

**GUIDELINES**

**ON**

**TECHNICAL SPECIFICATIONS**

**FOR THE**

**INSTALLATION OF**

**TELECOMMUNICATIONS MASTS AND TOWERS**

**ISSUED THIS 9TH DAY OF APRIL, 2009**

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# CHAPTER ONE

## 1. GENERAL INTRODUCTION

(1) These guidelines provide standards to be adhered to by telecommunications services providers/operators, designers, fabricators and installers of telecommunications 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 telecommunication 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 Processes, etc.) Regulations 2005 and other applicable laws.

## 2. TYPES OF TOWERS AND MASTS

These guidelines recognise the following types of telecommunication towers, namely;

### (1) Monopole Towers or Post Masts

- (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  $1\frac{1}{2}$  times the pole diameter at the splice.
  - (iv) Pipe diameter should decrease from bottom to top
  - (v) Monopole 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 expected height of a tower, the thickness of the pipe walls, the base diameter and whether the tower shall be guyed or not.

(2) Guyed Towers

- (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 ° 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.

(3) Self-Supporting Towers

- (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

#### (4) Roof Mounts

- (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 support or guyed. However non- penetrating roof mounts are most suitable for flat surfaces.

#### (5) General Features of Towers

- (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 must 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 been exposed to torque that may result in loss of signal during strong winds speeds.

### **3. 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) Telecommunications 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 5 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 would be removed and the owner of the tower would bear the cost of such removal.

## CHAPTER TWO

### 4. DESIGN AND CONSTRUCTION

(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 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 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:

<b>Tower Height</b>	<b>Light Intensity</b>	<b>Light Colour</b>
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.
  - (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  $16\text{kNm}^{-3}$
  - 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.
- (b) Types of Foundations
- (i) *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 should incorporate a minimum safety factor of 2.0 against ultimate soil strength.

(ii) *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 with 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.

(iii) *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 conspicuous location at the tower base.

(iv) *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.

(v) *Foundation Drawings*

- a. Foundation drawings shall indicate structure reactions, material strengths, dimensions, reinforcing steel and embedded anchorage material type, size and location.
- b. Every foundations that is designed for normal soil conditions shall duly be noted and every foundation design shall include site soil data as a footnote.

(vi) *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 shortened 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.

(c) *Anchors*

(i) *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.

(ii) *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.

(iii) *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  $30^{\circ}$  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  $16\text{kN/m}^3$  and concrete  $24\text{kN/m}^3$ .
- 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.

(6) General

(a) 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  $24\text{kNm}^{-3}$ .
- (vi) Concrete mixture must be such as to enable the concrete develop a minimum compressive strength of  $30\text{Nm}^{-2}$  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 should 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 must be used until all concrete is in place.
- (x) The concrete column of the foundation must always be installed inside wood or steel formwork and left in place for 24 hours before removing.
- (xi) When the formwork is removed, concrete must 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  $1.6\text{kNm}^{-3}$ .
- (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.

- (b) Reinforcement
  - (i) 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.
  - (ii) 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.
- (c) Factors of safety
  - (i) In all cases, the factors of safety for foundations and any component thereof against overturning shall be made for the worst design load condition.
  - (ii) In the case of guy anchor blocks, a safety factor of 2 shall be applied to the maximum design guy tension.
  - (iii) 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.
  - (iv) 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.
  - (v) The soil surrounding the foundation shall not be included in the calculation of resistance to uplift and overturning.

## **5. 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 lightning 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 must be prevented from entering equipment rooms.

- (c) Equipotential conditions shall be maintained throughout the site by bonding.
- (d) Due cognisance must 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:

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

Where R is the target resistance

$\rho$  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 among other things the appropriate depth to drive in the copper earth rods, the number of rods and the need for an earth mat, among 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° 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 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.

## 6. 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) 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 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 forbidden.
- (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 of 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 THREE**

### **7. GENERAL SPECIFICATIONS**

#### **(1) Towers and Masts**

- (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 must 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.

(2) The Superstructure

(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 steel
    - Extra High Strength stainless steel or galvanised 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.

(3) Concrete

- (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, flouy 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) Earthing and Lightning Protection Installation Materials

- (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 Ubolts 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.

(5) Metals and Galvanising

- (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

(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 must 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 FOUR**

### **8. MAINTENANCE AND TESTING**

(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.

