRP. The roof shall be made steel sheet which is resistant for min.7kN.

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Figure 8: Reinforced Plastic (GRP) handhole

Commented [p22]: Go to Schedule

i. All manholes shall have galvanized pulling-eyes.
j. All manholes/handholes shall be pre-cast and from an approved supplier with serial numbers for identification.
k. The manhole cover shall be installed to be at the same level with the asphalt surface.
l. Selecting the size of a manhole is based on the number of ducts that will pass through it.

2. Manhole/Handhole Locations

a. Place manholes to the degree possible in line with the main duct structure to minimize offsets in the duct run.
b. A manhole / handhole shall be installed near the location of an Optical Distribution Frame (ODF) and the duct termination may be integrated in the ODF housing.
c. A manhole shall be installed within 5 m from where a duct changes direction by an angle equal to or greater than 90 degrees.
d. The first manhole shall be placed at the beginning of a New Development. A manhole shall be installed at the end of a route where significant time is expected between stages of a new development.
e. Ducts shall not be installed in runs greater than 250 meters without transitioning through a handhole to allow the use of pulling techniques for cable installation. The span length may be longer considering the installation technique (e.g. blowing, etc.) and shall be determined in the project design.
f. The following areas are considered as hazardous and in such areas, placement of manholes shall be avoided:
    i. In traffic lanes
    ii. On the blind side of a curve
    iii. On a hill or in a valley
    iv. The center of a highway
    v. Road cross sections
g. Handholes shall not be subjected to vehicular traffic.
h. Where the location is in proximity to a street intersection, select a location on the side of the duct run that connects to the FBPs core network and on the side of the intersection which will not conflict with future street widening. This will allow for better

layouts of the radii for branch routes or ducts to the side streets. Further, it should be located to allow the necessary space for cable placing operations. Normally, 30 meters or more from the intersection is desirable.

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3. Manhole/Handhole Entry

a. Ducts shall only enter a manhole/handhole at the narrow ends i.e. those faces of the pit with the least surface area. They shall enter the manhole/handhole at right angles to the walls and no change of direction shall occur.
b. A minimum distance of……. will be kept between ducts at the entrance to the manhole/handhole.

Commented [p24]: TSNI to provide distance

c. The duct shall extend some space into the Manhole.
d. Ducts shall exit a Manhole in a standard formation and enter the subsequent Manhole with each duct in the same relative location.

Commented [p25]: Meet with HIT

9 (7) <u>Protection of Cables and Associated Equipment</u>

a. During the cutting of duct entries into a manhole/handhole, all reasonable measures will be taken to protect existing cables and associated equipment.
b. All movement of cables shall be carried out in a controlled manner such that all cables are evenly supported throughout their length.
c. Under no circumstances shall cables, joints and equipment be used for climbing, standing or sitting on.
d. Plant or materials shall not be supported on cables or associated equipment at any time.
e. Sufficient pumping capacity shall be made available and operated to ensure that when cables are removed from their bearers they shall not be immersed in water at any time.
f. All cables shall be protected and shielded against mechanical damage.

9 (8) <u>Duct Entries</u>

a. New duct entries into existing Manholes/Handholes or other buildings shall be cut by core drilling techniques only. Where the duct enters the chamber the finishing shall be flush and smooth. No protrusions shall remain that may cause damage to cables.
b. Existing cables and equipment shall be protected prior to drilling operations.

Table 6: Specification for Metro Fibre duct and core

Quantity	Feeder	Distribution unit
Ducts	Min 2 (+ 50% of total installations shall remain reserve capacity = 2 reserve)	min 2 (+ 50% of total installations shall remain reserve capacity = 2 reserve)
Fibres	48 Fibres	12 Fibres

9 (9) Standards for Street Cabinets (SC)

a. From SCs drop cables are laid to the Access Points in front of a building.
b. The SC design shall be based on the following criteria:
c. The SC should have at least two compartments. One compartment shall be for entrance of cables coming from the last manhole. The remaining compartment(s) shall be dedicated for the patching (Fibre termination and cross-connection).
d. The SC shall be allowed to serve multiple public Communicationss Networks.
e. The Street cabinet shall include spare capacity for the OSP.
f. The cable distance from the SC to the furthest customer building shall be within 500 meters. The distance may be extended to meet the project design in rural areas.
g. The total number of building terminations in one SC will be up to 1728. It may be reduced to 864 terminations to meet the project design.
h. Customer buildings can be connected from the SC without route diversity.
c) Protection posts may be installed according to local/municipal standards.

9 (10) Clearance from Utilities Services

a. All types of ducts and cables laid directly in the ground shall be kept clear of water mains, service pipes, sewers, subways, manholes, joint boxes or other plant belonging to other utilities.
b. The standard clearances as specified by the relevant authority shall be strictly followed.

9 (11) Road Crossings

Ducts in a road crossing shall be locatable e.g. through the use of permanent marking on the curb on both sides of a road, or coordinates that record survey points.

9 (12) Active Elements

Unless explicitly stated and for mobile network sites only, no dispositions for active equipment in the OSP (e.g. electricity) are to be provided.

CHAPTER TEN
ACCESS NETWORK FIBRE (FTTX) INSTALLATION FOR SINGLE UNITS BUILDING (SUB)

10.1 Access Configuration

a. Construction of a new SUB provides an opportunity to incorporate a High-speed-ready broadband infrastructure at relatively low cost. The installations of such infrastructure have to be done in three areas: access area, riser area and the office/housing area. For a smooth implementation, the following infrastructure elements shall be taken into account at the planning stage of the building:

i. Access point
ii. Access area
iii. Communications Space (containing the UD)
iv. Riser area

b. The following figure shows the access schematic diagram for Single Unit In-building Physical Infrastructure (based on ISO/IEC 11 801 and ITU Rec. L.82).

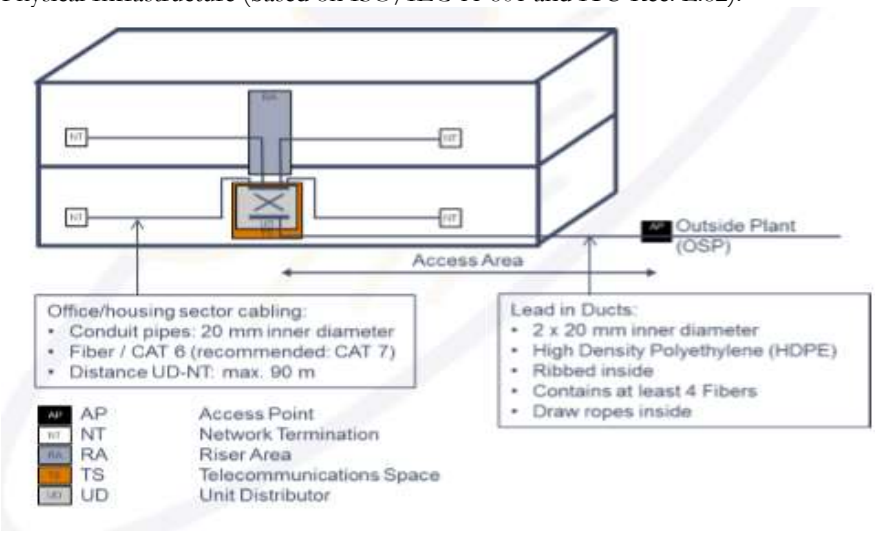

Figure 9: Access schematic diagram for Single Unit Building (SUB) In-building Physical Infrastructure.

c. There shall be at least one Access Point per SUB. Access Points shall be accessible to public Communicationss Networks. Access Point are the demarcation point between Outside Plant and In-building Physical Infrastructure and should be accessible to public networks.

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d. The SUB shall be equipped with a Communicationss Space. This space includes the UD, where via the access area and the lead in ducts / cables the outside and inside cabling is mounted. In addition, the Communicationss Space serves as collocation area for equipment required by public Communicationss Networks. This equipment is also connected to the UD. The UD allows connections between cabling coming from outside of the building with the inside cabling and equipment from public Communicationss Networks.

e. For SUB, at least one Network Termination at the Communicationss Space must be installed. Each room may be equipped with one or more Network Terminations, which are connected to the Unit Distributor.

