TECHNICAL CODE

RADIOCOMMUNICATIONS NETWORK FACILITIES - EXTERNAL INFRASTRUCTURE SPECIFICATIONS (FIRST REVISION)

Developed by

Malaysian Technical Standards Forum Bhd

Registered by

MCMC

Registered date: 23 May 2023

MCMC MTSFB TC G040:2023

Development of Technical Codes

The Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) ('the Act') provides for a Technical Standards Forum designated under section 184 of the Act or the Malaysian Communications and Multimedia Commission ('the Commission') to prepare a technical code. The technical code prepared pursuant to section 185 of the Act shall consist of, at least, the requirements for network interoperability and the promotion of safety of network facilities.

Section 96 of the Act also provides for the Commission to determine a technical code in accordance with section 55 of the Act if the technical code is not developed under an applicable provision of the Act and it is unlikely to be developed by the Technical Standards Forum within a reasonable time.

In exercise of the power conferred by section 184 of the Act, the Commission has designated the Malaysian Technical Standards Forum Bhd ('MTSFB') as a Technical Standards Forum which is obligated, among others, to prepare the technical code under section 185 of the Act.

A technical code prepared in accordance with section 185 shall not be effective until it is registered by the Commission pursuant to section 95 of the Act.

For further information on the technical code, please contact:

Malaysian Communications and Multimedia Commission (MCMC)
MCMC Tower 1
Jalan Impact
Cyber 6
63000 Cyberjaya
Selangor Darul Ehsan
MALAYSIA

Tel: +60 3 8688 8000
Fax: +60 3 8688 1000
http://www.mcmc.gov.my

OR

Malaysian Technical Standards Forum Bhd (MTSFB)
MCMC Tower 2
Jalan Impact
Cyber 6
63000 Cyberjaya
Selangor Darul Ehsan
MALAYSIA

Tel: +60 3 8680 9950
Fax: +60 3 8680 9940
http://www.mtsfb.org.my

Contents

Committee representation

The Technical Code was developed by Radio Network Facilities Working of the Malaysian Technical Standards Forum Bhd (MTSFB), constituted by representatives from the following organisations:

Celcom Axiata Berhad

Digi Telecommunications Sdn Bhd

Digital Nasional Berhad

edotco (M) Sdn Bhd

Maxis Broadband Sdn Bhd

REDtone Telecommunication Sdn Bhd

SIRIM QAS International Sdn Bhd

Telekom Malaysia Berhad

TIME dotCom Berhad

U Mobile Sdn Bhd

Webe Digital Sdn Bhd

YTL Communications Sdn Bhd

Foreword

This technical code for the Radiocommunications Network Facilities - External Infrastructure Specifications (First Revision) ('this Technical Code') was developed pursuant to Section 185 of the Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) by the Malaysian Technical Standards Forum Bhd (MTSFB) via its Radio Network Facilities Working Group.

Major modifications in this revision are as follows:

a) Restructuring of all clauses to ensure the clarity of the specifications.

b) Updates on Civil, Mechanical and Electrical specifications.

c) Addition of infrastructure safety requirements.

This Technical Code replaces MTSFB 001:2009, *Technical Standard and Infrastructure Requirements: Radiocommunications Network Infrastructure (External).*

This Technical Code shall continue to be valid and effective from the date of its registration until it is replaced or revoked.

RADIOCOMMUNICATIONS NETWORK FACILITIES - EXTERNAL INFRASTRUCTURE SPECIFICATIONS

1. Scope

This Technical Code outlines the following requirements:

a) the technical requirements for radiocommunications network facilities for new, modified or replacement of structure;

b) the design concepts used in the radiocommunications network facilities, which include Civil, Mechanical, and Electrical (CME) works; and

c) the safety requirements for radiocommunications network facilities for new, modified or replacement of structure.

This Technical Code does not cover broadcasting infrastructure.

2. Normative references

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

For the purposes of this Technical Code, the normative references in Annex A apply.

3. Abbreviations

For the purposes of this Technical Code, the abbreviations in Annex B apply.

4. Terms and definitions

For the purposes of this Technical Code, the following terms and definitions apply.

4.1 Professional Engineer (PE)

Personnel with Practising Certificate registered under subsection 10D of the Act 138, *Registration of Engineers Act 1967 (Revised - 2015)*.

5. Site selection

Radiocommunications network site selection is based on the coverage design requirement by Network Service Providers (NSP) to achieve their coverage area and expected improvements. The site selection shall be based on the criteria below:

a) location of the site;

b) elevation of the site; and

c) availability of the transmission backhaul connection system.