(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 and that 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.

(3) Tower Maintenance

- (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 after severe winds 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 should show that the inspection or the maintenance was carried out and by whom.

(4) Routine Checks

- (a) The following routine checks should 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 well 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) Annual Preventive Maintenance Checks

- (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 fasteners weather tight and secure
- e. Bulb condition - change all bulbs at the same time immediately before the rated service hours is 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

(6) Testing

(a) Measurement of Guy Tension

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

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

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.

#### The Indirect Method

- e. 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 FIVE

### ENVIRONMENTAL REQUIREMENTS

#### (1) Height

- (a) The maximum height for a telecommunication 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.

#### (2) Space requirements.

- (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.

#### (3) Screening

- (a) The screening of telecommunications masts and towers shall in all cases conform to the followings:
  - (i) The base of all telecommunications 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.

(4) Removal of abandoned towers

- (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 and a minimum penalty of two hundred and fifty thousand naira shall be paid by the owner to the Commission.

(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 employed by the Commission.
- (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) 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 Nigeria Airspace Management Authority.

(7) Shared Use of Towers & 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 telecommunications 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.

(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 rights-of-way, shall be painted to reflect the colour and character of adjoining structures or blend with adjacent landscaping and other surroundings.

(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) 5 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.

(10) Signage

- (a) No signage, lettering, symbols, images, or trademarks in excess of 1200 cm<sup>2</sup> 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 telecommunication 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.

(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.

(12) Obstruction Lighting

- (a) The 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 compensations for accidents occurring as a result of such omissions.
- (13) Tower to Tower Spacing
- (a) The minimum spacing between two or more towers in excess of 55 metres in height shall be 1 (one) kilometre.
- (14) Nearness to Power Lines
- (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.
- (15) Alternative Mounting Structures
- (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.
- (16) Antenna Mounts

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 telecommunications 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) Telecommunications 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 SIX**

### **10. APPLICATION TO THE COMMISSION FOR PERMITS**

- (1) Any person erecting a telecommunications mast or tower whose 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 in the alternative, 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.
  - (e) Detailed information on the software package used in the design to enable easy verification of the fidelity of the design of the structure.

## **11. LICENSE**

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

## **12. 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 SEVEN

### 13. GENERAL MATTERS

#### (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 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) 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.

(2) Basic Wind Speed

- (a) The superstructure should be designed to resist various pressures including wind load, the predominant factor in Nigeria.
  - (i) Every such design shall take cognisance of the fact that:
    - a. Wind velocities constitute the measured data generally available and a conversion has to be made from wind velocity to wind pressure.
    - b. Various existing standards define and measure wind velocity in different ways.
    - c. The formula used to convert these velocities to pressure produce results that can vary as much as 25%, which may translate into a 25% difference in design loads that will produce different foundation sizes.
    - d. The use of basic wind speeds shall be encouraged in the design of wind loading.
    - e. Basic wind speed approach assumes given winds speeds, from meteorological measurement to be at 10m above ground level, and
    - f. Basic wind speed design escalates the wind load from 10 metres above ground level to the top of the structure.
  - (ii) Considering that wind speed escalates with height, structures shall be designed to withstand forceful wind speeds that occur on the average of once every 30 to 50 years.
  - (iii) A gust factor to account for the varying nature of wind shall be incorporated into the design for the structure.
  - (vi) For greater accuracy, the calculation of wind speed should be based upon information provided in the Wind flow Map of Nigeria and Figure 1.2 of the First Schedule to these Guidelines.

(3) Insurance and Compensation

- (a) Owners of telecommunications 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) If 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.

(4) Service Life

- (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.

(5) Tolerable Radiation Level

Tolerable radiation level should be within the limit approved by International Council 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
- (6) Permissible Generator setback, sound level , smoke and vibration.
- (a) All generators within a base station must be sited 5 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.

**14. 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 Telecommunications Masts and Towers are hereby repealed.

**15. 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 telecommunications 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 telecommunications 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 telecommunications tower and/or site by more than one telecommunications 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 telecommunications 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 telecommunications 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 telecommunications 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 no-wind load position at a specified elevation.

"Telecommunications Antenna" means an antenna used to provide a telecommunications service.

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

ISSUED THIS 9<sup>th</sup> DAY OF APRIL, 2009