10 (2) General Requirements

a. All SUB shall be equipped with a High-speed-ready In-building Physical Infrastructure, from the Access Point up to the NT(s). Planning and design of the In-building Physical Infrastructure shall be executed by persons specialized in such planning and design.
b. In-building Physical Infrastructure in SUBs shall be future-proof.
c. It is highly recommended that only components that have been tested and accepted by internationally accredited and recognized laboratories are used.
d. In-building Physical Infrastructure shall have capacity to provide at least four Fibre connections per SUB (from the Access Point to the Unit Distributor (UD)). From UD there is one connection to each NT.
e. For international specifications (ITU-T, ISO/IEC, etc.), the latest version shall apply

10. (3) Specific Requirements for In-building Infrastructure Elements

1. Internal Cabling

a. The internal cabling shall be based on international standard ISO/IEC 11801 Edition 2.2.
b. Fibre Optical Cables (FOC) shall preferably be used for internal cabling. Where twisted pair copper cable is used, the internal cabling shall at least conform to Category 6 in accordance with ISO/IEC TR 11801 Edition 2.22. Category 7 in accordance with ISO/IEC TR 11801 Edition 2.2 shall be the preferred solution.
c. Splicing of FOC shall be avoided. Splice attenuation shall not exceed 0.15 dB, and be typically at 0.01 dB. Return loss shall not be measurable.
d. For FOC, either SC/APC connectors (IEC 61754-4) or LC/APC connectors (IEC 6175420) shall be used.
e. From the Access Point to the UD, at least four (4) Fibre connections shall be installed.
f. The In-building Physical Infrastructure shall be designed to meet the projected service requirements at the floor level and shall have built-in flexibility to meet the growing needs of occupants.

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10 (4) Bend Radius

a. The internal cabling shall take into account the specified minimum bend radii for the respective cable in use.
b. The bend radii are defined in ITU-T G657 A1/A2/B2/B3. The minimum bend radius ranges from A1 at 10 mm to B3 at 5 mm.
c. The smaller the radius the higher the bending loss. Thus, bigger radii shall be preferred.

10 (5) Access Point

a. Where the Metro fibre is constructed before the building, the Metro fibre termination at each property should be identified with a marker. The Metro fibre terminal shall be provided by the Metro fibre developer in a way that lead in ducts can be joined in the process of building construction. During building planning and construction, the location for the access point shall be coordinated between the building developer and service provider. The process shall be aligned with the construction of other utilities.
b. Where the building is constructed before a Metro fibre is available, the location for the access point and the termination for Metro fibre connection, as shown in see figure 5 and 6, shall be provided by the Building Developer and marked clearly, coordination between building developer and the Metro fibre developer shall be as far as possible. A temporary terminal of the lead-in ducts shall be deployed with the view to be integrated into the access point when the Metro fibre becomes available.

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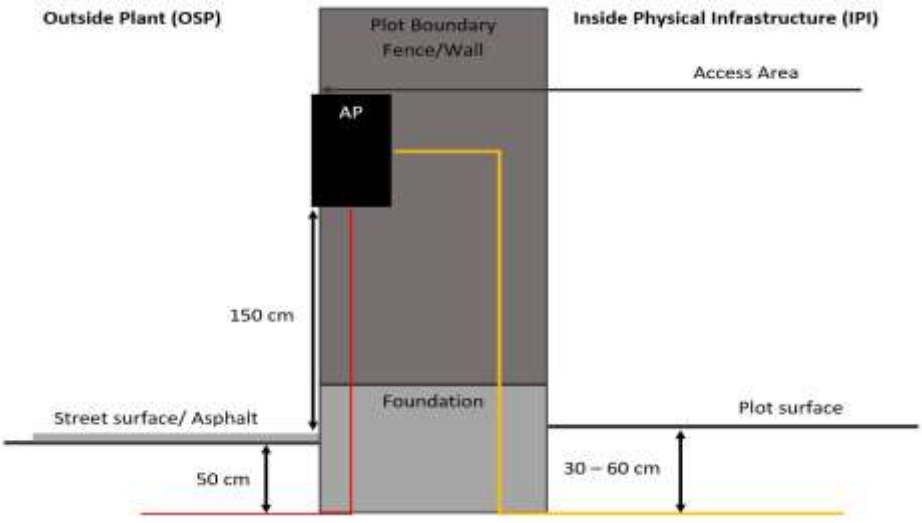
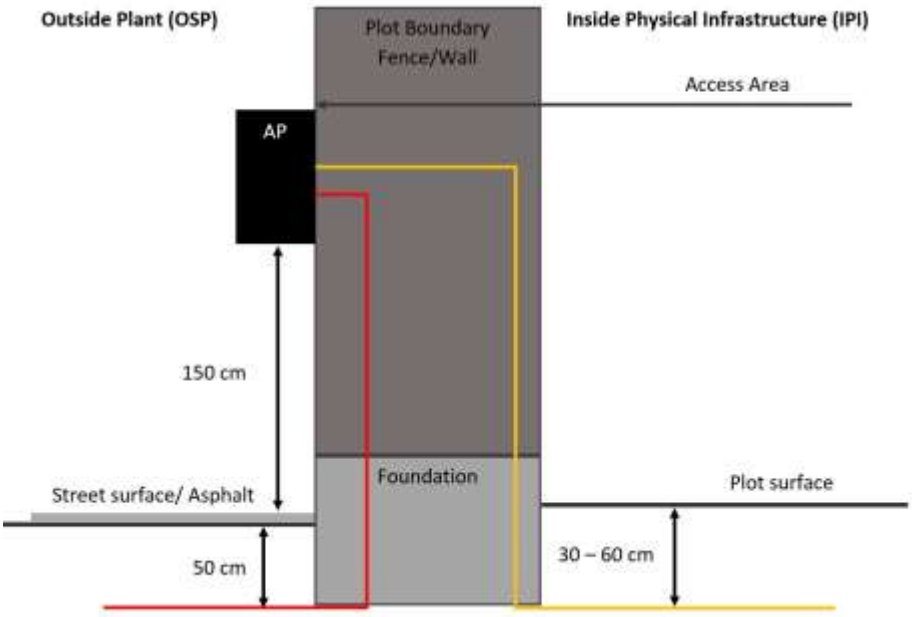


AP = Access Point
Lead-in Duct: 2 x 20 mm or 1 x 33mm & 4 Fibres per unit
OSP
Figure 10: Access Point -mounted flush- with Lead-in Duct



AP = Access Point
Lead-in Duct: 2 x 20 mm or 1 x 33mm & 4 Fibres per unit
OSP
Figure 11: Access Point –wall mounted- with Lead-in Duct

10 (6) <u>Lead-in Duct</u>

a. The fibre cables that connect the Access Point to the Communicationss Space shall be protected and lead-in ducts shall be provided by the developer of the building from the access point to the Communicationss Space.
b. Lead-in ducts shall be laid at a depth of about 300-600 mm and protected against damage.
c. The lead-in ducts shall meet the following functional requirements:
   i. At least one (1) [plus one (1) reserve] lead in-duct(s) shall be installed.
   ii. The inner diameter of each lead-in ducts shall be at least 20 mm.
   iii. The ducts shall be sealed at each end.
   1v. The location of lead-in ducts shall be clearly marked above ground for ease of locating.
   iv. Lead-in ducts shall be assigned exclusively for communications services.
   vi. No right-angled sharp bends should be installed throughout the duct length, except one wide-angle, long radius bend (factory made) at the terminating end of the duct, inside the main communications space. Alternatively, at the location of the

sharp angle bend, a cable pull-box of minimum size 600mm (L) X 600mm (W) X 800mm (D) must be provided.

d. The flat inner wall COD shall be made from High Density Polyethylene (HDPE) or unplasticized Polyvinyl Chloride (uPVC) in accordance with internationally recognized standards. The lead-in ducts shall be corrugated outside and ribbed or silicone coated inside and be capable of accommodating FOCs. A continuous and strong draw rope shall be installed in the ducts and shall remain for additional cable installations.

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10 (7) <u>Communications Space</u>

a. The communications Space shall meet the following requirements:
   i. Central, accessible, dry, and clean location. It shall be located where the distance to the farthest NT within the Unit does not exceed 90 meters.
   ii. Good lighting, proper ventilation and air circulation.
   iii. Space of 60 x 60 cm.
   iv. All metal parts must be earth bonded with resistance of less than 1 ohm.
   v. Space for collocating equipment of at least three public Communicationss Networks.
   vi. Power supply of 240 volt.
b. The space can be nearby technical equipment for other utility infrastructures with proper clearance between different infrastructures.