6. Types of radiocommunications structure

The types of radiocommunications structure are as follows:

a) rooftop;

b) landed structure; and

c) temporary - Base Transceiver Station (BTS).

6.1 Rooftop

Rooftop structure includes the radiocommunications equipment and support structure, where the types are listed below:

a) wall mounted antenna pole;

b) floor mounted antenna pole;

c) mini mast; and

d) unipole.

Rooftop structure is commonly located in urban area with high density population and development area with the medium height coverage area.

6.2 Landed structure

Landed structure includes the radiocommunications equipment and structure, where the types are listed below:

a) monopole;

b) lattice tower; and

c) guyed mast.

6.2.1 Monopole structure

A monopole is a single legged tubular tapered steel or concrete specially designed to serve the lower loading of mounting features.

The types of monopole structure are as follows:

a) steel monopole;

b) concrete monopole; and

c) monopole with the option of aesthetic appearance.

Monopole structure is commonly located in the urban area, medium-density population coverage area and availability of transmission backhaul connection at a higher level is required.

6.2.2 Lattice tower structure

Lattice tower structure shall be self-supporting with a base of either 3-legged or 4-legged and mounted on a concrete foundation.

Lattice tower structure is commonly located in rural area, hilly and low-density population coverage areas with the availability of transmission backhaul connection at a higher level.

6.2.3 Other structures

NSP may consider other types of radiocommunication structure in order to provide the required coverage area as follows:

a) multi-functional structure;

b) street furniture; and

c) Minor Communications Infrastructure (MCI).

6.3 Temporary - Base Transceiver Station (BTS)

Temporary BTS shall include a retractable mast for the installation of radio antennas (panel type or omni-directional) and a solid microwave dish on the mast.

Temporary BTS is divided into 2 types of structure:

a) mobile BTS - a temporary structure installed on a movable platform (e.g., truck, van); and

b) portable BTS - a temporary non-movable structure that can be constructed and easily dismantled.

7. Radiocommunications infrastructure design requirements

7.1 Rooftop

Rooftop sites require careful engineering to preserve the structural integrity of the existing roof or wall. Such sites require extra care with regard to the design and appearance of the antennas to be installed.

7.1.1 General requirements

This specification sets out the requirements for the design and construction of an internal room and an external rooftop space as equipment housing for radio sites.

The room and external rooftop space will be a permanent site location while in use. The equipment in the room and external rooftop space is intended for continuous operation. Any equipment upgrade at an existing structure shall be endorsed by PE and structure strengthening shall be done if required.

Any requirements set by the NSP, and authorities shall be adhered to and adopted when designing the site. It is important to ensure the load bearing capacity of an existing building structure is sufficient and shall be endorsed by a PE prior to the implementation of the project.

7.1.2 Technical requirements

7.1.2.1 Indoor type equipment room and cabin

7.1.2.1.1 Dimensions

The room shall have a minimal internal height of 2.6 m. The floor area should be large enough for the installation of radiocommunications equipment's enclosure, main distribution board, air conditional etc.

7.1.2.1.2 Materials

Materials to be used in the room such as floor, walls and ceilings shall be approved by the NSP which will determined by NSP in the Technical Site Survey (TSS) report.

7.1.2.1.3 Doors

The room shall be equipped with a door, with a minimum size of 900 mm x 2,100 mm and shall be constructed by using materials approved by the NSP. The door shall be accessible from both sides.

The doors shall be lockable from the outside by means of a lever tumbler lock.

7.1.2.1.4 Floor

The floor surface shall be made of a 3 mm non-slip, water resistant and hard wearing anti-static vinyl floor tiles.

7.1.2.1.5 Existing walls

The walls shall be treated against dust production, such as by painting.

7.1.2.1.6 Climate conditions

The temperature and humidity shall be in accordance with the environmental specifications of the equipment.

It is important to take special precautions to avoid dust from entering the building along with ventilation air. When using air conditioning systems, caution should be taken to ensure proper disposal of condensed water in the equipment room. This can be done by having appropriate channels in place to ensure that such water is drained out of the system regularly and any accumulated water is extracted appropriately. Furthermore, filters should be used to ensure that ventilation entering the building remains as dust free as possible.

7.1.2.1.7 Loading requirement

The floor, ceiling and all walls shall be dimensioned and designed to withstand the load carried by the equipment attached to them.