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10 (8*) Unit Distributor*

a. The Unit Distributor shall be installed at the communications Space where more than one NT is installed in the Unit. The Distribution Unit shall connect each NT with a conduit pipe of 20 mm.
b. The conduit pipes and the Unit Distributor shall be able to handle different types of cables, including:
   i. Fibre cables (G657.A1/A2)
   ii. Twisted pair Ethernet cables
   iii, Coaxial cables (75 Ohm resistance)
c. Different ICT technologies shall be segregated in accordance with the nature of services it provides.
d. Where active elements are required, a power supply must be provided.

10 (9) <u>Floor Distributor</u>

a. Floor distributors may be located on the second floor of a SUB. Floor Distributors shall be installed at a minimum height of. 600 mm from finished floor level. The space for the floor distributor shall be dry and clean.
b. A floor distributor should not require active elements.
c. Where active elements are required, a power supply must be provided.
d. Each room of a floor shall be connected with a 20 mm conduit pipe with the Floor Distributor.

e. A star topology shall be used for the cabling on each floor. Looping of the horizontal cabling from room to room shall be avoided.

10 (10) Network Termination

For SUB, at least one Network Termination at the Communications Space must be installed. It is recommended that each residential room (except the wet rooms such as: bathrooms and laundry rooms) or office room is equipped with at least one Network Termination (NT). An electrical power source shall be available nearby an Optical NT.

10 (11) Installations

a. Installations shall be executed by qualified personnel only according to manufacturers' specifications using the proper tools and testing equipment to ensure quality, high performance of the system and that it meets expected standards.
b. Cables for ICT shall be installed separately from electrical cabling. When installing ICT infrastructure in parallel to other installations, all regulations regarding noise protection, fire protection, or the security of electrical installations must be followed.
c. All materials shall be flame retardant, low smoke and zero halogen emission.

10 (12) Testing

a. The testing for FOC must conform to ISO/IEC TR 14763-3 and to the relevant ITU specifications.
b. The testing for balanced cabling installations (CAT6 etc.) must conform to IEC 61935-1 and to the relevant ITU specifications.

10 (13) Documentation

a. All infrastructure components shall be clearly and uniquely labeled. Labels on components must match the label in the documentation and as-built drawings.
b. The building records shall include the following:
    i. Building location information (e.g. building number and way number).
    ii. A list of all NT's and their locations in the building.
    iii. A list of all distributors and the connections.
    iv. Labeling of all infrastructure components.
    v. Contact information.
    v. As-built drawings.
c. All above documents shall be kept in the Communications Space.
d. The above documents shall be updated as soon as changes to the building records have occurred.

CHAPTER TWELVE
ACCESS NETWORK FIBRE (FTTX) INSTALLATION FOR MULTI BUILDING UNITS (MBU)

11 (1) Access Configuration

a. Construction of a new MBU provides an opportunity to incorporate a High-speed-ready broadband infrastructure at relatively low cost. The installations of such infrastructure have to be done in three areas: access area, riser area and the office/housing area. For a smooth implementation, the following infrastructure elements shall be taken into account at the planning stage of the building:
   i. Access Point
   ii.Access Area
   iii. Communications Room
   iv. Riser Area
   v. Floor Distributor

b. The following figure shows the access schematic diagram for Multi Building Unit for In-building Physical Infrastructure (based on ISO/IEC 11 801 and ITU Rec. L.82).

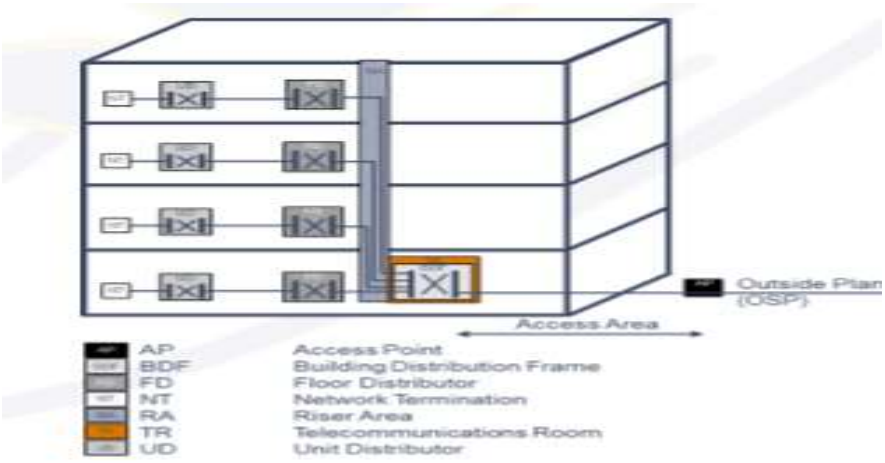

Figure 12: Access schematic diagram for Multi Building Unit (MBU) In-building Physical Infrastructure.

c. There shall be at least one Access Point per MBU. Access Points shall be accessible to public Communications Networks. Access Points are the demarcation point between Metro Fibre and In-building Physical Infrastructure. Access Points are connected to the Communications Room through two or more lead-in duct(s).

d. Each building in a New Development shall be equipped with a Communications Room. This room includes the BDF, where - via the Access area and the lead in ducts / cables –

the outside and inside cabling is mounted. In addition the Communications Room serves as collocation area for equipment required by public Communications Networks. This equipment is also connected to the BDF. The BDF allows connections between cabling coming from outside of the building with the inside cabling and collocated equipment.

e. In MBUs a vertical riser area shall be provided between BDF and each floor. Each floor may contain a Floor Distributor to connect between vertical and horizontal cabling. Each Unit is equipped with one or more Network Terminations, which are connected to the Unit Distributor. The Unit Distributor is then connected to the Floor Distributor.

11 (2) <u>Internal Cabling</u>

The reference configuration allows for two options of the internal cabling namely: Floor Distributor Topology and Star Topology.

1. Floor Distributor Topology

a. The floor distributor topology represents the reference configuration. It is the preferred solution for MBU. A Floor Distributor is installed in each floor of the building. Each Unit Distributor connects directly to the Floor Distributor that is connected to the Building Distribution Frame.
b. The Floor Distributor topology is normally used for buildings with more than 10 Units as it limits cable lengths and capacity in the riser area.
c. The Floor Distributors allow for higher flexibility of the In-building Physical Infrastructure. Further, this configuration potentially reduces the length of the cables as connections between Floor Distributors are possible. On the other hand, it requires additional investments for infrastructure elements (Floor Distributors). Further, Floor Distributors represent a potential source of faults.
d. The following figure shows the access schematic diagram for Floor distributor topology configuration for In-building Physical Infrastructure

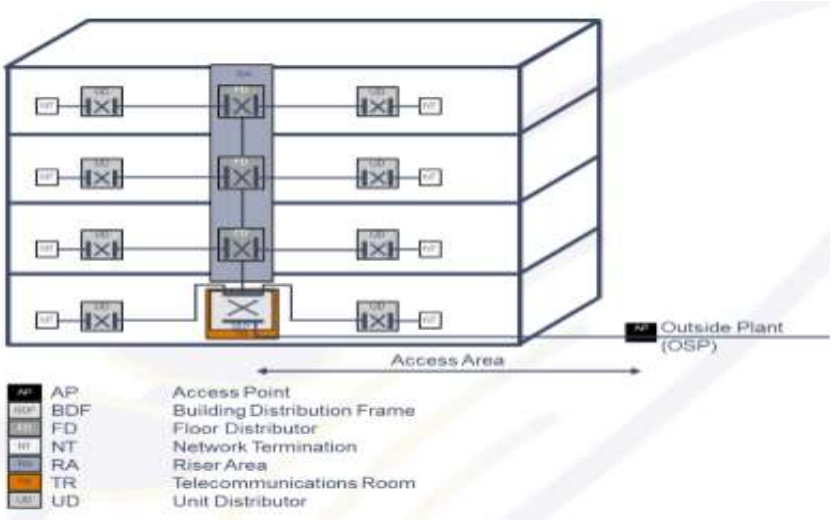

Figure 13: Floor distributor topology configuration for In-building Physical Infrastructure

2. Star Topology

a. The star topology deviates from the reference configuration as it lacks a Floor Distributor. Each Unit Distributor connects directly to the Building Distributor Frame.
b. Such configuration is normally used for up to 10 Units in a building as it requires longer cable lengths and considerable capacity in the riser area.
c. The advantage of star topology configuration lies in the elimination of the interface of the Floor Distributer. Such configuration saves costs and reduces sources of error (Floor Distributer). On the other hand, the riser area must be capable of accommodating larger conduits, sleeves, etc. as more cables are needed.
d. The following figure shows the access schematic diagram for Star topology configuration for In-building Physical Infrastructure.

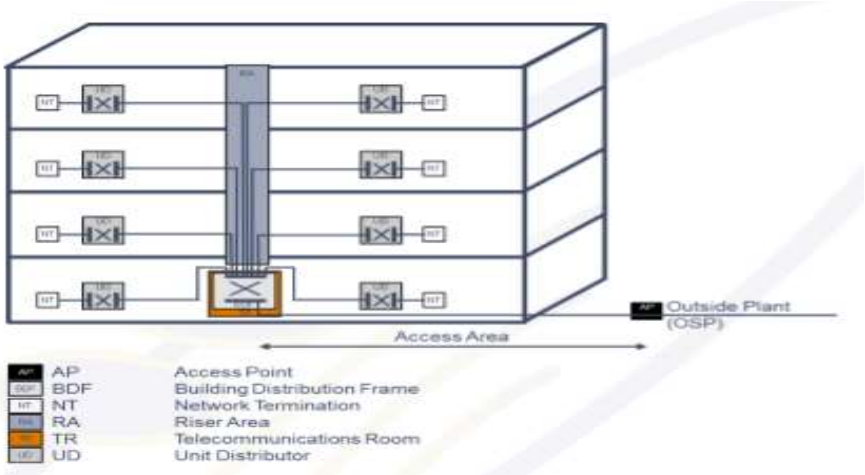

Figure 14: Star topology configuration for In-building Physical Infrastructure

11 (3) <u>General Requirements</u>

a. All MBU shall be equipped with a High-speed-ready In-building Physical Infrastructure, from the Access Point up to the NTs. Planning and design of the In-building Physical Infrastructure shall be executed by Persons specialized in such planning and design.
b. In-building Physical Infrastructure in MBU shall be future-proof.
c. It is highly recommended that only components that have been tested and accepted by internationally accredited and recognized laboratories are used.
d. In-building Physical Infrastructure shall have capacity to provide at least four Fibre connections per Unit from the Access Point to the Communications room. From the Communications Room there are at least four connections (Fibres, coaxial, or twisted pair Ethernet) to the Unit Distributor (UD). From UD there is one connection to each NT.
e. For international specifications (ITU-T, ISO/IEC, etc.), the latest version shall apply.

11 (4) <u>Requirements for Mobile Services</u>

a. In-building Physical Infrastructure may be used to facilitate mobile network coverage.
b. It is recommended to coordinate during the planning stage with mobile Service Providers to identify whether a building is suitable as a location to host masts. In this case a Fibre connection is required between the Access Point and the mast, a Network Termination at the mast shall be made available according to the requirement of the mobile Service Provider(s).
c. To facilitate good indoor coverage for mobile services, indoor antenna systems and repeaters may be installed within the building. In this case, early coordination with mobile operators is mandatory to ensure service provision. In addition, coordination

with mobile operators is useful to identify the proper locations for such indoor antenna systems and repeaters.

d. Adequate power sources, cooling systems, firefighting systems, etc. shall be provided in accordance with the project design requirements.

6.5 Specific Requirements for In-building Infrastructure Elements

This section includes recommendations for IPI design. The final design shall take into account the size of the development and possible further enhancements.

11 (5) Internal Cabling

a. The internal cabling shall be based on international standard ISO/IEC 11801 latest Edition.
b. Fibre Optic Cable (FOC) shall preferably be used for internal cabling. If twisted pair copper cable is used, the internal cabling shall at least conform to Category 6 in accordance with ISO/IEC TR 11801 latest Edition. Category 7 in accordance with ISO/IEC TR 11801 latest Edition shall be the preferred solution.
c. Splicing of FOC shall be avoided. Splice attenuation shall not exceed 0. 15 dB, and be typically at 0. 01 dB. Return loss shall not be measurable.
d. For FOC, either SC/APC connectors (IEC 61754-4) or LC/APC connectors (IEC 6175420) shall be used.
e. The dimensioning of the In-building Physical Infrastructure shall be according to the number of units in the building and the associated number of connections (4 connections per unit) including a suitable reserve capacity.
f. The In-building Physical Infrastructure shall be designed to meet the projected service requirements at the floor level and shall have built-in flexibility to meet the growing needs of tenants.

11 (6) Bend Radius

a. The internal cabling shall take into account the specified minimum bend radii for the respective cables used.
b. The bend radii are defined in ITU-T G657 A1/A2/B2/B3. The minimum bend radius ranges from A1 at 10 mm to B3 at 5 mm.
c. The smaller the radius the higher the bending loss. Thus, bigger radii shall be preferred.

11 (7) Access Point

The Access Point is the demarcation between Outside Plant and In-building Physical Infrastructure (see Article 3). The Access Point shall be easily accessible for public Communications Networks and protected against potential damage. A lockable cover is preferred. The Access Point hosts the Optical distribution box (ODB) and shall be able to accommodate at least 4 Fibre connections per unit in the building. The optical distribution box in the access point to be provided by the Service Provider. The necessary physical facilities and space for the Access Point is to be provided by the

Building Developer. Building Developers shall provide appropriate space on or inside the wall or in the ground such that the physical facilities including the ODB can be situated. Since OSP and IPI may be constructed at different timescales, coordination between the entities responsible for OSP and IPI concerning the location of the access point may be required.

a. If the OSP is constructed before the building, the OSP termination at each property should be realized with a marker. The OSP termination shall be provided by the OSP developer in a way that lead in ducts can be joined in the process of building construction. During building planning and construction, the location for the access point shall be coordinated between the building developer and service provider. The process shall be aligned with the construction of other utilities.
b. If the building is constructed before a Metro Fibre is available, the location for the access point shall be marked clearly and coordinated between building developer and the Metro Fibre developer as far as possible. A temporary terminal of the lead-in ducts shall be deployed with the view to be integrated into the access point when the Metro Fibre becomes available.

11 (8) Lead-in Duct

a. The Fibre cables that connect the Access Point to the Communications Room must be protected. Therefore, lead-in ducts shall be provided by the Developer of the Building from the Access Point to the Communications Room.
b. Lead-in ducts shall be laid at a depth of about 300-600 mm and protected against damage, considering any local municipal rules.
c. The lead-in ducts shall meet the following functional requirements:
   i. At least one (1) [plus one (1) reserve] lead in-duct(s) shall be installed per building. Duct systems with subducts should be used.
   ii. The inner diameter of to each lead-in (sub-) duct shall be at least 20 mm and specifically defined in the project design.
   iii. For MBUs with more than 30 units at least 50 mm (sub-) ducts shall be used.
   iv. The ducts shall be sealed at each end.
   v. The location of lead-in ducts shall be clearly marked above ground for ease of locating.
   vi. Lead-in ducts shall be assigned exclusively for Communications Services.

The following table provide the standards for Lead-in Duct.

Table 7: Standards for Lead-in duct dimension

Minimum Dimension (inner diameter)	[SUB and] MUB < 30 units: 20 mm MUB > 30 units: 50 mm]
Thickness (mm)	+/-2.00 (for 20 mm ducts) +/-3.25 for 50 mm ducts)
Thickness (mm) COD	2.0mm+/-0.5 (for 20 mm) for 50 mm ducts)

Table 8: Specification for Lead-in duct and core

Quantity	From distribution Point	[Lead-in]
Ducts	min 2 (+ 50% of total installations shall remain reserve capacity = 2 reserve)	[min 1 (+ 50% of total installations shall remain reserve capacity = 1 reserve)]
Fibres	12 Fibres	4 Fibres per unit

vii. No right-angled sharp bends should be installed throughout the duct length, except one wide-angle, long radius bend (factory made) at the terminating end of the duct, inside the main telecom room. Alternatively, at the location of the sharp angle bend, a cable pull-box of minimum size 600mm (L) X 600mm (W) X 800mm (D) must be provided.

d. The standard lead-in ducts shall be made from High Density Polyethylene (HDPE), unplasticized polyvinyl chloride (uPVC) or better material, in accordance with internationally recognized standards. The lead-in ducts shall be ribbed inside and be capable to accommodate FOCs. A continuous and strong draw rope shall be installed in the (sub-) ducts and shall remain for additional cable installations.