The floor shall support the load of the cabinets and a distributed load of 2 kN/m^2 for spaces not occupied by cabinets.

The walls shall be able to withstand a minimum load of 35 kg from a cabinet and the ceiling and walls shall be able to withstand a load of 20 kg/m from a cable ladder.

7.1.2.1.8 Cable management and cable entries

7.1.2.1.8.1 Cable ladder racking

Cable ladders and mounting ancillaries shall be galvanised in accordance with the MS 739 and MS 740 for all external applications. Cable ladders shall be of sufficient width to accommodate all intended cables.

Waveguide or feeder cable supports shall be provided at a spacing recommended by the manufacturer. These support points are to be located adjacent to the access ladder for ease of installation and maintenance. If the support points are located directly behind the access ladder, a minimum of 200 mm space clearance between the ladder and feeder cables shall be maintained.

7.1.2.1.8.2 Cable entries

The NSP shall approve the cable entry gland provided and installed by the vendors.

7.1.2.1.9 Mechanical services

7.1.2.1.9.1 Air-conditioning system

The proposed air-conditioning system shall be able to keep the indoor temperature and relative humidity as required by the NSP.

7.1.2.1.9.2 High temperature sensor

A temperature sensor shall be available to register when the room temperature has exceeded the pre-determined limit. The temperature sensor can be either built-in within the radiocommunications equipment or a separate sensor to be installed or located at a minimum of 400 mm below the ceiling.

7.1.2.1.10 Electrical services

7.1.2.1.10.1 Design layout

The electrical installations shall be designed in accordance with the rules and regulations by the relevant authorities.

The electrical services installation shall consist of the following main elements:

a) Mains power distribution system

   The mains power distribution system shall consist of an intake point and a power distribution board. The distribution board shall be a single phase or three phase metal clad type and shall be fitted with the necessary Mains Circuit Breakers (MCBs) as per the NSP requirement.

   A circuit layout shall be affixed to the inside of the front cover of the distribution board and shall be presented in a neat and tidy manner and laminated in a clear plastic weatherproof envelope. All labelling shall comply with any relevant wiring regulations.

b) Lighting

   The room shall be provided with ceiling mounted high efficiency fluorescent lighting giving at least 300 lux at floor level. The room shall be installed with a 3-hour emergency lighting. The lighting fitting shall be controlled from a switch near the entrance.

c) Small socket power outlet

A surface mounted twin socket outlet shall be provided. The socket outlets shall be connected in a radial circuit using 4 mm^2 MCB located within the distribution board.

Supplies to fixed equipment shall be provided as required, fed from radial circuits protected by the MCB. The circuits to the Direct Current (DC) power supply unit shall be provided. The circuits shall run directly from the MCB provided in the distribution board for that purpose.

All items shall be labelled.

d) Earthing facility and cross bonding

The earthing of the installation shall comply with the requirements of any relevant wiring regulations.

An earth point shall be installed at a high level adjacent to the telecom cabling entry gland. Earth connections to the telecom earth bar shall be provided in accordance with the NSP requirement. In addition, the steel door frame shall be connected to the earth including other metal parts in the room's vicinity if applicable.

e) Fire extinguisher

A fire extinguisher with a minimum of 2 kg CO_2 type shall be mounted on the wall in accordance with the floor plan layout. The fire extinguisher shall have the manufacturer's name and test label attached with the original date of issue marked on it. The fire extinguisher shall be maintained periodically as per the manufacturer’s schedule and the requirements by the authority.

f) Security facility

The room door system shall be provided with a reed switch door contactor to monitor the site access from unauthorised intrusion.

g) Wiring system

The wiring system shall comprised of copper with Permanent Virtual Circuit (PVC) single insulated cables in accordance to BS 6004. The cables should generally be installed within a conduit or trunking in a neat and tidy manner.

The sizing of all electrical cables shall consider voltage drop, grouping, and environmental conditions in accordance with any relevant wiring regulations.

7.1.2.2 Outdoor type equipment cabinet

7.1.2.2.1 Dimensions

The floor area should be large enough for the installation of radiocommunications equipment enclosure, mains distribution board, cable ladders, etc.

7.1.2.2.2 Materials

Materials to be used shall comply with the requirements defined in 7.1.2.1.2.

7.1.2.2.3 Cabinet location

The equipment location design and technical specification shall follow the requirements as determined by the NSP in the TSS report.