11 (9) <u>Communications Room</u>

a. Each MBU with more than 30 units shall be equipped with a Communications Room. Multiple Communications Rooms shall be interconnected by separate cable trays (200 mm x 50 mm) or equivalent.

b. The Communications Room shall meet the following requirements:

c. Good lighting, clean, dry, proper ventilation and air circulation.

d. 24/7 secured access for staff of service providers of public Communications Networks.

e. Properly accessible for adding or removing equipment and tools.

f. Master lock for the entrance door.

g. No windows,

h. Must not be beneath or next to kitchens, washrooms, garbage areas, swimming pools and other wet areas and the surrounding walls shall have no concealed water/drainage pipes and air-conditioning ducts passing through.

i. Dedicated spaces not shared with other functions (such as electrical or mechanical).

j. Air conditioned to maintain the temperature at 25 °C ± 10 °C; with humidity 40% - 60%.

k. All metal parts must be earth bonded with resistance of less than 1 ohm.

l. Extra space for future network equipment additions.

m. Space for collocating equipment of at least three providers of public Communications Networks, with a minimum of two square meters for each provider

of a public Communications Network. The final project design shall take into account the size of the building and the number of units as well as possible enhancements. Power supply with at least 10 A/C sockets (240 volt, 20 amp) with a dedicated circuit breaker.

11 (10) Building Distribution Frame (BDF)

The Building Distribution Frame allows arbitrary connections between in-building cabling and outside plant cabling. The BDF shall have sufficient space to accommodate 4 connections to each unit.

11 (11) Riser Area

a. A riser area shall be provided for all multi-storied buildings. The riser area shall be able to accommodate at least 4 connections to each unit (UD). 15 % reserve capacity in the riser area shall be provided for manipulation purposes.
b. Any cables that are installed in the riser area shall be easily replaceable in case of damage or faults. Cables shall be placed in cable risers, conduits, sleeves, tubes, etc.
c. The following principles shall apply:
   i. Riser areas shall be accessible at any time.
   ii. The installations shall be done using the shortest route and preferably as vertical as possible.
   iii. Riser areas shall not be located inside units or air shafts.
   iv. The diameter of the conduit pipes shall be at minimum 25 mm.

12 (12) Floor Distributor

a. Floor Distributors shall be located close to the riser area. Floor Distributors shall be installed at a minimum height of 600 mm from finished floor level. The space for the floor distributor shall be dry and clean.
b. In general, a floor distributor should not require active elements.
c. In case active elements are required, a power supply must be provided.
d. Each Unit of a floor shall be connected with a 20 mm conduit pipe with the Floor Distributor.
e. A star topology shall be used for the cabling on each floor. Looping of the horizontal cabling from Unit to Unit is prohibited.

12 (13) Unit Distributor

a. Each Unit (dwelling or office) shall have a Unit Distributor installed at a central and accessible location in case more than one NT is installed in the Unit. The Unit Distributor shall connect each NT with a conduit pipe of 20 mm. It shall be located where the distance to the farthest NT within the Unit does not exceed 90 meters.
b. The conduit pipes and the Unit Distributor shall be able to handle all possible cables:
   i. Fibre cables (G657.A1/A2)

ii. Twisted pair Ethernet cables
iii. Coaxial cables (75 Ohm resistance)

c. Different ICT technologies shall be segregated to accommodate for operational issues. Each type of cable must have its separate Unit Distributor.
d. In case active elements are required, a power supply must be provided.

12 (14) Network Termination

a. Each Unit shall have at least 4 connections to the BDF. For business customers a higher number of connections may be designed if demand is expected.
Each residential room (except the wet rooms such as: bathrooms and laundry rooms) or office room shall be equipped with at least one Network Termination (NT). An electrical power source shall be available nearby an Optical NT.

12 (15) Installations

a. Installations shall be executed by qualified personnel only according to manufacturers' specifications using the proper tools and testing equipment to ensure quality, high performance of the system and that it meets expected standards.
b. Cables for ICT shall be installed separately from electrical cabling. When installing ICT infrastructure in parallel to other installations, all regulations regarding noise protection, fire protection, or the security of electrical installations must be followed.
c. All materials shall be flame retardant, low smoke and zero halogen emissions.

12 (16) Testing

a. The testing for FOC must conform to ISO/IEC TR 14763-3 and to the relevant ITU specifications.
b. The testing for balanced cabling installations (CAT6 etc.) must conform to IEC 61935-1 and to the relevant ITU specifications.

12 (17) Documentation

a. All infrastructure components must be clearly and uniquely labeled. Labels on components must match the label in the documentation and as-built drawings.
b. The building records shall include the following:
i. Building location information (e.g. building number and way number).
ii. A list of all NT's and their locations in the building.
iii. A list of all distributors and the connections.
iv. Labeling of all infrastructure components.
v. Contact information.
vi. As-built drawings.
c. All above documents must be kept in the Communications Room / Space.
d. The above documents must be updated as soon as changes to the building records have occurred.

CHAPTER THIRTEEN
FIBRE DEPLOYMENT ARCHITECTURE

13 (1) <u>Fixed Networks Deployment</u>

a. For fixed networks, the preferred technical solution is a point-to-point network architecture with four connections (Fibre optics) per unit (dwelling or office). The network architecture shall allow network sharing and access.
b. Any network architecture shall support both point-to-point and point-to-multipoint access network topologies.
c. The following duct architectures shall be used:
I. Dual Side of the Street: ducts are placed on both sides of the street. Road crossings are generally to be placed at road intersections.

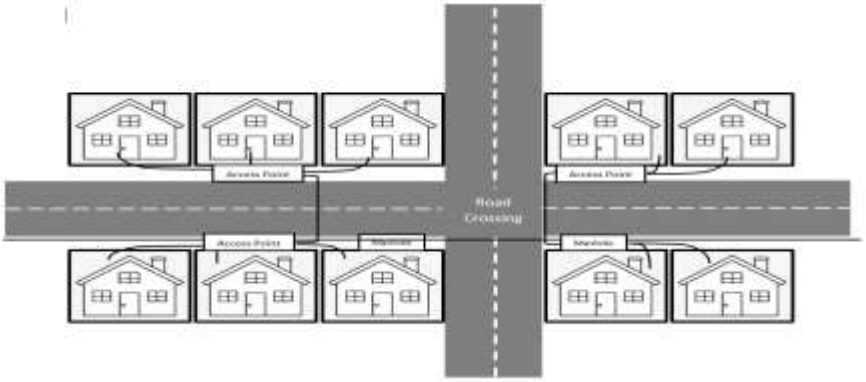

Figure 15: Dual side duct

II. Single Side of the Street: the duct is placed on only 1 side of a street with road crossings used to reach lots on the other side of the street.

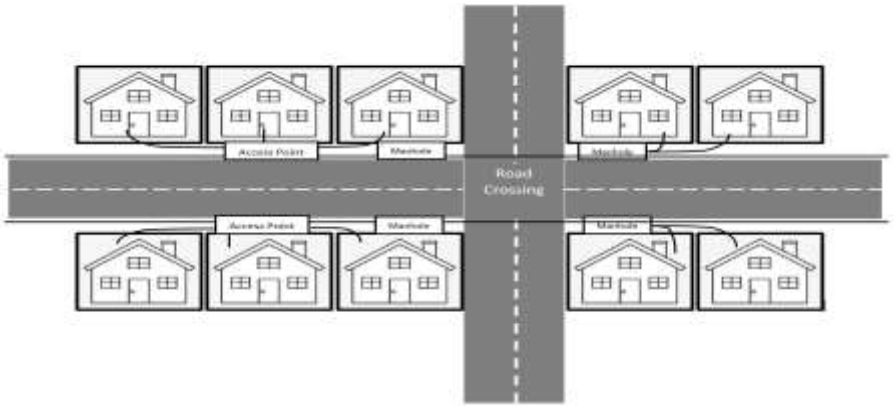

Figure 16: One side duct

d. Combinations of the two architectures are also allowed.
e. To provide for diversity, at least two alternative feeder duct runs should be provided to connect the distribution network.
f. Usually up to 4 but not more than 10 lots are connected to a local Access Point. Further, usually up to 10 Access Points are connected back into a local network splicing point (Manhole). And about 5 local network splicing points are connected to a street cabinet. The exact configuration of physical infrastructure shall be determined during the project design.
g. Street cabinets shall be connected with feeders having 50 mm ducts from the boundary of the New Development. At the boundary of the new development, an ODF and an associated Manhole shall be placed.
h. Road crossings shall be served with sufficient extra reserve capacity.
i. In a new business, industrial or governmental development, the feeder ducts shall run in rings rather than a simple branch configuration and shall pass by each potential building/premises.
j. In the event of a tower / mast to be served, it shall be possible to configure network rings which originate and terminate at the mobile tower to provide for diversity.

CHAPTER FOURTEEN
AS BUILT DOCUMENTATION

14.1 Configuration Documentation

a. The owner of the installations must ensure that accurate records of the as-built work are established and continually maintained. Any changes made during construction must be updated in the original "to-build" plan. The drawings shall accurately indicate the location of the installations, cable types and labeling. The updated 'as-built' plan shall be used as the basis for the complete documentation of the network.
b. The documentation of original design including any deviations of it as the "as-built" network shall contain at least the following information for each section and cable:

1. Civil infrastructure

i. Name and address of the construction company
ii. Construction approval details
iii. Accurate location data (including GPS coordinates)
iv. Accurate as-built trench lengths
v. Manufacturer and model of all items
vi. Duct space records
vii. Mast support information (guys, anchors, etc.).

2. Cables

i. Manufacturer
ii. Number of cables
iii. Number of Fibres
iv. Routing of cables
v. Routing of Fibres
vi. Manufacture and installation date of the cable used
vii. Optical Time Domain Reflectometer (OTDR) measurement results
viii. The as-built documentation needs to be kept up-to-date in order to enable operations and maintenance work.

3. Database

The Rules on Access to Physical Facilities require detailed and accurate records for newly deployed Communications facilities. These documentation requirements shall be followed.

CHAPTER FIFTEEN
SAFETY FOR OSP WORKS

15 (1) Safety Procedures

a. Any accident and incident and hazard during the construction shall be avoided.
b. A suitable number of expert personnel and adequate equipment and construction material is to be used to provide for:
   i. Safety of employees
   ii. Safety before start of work
   iii. Safety during progress of work
   iv. Safety of public and private property
   v. Adequate tools and equipment at work area.
c. All efforts shall be undertaken to safeguard the workers from any injury and damage or loss of properties by complying with national and international standards on safety of OSP works.
d. Any workers must wear suitable protective clothing.
e. Before commencing any activities for a road crossing site, contractors shall ensure that adequate safety control measures are taken at the road crossing site, contractors shall ensure that adequate traffic safety control measures are in place, and any approvals and coordination required from relevant authorities is obtained. Ensure that the project activities do not negatively impact the environment. This implies that necessary Environmental Impact Assessment (EIA) is conducted and the result is found to be satisfactory. Any noise pollution in the work shall be kept to a minimum.
f. Open trenches must be secured and adequate warning signs provided.
g. Safe and secure working conditions shall be ensured. Any unsafe acts or conditions shall be corrected immediately.

h. Rules and regulations of all relevant authorities for safety and security must be followed.
i. Unannounced inspections and evaluations of the safety precautions and procedures in the work area shall be performed from time to time to ensure proper application of safety rules and procedures.
j. Safety glasses with side shields and protective gloves shall always be worn during FOC installations. Fibre optic splinters shall be treated in the same way as glass splinters.
k. All Fibre pieces shall be placed in a properly marked container for disposal. The work area must be thoroughly cleaned when the work is done.
l. When installed on a live system, invisible laser radiation may be present; do not stare into the connector end face or view directly with optical instruments.
m. All Personnel entering the worksite are required to comply with CLIENT's General SHE Specifications, and Contractors' Health, Safety and Environmental Policies and Procedures. In general, the following precautions shall apply:
n. Before commencing any activities, and for the entire duration of the work activities, ensure that the work site does not present a hazard to the health or safety of workers, traffic, pedestrians, or the general public.
o. Fibre optic cable can cause skin punctures and may separate below the skin following puncture.
p. If a Fibre optic cable gets cut, the Fibre may piston out the end of the cable and cause a hazard. If this happens get two pieces of tape and install the tape as flags over the cut ends to capture the Fibre.
q. The light from functioning optical Fibres resides in the non-visible infrared spectrum. This is below our perceivable visual range. If you look at a Fibre that is transmitting it will burn the retina of your eye and cause permanent damage to your eye.
r. Before examining the connector or the termini end-face, disconnect the connectors from the equipment at both ends or set the equipment to off. (Lock out – Tag out.

PART IV

GENERAL PROVISIONS

CHAPTER SIXTEEN

16 (1) Licence

(1) Any company that applies for a mast or tower certification/licences shall satisfy the Commission that it has:

(a) Enough capital equipment to enable it deliver safe and quality fabrication.
(b) In its employment, qualified and licensed fabricators.
(c) A good Workmen's compensation insurance policy from a reputable insurance company.
(d) A good third party accident insurance policy.
(e) A viable Health, Safety and Environment policy.

(2) The capital equipment referred to in sub-paragraph (1) of this Guidelines shall include:

(a) packer
(b) Excavators
(c) Bull Dozer
(d) Forklift
(e) Long Boom Arm Crane
(f) Concrete Vibrator and Poker

(3) It shall not be lawful for a person to engage in the business of installation of Communications mast and towers without a valid licence issued by the Commission.

(4) All checking visits and maintenance interventions shall be done by employees with special qualification in telecom tower manufacture or maintenance.

(5) The minimum educational qualification for employees in mast and tower fabrication, erection and maintenance shall be as follows:

(a) A Certificate obtained on completion of a four year training programme in welding and machining from an accredited Technical College. (b) A City and Guilds Final Certificate.

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(6) Installers whose employees meet the above requirements will be eligible for the grant of a certification/licence by the Commission.

16 (2) STRUCTURAL CERTIFICATION

(1) Prior to the installation of a tower, mast and antenna support structure on any building or roof the Commission shall be provided with a structural engineer's certification that the structure will support and not be adversely affected by the proposed mast, tower, antenna and associated equipment.

CHAPTER SEVENTEEN

GENERAL MATTERS

17 (1) The Terrain

(a) The design of structures for masts and tower shall be determined by the "terrain" and for this purpose, terrain is classified into three broad geographical zones. These are:

(i) The Exposed smooth terrain with virtually no obstructions and in which the height of any obstructions is less than 1.5m. This category includes open sea coasts, lake shores and flat, treeless plains with little vegetation other than short grass.

(ii) The Open terrain with widely spaced obstructions (100m apart) having heights and plan dimensions generally between 1.5m and 10m. This category includes large airfields, open parklands or farmlands and undeveloped outskirts of towns and suburbs with few trees.

(iii) The Terrain having numerous closely spaced obstructions generally the size of domestic and high rise buildings. This category includes wooded areas and suburbs, towns and industrial areas, fully or substantially developed.

(b) In designing masts and towers, wind loading shall be the predominant dynamic loading to be considered outside dead weights since severe environmental conditions that may lead to additional seasonally variable loads are non-existent.

(c) Wind load rating shall be based on the height of the tower and where it is located.

(d) The design of towers and mast shall provide for specific conditions that might exceed the given standard values specified in this Guidelines.

(e) Design philosophy shall be based on two limiting factors: strength limit, which considers the loading of a tower under extreme conditions and serviceability limit which ensures that the tower will provide the proper service under normal conditions.

(f) Towers shall be analysed under three specific types of loading:

(i) Wind
(ii) Environmental
(iii) (iii) Seismic

(g) The Wind effect on a tower shall take cognisance of a number of external conditions that may change the dynamics of the wind, such as terrain, gusts, the method of wind-speed determination and the value of safety factors needed for a specific tower type. Figure 1.2 of the First Schedule to these Guidelines is the wind flow map of Nigeria with parameters for the wind speed measurement.

(h) A proportionate amount of over design must be applied to take care of the safety factor which defines the impact a failure would have on the operational integrity of the tower, and human life and property.

17 (2) <u>Insurance and Compensation</u>

(a) Owners of communications masts and towers shall maintain the following insurance policies;

(i) Workmen Compensation Policy. A tower or mast erecting crew must have a current Workmen's Compensation policy from a reputable insurance company to a minimum value of five million naira per head or any such amount as may from time to time be specified by the Commission for such claim or third party claims.

(ii) All masts and towers shall be insured by their owners against third party claims in the event of collapse. However, the responsibility for accidents during the installation period shall be that of the installer and shall only revert to the owner of the masts or towers on completion and handover.

(iii) Where a tower collapses and causes injury to a person or damages property as a result of either faulty design by the Structural Engineer or non use of material specifications by the builder, the owner of the tower shall be jointly liable with either of the parties at fault, to compensate the person or owner/owners of the property.