7.1.2.2.4 Earthing and lightning protection

Earth continuity conductors and earth leads shall be of high-conductivity copper, or any other type of conductor treated with anti-corrosive material, which are continuous throughout their whole lengths and without joints, except by means of approved mechanical clamps. Where connections are made at switchgear and such items of electrical equipment, the conductors shall terminate in soldered or compression-type sockets.

In the case of Mineral-Insulated Copper-clad Cable (MICC) or PVC cables is used, the copper outer sheaths of the cables may be utilised as earth continuity conductors. The termination of each cable-run the copper sheaths (or sheaths in the case of single-core, multiple runs of MICC or PVC cables) shall be effectively bonded to earth.

Every circuit of a switchboard, distribution board, control board, tap-off unit and splitter switch-fuse unit shall be provided with its own earth-continuity conductor.

In hazardous locations, additional earth continuity conductor networks with their own earth electrode systems shall be provided for bonding metalwork to earth. Such networks, when required, shall be indicated on relevant layout drawings.

The impedance measured at any of the earth chambers connected as part of the earth grid shall not exceed 10 Ω.

For earth electrode system, electrodes shall comprise of 16 mm diameter, 1.6 m long, extensible-type, copper-steel-cored rods (‘copper weld’ or approved equivalent make), driven into the ground at an interval of at least twice the driven length of any 2 electrodes. Electrodes shall be driven into ground by means of a ‘KANGO’ or similar type electric or pneumatic hammer. Every connection clamp shall be provided with regulation-type concrete inspection chamber and cover.

The number of electrodes installed shall be 3 to 5 earth points at each site. Each earthing point shall consist of 2 rods and the minimum length of each electrode shall be 1.5 m. The length between each point shall be 6 m, which is 2 times the earth points vertical length. The numbers of earthing points indicated in the drawings are indicative only and shall in no way imply that the earthing points are sufficient to obtain the value of less than 10 Ω.

The contractor shall increase the driven length or number of earth electrodes and if necessary, non-soluble earth enhancing compound to be considered to obtain the required earth resistance, subject to the approval of service providers. In exceptionally bad areas, the contractor shall propose the use of extra copper earth grids and earth enhancing compound to achieve the desired earth resistance value.

Each MCI structure and its equipment must have a lightning protection air termination or lightning rod installed on top. In case the structure is attached or located nearby buildings with sufficient lightning protection system, it may not be compulsory for the said structure to be installed with its own lightning protection system.

7.1.2.3 Roof access, climbing ladders, walking and working platform

The infrastructure material, design and method of installation shall comply with the JKKP DP/G 127/379/4-35 or at least recommended and endorsed by PE.

7.1.2.4 Structure design requirements

This clause deals with the analysis and design aspects of floor and wall mounted structures. Total dead weight shall be divided into the following categories:

a) structure self-weight;

b) equipment weight; and

c) ancillaries weight.

7.1.2.4.1 Design and analysis assumptions

Member end conditions, its reference axis and any conditions that will affect the analysis due to the computer program in-built assumptions, such as connected leg, allowance for loss in metal due to connection or splicing, orientation of principal axes, etc shall be clearly defined. The assumption of the conditions of support should be appropriate and be clearly stated. Whether static, dynamic analysis or spectral analysis is to be used should be clearly defined and reference to the appropriate standards and codes of practice. Second order effects may be required to be checked to ensure that the structures are safe and reliable where it involve analysis of the design for the structural systems.

7.1.2.4.2 Analysis and design standards

All standards and codes of practice shall be defined correctly and applied consistently between analysis and design. If code of practice for design of building is used for the detailed member design and stresses check, it should be shown clearly and explicitly that it is appropriate for such design. All load factors and material factors, its derivation and appropriateness in use should be clearly stated.

7.1.2.4.3 Grade of steel

All steel grades used shall be clearly specified. If different grade of steel is to be used in the same structure, the method of identification of members after galvanising and control at site should be clearly specified.

A tensile test shall be carried out to determine the actual strength of the steel supplied. Mill certificate for the batch of members used should also be provided.

7.1.2.4.4 Loading and load cases

Load cases are to be clearly shown, whether primary loading cases or combinations of load cases. Loading derivation should be clearly defined for each ancillary item. The appropriate clauses of the adopted loading code should be clearly stated for each load derivation.

The load factor as required by the chosen code of practice should be clearly defined and shown explicitly in the various load combinations generated.