17 (3) <u>Service Life</u>

(a) The expected service life of a tower shall be 25 years.

(b) The design, fabrication materials, fabrication methods, installation accessories, safety factors and tower loadings shall conform to standards and last for the expected service life of the tower.

(c) To ensure that the maximum service life of a tower is attained, the design, selection of materials and welding of towers shall be carried out by professional engineers and certified experts.

17 (4) Tolerable Radiation Level

Tolerable radiation level should be within the limit approved by International Commission on Non-Ionizing Radiation Protection (ICNIRP)

(a) Permissible Radiation level for occupational staff on site must conform to specifications under Table 6.1 of the Appendix

(b) Permissible Radiation level for the general public must conform to specifications under Table 6.2 of the Appendix

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(6) Permissible Generator setback, sound level , smoke and vibration.

(a) All generators within a base station must be sited 10 meters away from all demised properties excluding the fence.

(b) All generating sets must be sound proof

(c) All generating sets must be installed on good shock absorbers so as to minimize vibrations to the barest minimum

(d) The exhaust of all generators must not be directed towards any demised property.

17 (5) Repeal

(1) This Guidelines supersede any other Guidelines or specifications made for the regulation of masts and towers under the Nigerian Communications Act, 2003. The earlier published Guidelines on Technical Specifications for the Installation of Communicationss Masts and Towers are hereby repealed.

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17 (6) Interpretation

In these Guidelines

"Alternative Mounting Structure" refer to man made tree, clock tower, church steeple, bell tower, utility pole, light standard, identification pylon, flagpole, or similar structure, designed to support and camouflage or conceal the presence of communications antennas.

"Antenna" means structure or device used to collect or radiate electromagnetic waves, including directional antennas, such as panels, wireless cable and satellite dishes, and omnidirectional antennas, such as whips, but not including satellite earth stations. "Antenna Array" means an arrangement of antennas on their supporting structure.

"Antenna Stealth" means a communications antenna that is effectively camouflaged or concealed from view.

"Candela" means light intensity with its unit as the lumen.

"Climbing Facilities" mean the components specifically designed or provided to permit access, such as fixed ladders, step bolts, or structural members.

"Climbing Safety Devices" means the equipment devices other than cages, designed to minimize accidental falls, or to limit the distance of such falls. The devices permit the person to ascend or descend the structure without having to continually manipulate the device or any part of the device. The climbing safety device usually consists of a carrier, safety sleeves, and safety belts.

"Collocation" means the use of a single communications tower and/or site by more than one communications service provider.

"Dish Antenna" means a parabolic or bowl shaped device that receives and/or transmits signals in a specific directional pattern.

"Displacement" means the horizontal translation of a point relative to the no-wind load position of the same point at a specified elevation.

"Grounding" means establishing an electrical connection between the structure and the earth, adequate for lightning, high voltage, or static discharges.

"Guy Connection" means the hardware or mechanism by which a length of guy strand is connected to the tower, or guy anchor.

"Guyed Tower" means any communications tower supported in whole or in part by cables anchored to the ground.

"Identification Pylon" means a permanent ground mounted sign consisting solely of a single monolithic structure used to identify a development.

"Length" for tubular steel pole structures with telescoping joint, butt welded or flanged shaft connections, the overall length of the assembled structure shall be within plus 1 percent or minus 1/2 percent of the specified height.

"Lux" means lumens/sq m

"Monopole" means a self-supporting communications tower which consists of a single vertical pole fixed into the ground and/or attached to a foundation.

"Normal Soil" means a cohesive soil with an allowable net vertical bearing capacity of 192 kPa and an allowable net horizontal pressure of 63 kPa per linear metre of depth to a maximum of 92 kPa.

"Panel Antenna" means an antenna which receives and/or transmits signals in a directional pattern.

"Plumb" means the horizontal distance between the vertical centerlines at any two elevations shall not exceed .25 percent of the vertical distance between the two elevations.

"Primary Ground" means the conducting connection between the structure and earth or some conducting body, which serves in place of the earth.

"Secondary Ground" means the conducting connection between an appurtenance and the structure.

"Self-supporting Lattice" means a communications support structure which consists of an open network of metal braces forming a tower which is usually triangular or square in plan.

"Sway" means the angular rotation of the antenna beam path in a vertical plane from the nowind load position at a specified elevation.

"Communications Antenna" means an antenna used to provide a communications service.

"communications tower" means a self-supporting or guyed structure more than 5 metres in height, built to support one or more communications antennas.

"Tower Height" means the distance measured from ground level to the highest point of any and all components of the structure, including antennas, hazard lighting, and other appurtenances.

"Twist" means the twist (angular rotation in the horizontal plane) between any two elevations shall not exceed 0.5 degrees in 3 m and the total twist in the structure shall not exceed 5".

"Working Facilities" means work platforms and access runways.

"Whip Antenna" means an omni-directional dipole antenna of cylindrical shape which is no more than 15 cm in diameter.

16. Definitions of Terms

FTTB (Fibre to the building)
The apartment block is wired with unshielded twisted-pair (UTP) data cables (newly installed), forming a LAN serving all inhabitants, with its Ethernet switch performing termination of Fibre link. Data rates up to 1 Gb/s, most often 100 Mb/s.
Fibre to the curb/cabinet (FTTC)
Optical Fibres extend to a remote unit with a DSLAM. From there, short (50–400 m) twisted pair loops extend to NTs at customer's premises. Data rates up to 100 Mb/s.
Fibre to the distribution point (FTTDp)

Access network based on G.fast technology, with very short (10–250 m) twisted-pair or coax loops terminated at distribution point unit (DPU) located close to subscriber's premises: at the corridor, on pole, in manhole, etc. Data rates up to 1 Gb/s.

Fibre to the home (FTTH)

Network with optical Fibres extending all the way to ONT 0-at customer's premises, also known as Fibre to the premises (FTTP). No active devices in the middle.

FTTH-PON

FTTH network where a feeder Fibre extending from OLT is split into 8–128 distribution Fibres reaching customer's premises, forming a passive optical network (PON). OLT bandwidth is shared among all users in a PON with time division multiplexing (TDM).

FTTH-P2P (point to point)

FTTH network with a separate optical Fibre to each customer, no Fibre splitting. Each customer is connected to a separate port at OLT. No sharing, data rates up to 1 Gb/s.

Fibre to the node (FTTN)

Network similar to FTTC, but with longer copper loops, up to approx. 1500 m; fever remote units; and lower data rates up to 20–40 Mb/s.

New Developments: means the real estates to be developed by land and building developers, including land planning and preparation and buildings construction for residential, commercial, industrial, governmental or any other purpose.

Passive Network Components: include all the non-electric physical elements, such as buildings, sites, ducts, towers and masts, manholes, hand-holes, and cables, among others, that may serve for the provision of Outside Plant and In-building Communicationss networks.

Outside Plant (OSP): Any ICT network implemented with the aim of connecting it, or using it to connect, with the public Communicationss networks. OSP includes passive ICT networks components and any associated hardware located between a central distribution point at the border of the New Development and Access Points.

In-building Physical Infrastructure (IPI): means passive ICT networks components in a building connecting the Access Point with the Network Termination Points in the building units (also known as Inside Plant), including Network Termination Points, distribution frames, risers, Communicationss rooms and spaces, and lead-in ducts.

Access Point: means a physical point located outside the building accessible by public Communicationss networks, hosting the Optical Distribution Box (ODB), through which a connection between the Outside Plant and the In-building Physical Infrastructure is made. It is the demarcation point between Outside Plant and In-building Physical Infrastructure.

Access Area: means the physical location containing the lead-in ducts and cabling from the Access Point to the Communicationss space / room.

Building Distribution Frame (BDF): means a distribution element between the Outside Plant and the In-building Physical Infrastructure (inside plant). The BDF allows connection of the lead-in cables from the Access Point (outside the premises) to the cables leading to each Unit.

Riser Area: means the physical location containing the vertical ducts and distribution cabling that connects each floor with the BDF.

Floor Distributor (FD): means a sub-dividing element between the BDF and the Unit Distributor / Network Termination Points located nearby or in the riser area which allows the transition from the vertical to the horizontal indoor cable. Use of Floor Distributors is optional.

Network Termination Point (NT): is the point at which the In-building Physical Infrastructure (IPI) of a building unit terminates. A building unit may have multiple NTs.

High-speed-ready: means that the Outside Plant (OSP) and the In-building Physical Infrastructure (IPI), hosting all necessary passive network elements, enable data delivery at a minimum speed of 100 Mbps.

Communicationss Space (TS): is space designed to contain Communicationss equipment of different public Communicationss Networks, cable terminations, and distribution frames. As various equipment and cables that are used to distribute Communications, image and security services to each dwelling Unit are often installed in the Communicationss Space. The Communicationss Space may also include other infrastructure.

Unit: means town house, residential apartment, office space, or any other closed entity within a building.

Multi-dwelling Unit (MDU): refers to two or more Units that are joined by a common wall or property boundary. Examples of MDUs include apartments, office and commercial premises, shopping malls and the like. An MDU may consist of multiple towers that are part of a common main building.

Single-dwelling Unit (SDU): means a structure that contains only one Unit (residence / office / commercial premise).

Unit Distributor (UD): means an element which concentrates all cables of a Unit.

Floor Distributor (FD): means a sub-dividing element between the BDF and the Unit Distributor / Network Termination Points located nearby or in the riser area which allows the transition from the vertical to the horizontal indoor cable. Use of Floor Distributors is optional.

Communicationss Room (TR): is an enclosed architectural space designed to contain Communicationss equipment, cable terminations, and a Building Distribution Frame (BDF). This room is also used as a collocation area to house various equipment and cables used to distribute Communications, image and security services to each Unit.

Developer: means a Person developing real estate through any of the following:

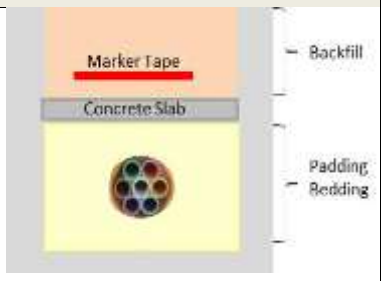
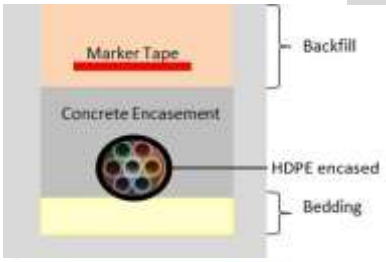
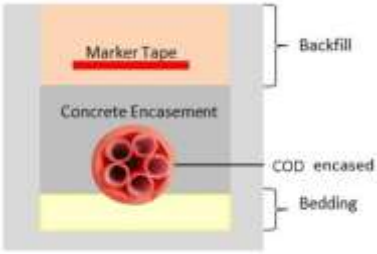
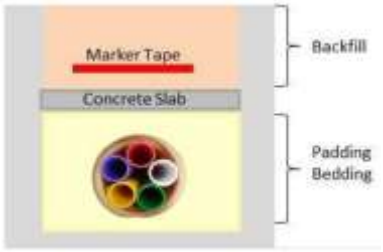
- Preparing New Development sites for residential, commercial, industrial, governmental, or any other special purpose or public use (Land Developer).
- Construction of buildings (Building Developer).

Often, the owner of the real estate is also the Developer, he is responsible for observing building codes for construction and land development works.

APPENDIX

Appendix Technical specifications for the Engineering and Construction.

S/N	Activity	Standard
1	**Construction**	**Trenching** • Trenches are to be excavated to a depth that the crown has at least 800 mm of backfill cover for standard ducts or 600mm for COD over the uppermost duct. This could be relaxed for hard rock conditions to a minimum depth of 300 mm. • Protection in the form of concrete slab should be placed on top of the padding material before backfilling, having minimum strength of 20 Mpa reinforced with tensile wires and measure 75 mm thick by 300 mm wide and 900 mm in length. • Adequate measures for support is required for trenches exceeding 800mm. • Pits and trenches must be guarded by barricades, warning tapes and covers and Route markers.

S/N	Activity	Standard
		    • Before pouring concrete, a slump test must be performed. A slump of 10 cm or less is typically deemed acceptable (must not shear-off or collapse), or as per Commission specifications. Concrete that is poured too wet will be weak, regardless of how it is cured.

S/N	Activity	Standard
		• After padding tampering, backfilling of the trench can be done. • Material excavated from trenches may be used as backfill, provided that it contains stones no greater than 150mm in diameter, trash, or organic matter that could potentially damage ducts. • Backfill material is to be installed in layers not exceeding 300 mm, with each layer compacted before the next is added. • After compacting the first layer of backfill, the warning/marking tape is placed. Take photos of this procedure as proof of existence. Conceivably, the warning tape will be encountered before damaging the ducts or cable **Trenching Near Power Cables** • Where no physical barrier exists, no duct or cable shall be laid within a distance of 600 mm measured horizontally, nor cross within a distance of 300 mm measured vertically from any high voltage power cable. • Where this separation is compromised, the duct or cable must be separated by concrete slabs. • The standard protection slab is 900 mm x 300 mm x 75 mm thick. This slab will be reinforced with 3.55 mm high tensile wires. **Dynamic Cone Penetrometer (DCP) Testing** • All excavations are subject to compaction tests, which must be certified and documented. • 8 tests per km, is recommended. • The testing should be carried out using a free-falling 8-kg hammer which strikes a cone, causing the cone to penetrate the soil, and then measuring the penetration per blow, called the penetration rate (PR), in mm/blow. • Always keep the DCP vertical and watch where you place your fingers. • The trench density must be better or at least equal to that of the virgin soil parallel to the trench. • A 25 mm PR is typically deemed acceptable. **Pilot Hole** • Pilot holes (PH) have to be set out at 30 m – 50 m intervals, specifically at points where new trench crosses existing services. • PH should be at least 150 mm deeper and wider than the

S/N	Activity	Standard
		trench. **Duct and Conduit** • The Duct should be High Density Poly Ethylene (HDPE) Corrugated Optic Duct (COD). • The conduit should at least meet the ASTM F2160 Standard Specifications for Solid-Wall HDPE conduit based on controlled outside diameter. • A minimum of three (3) conduits are to be installed inside the COD to support further expansions having minimum standard of OD32 mm X 3 lines. • In the case of metallic telephone cables or bigger size exceeding 144 Fibre shall be installed into the single wall corrugated duct COD, OD53/ID33mm
2	**Engineering**	**Optic Fibre Cable** • The type of Optic Fibre Cable (OFC) to be used must provide sufficient bandwidth to support up 10 Gigabit Ethernet within 300 m (laser-optimized). • Three (3) types of Single Mode: (8 – 10)/125 micro size is hereby recommended for the application: **a) ITU-T G.652 – Dual Window Single Mode Fibre:** *Application:* general application Fibre suitable for most uses having: ***i. Attenuation Coefficients:*** At 1310nm: 0.35-0.40dB/KM At 1550nm: 0.21-0.30dB/KM ***ii. Dispersion Coefficients:*** At 1310nm: 3.5ps/nm.KM Maximum At 1550nm: 18ps/nm.KM Maximum **b) ITU-T G.653 – Dispersion Shifted Single Mode Fibre:** *Application*: Fibre optimized in the third window (1550nm wavelength), recommended in very high speed and long distance applications. ***i. Attenuation Coefficients:*** At 1550nm: 0.23dB/KM Maximum ***ii. Dispersion Coefficients:*** At 1550nm: 3.5ps/nm.KM Maximum **c) ITU-T G.655 – Non –Zero Dispersion Shifted Single Mode Fibre:**

S/N	Activity	Standard
		Application: Fibre designed for DWDM applications. It is characterized by low dispersion at 1550nm and a high effective area which prevents the non-linear effects of high speed in this type of transmission, offering improved services in comparison to the previous Fibres mentioned. ***i. Attenuation Coefficients:*** At 1550nm: 0.22-0.25dB/KM At 1625nm: 0.25dB/KM, Maximum ***ii. Dispersion Coefficients:*** At 1535 - 1565nm: 0.1 to 6.0 ps/nm.KM or 1.0 to 10.0 ps/nm.KM Maximum At 1565 - 1625nm: 4.5 to 11.2ps/nm.KM Maximum • Equally, the electronic part must be able to handle the stated standard. **Earthing, Bonding & Surge Protection** • The armouring of optical fibre cables are to be lugged and bonded to Earth bar using at least a soft multi stranded 6 mm^2 insulating cables. • Good grounding (earthing) and bonding is required for the safe and effective dissipation of unwanted electrical current. • All Hand holes must be grounded by the use of splice termination box that has grounding capability inside the handholes.