The position and direction of each antenna shall be put in such a manner that when combined with others produce the maximum forces in the structure. It should be noted that the disposition of each antenna shall not be limited to one on each face but in any manner possible and practical that results in maximum stresses being generated in the floor and wall mounted structure.

7.1.2.4.5 Design of members

All members (primary, secondary, and all other related members) shall have detailed design calculations. Allowances for loss in cross-sectional area of a member due to its end or intermediate connection need to be clearly shown.

7.1.2.4.6 Design of joints

Detailed design calculations of all joints (welds, bolts, plates, stiffeners, etc) shall be shown. Derivation of the appropriate design strength of connecting elements shall be clearly stated. Prying force in tension connection using bolts shall be accounted for.

7.1.2.4.7 Design and analysis method

The tower design shall make use of verifiable, commercially available, comprehensive 3D structural engineering software with a direct emphasis on lattice tower design and analysis. The software shall also draw extensive reference to the equivalent code of practice. Detailed printouts shall be attached to the report inclusive of input and output files. The wind load is applied to the tower in a full 360 degrees.

7.1.2.4.8 Report and calculation structure design

All calculations should be compiled in the following order and should be endorsed by a PE registered under the Act 138, *Registration of Engineers Act 1967 (Revised - 2015).*

Calculations submitted shall be sufficiently detailed for an independent appraisal to be carried out when required. All calculations shall be submitted in hard and soft copy, in the original format to the owner of the structure for their future reference. All relevant input and output from relevant software files shall be provided in soft copy.

The report shall contain but not limited to, information in the following format:

a) introduction;

b) assumptions; and

c) design parameters.

The design standards and codes of practice are listed below:

a) derivation of wind resistance and drag coefficient shall be clearly stated;

b) loading (dead load, antenna load, imposed load and wind load);

c) summary of structure analysis;

d) summary on structure stability;

e) summary on structure design; and

f) summary on structure deflection.

The above report shall also include appendices section which shall contain an appropriate method of analysis, depending upon the structure type, which shall be explicitly stated for compliance;

a) equivalent static method; and

b) non-linear analysis.

The appendices deliverables shall contain the following items:

a) detailed structural analysis calculations;

b) detailed wind load calculations;

c) detailed design of mounting method; and

d) detailed design of counterweight and holding down bolts for structures.

7.1.2.4.9 Design loadings and standards

7.1.2.4.9.1 Loading and dead imposed

The loading and dead imposed factors are described in Table 1.

Table 1. Loading and dead imposed factor

Standards	Floor usage	Design imposed load
BS 6399: Design loading for buildings a) Part 1 - Code of practice for dead and imposed loads b) Part 3 - Code of practice for imposed roof loads	Roof with no public access	0.75 kN/m^2
	Roof with public access	1.50 kN/m^2

A sample of the loads imposed on a structure is shown in Annex C.

7.1.2.4.9.2 Wind loading derivation

The wind loading derivation are described in Table 2.

Table 2. Wind loading derivation

Standards	Specified design	Wind speed
BS 8100 - Lattice towers and masts a) Part 1 - Code of practice for loadings b) Part 4 - Code of practice for loadings of guyed masts	3-sec gust wind speed	33.5 m/s (120.6 km/h)
MS 1553 - Code of Practice on Wind Loading for Building Structure	Hourly mean wind speed	22 m/s

Partial safety factors shall be determined in accordance with BS 8100: Part 1 for mast and towers, and BS 8100: Part 4 for guyed masts.

Classification of structure shall be a minimum of Class B.

Network Facilities Providers (NFP) shall ensure that the design, fabrication, construction, and materials used for the tower and mast structures can meet the requirements specified above, as defined in BS 8100 and MS 1553.

Terrain classification for structure design shall follow the recommendations in BS 8100 and appropriate to the site of application.

The design drawings and details of the structure shown in other parts of this document are strictly for reference and guidance only, with the structure classified as above. A designer is required to submit a design of the structure based of NFP requirements. The contractor and their PE shall be liable for all their designs and subsequent submissions.

7.1.2.4.9.3 Steel design

All steel sections used shall comply with the following standards and requirements.

a) BS 5950:2000 Part 1 - Code of practice for design of rolled and welded sections or its equivalent. Gamma factor for material shall be 1.15.

b) BS 8100: Part 3 - (DD133: 1986) Code of practice for strength assessment of members of lattice towers and masts or its equivalent.

BS 5950 cannot be used as a direct design reference without giving due considerations as outlined in BS 8100: Part 3 - (DD133:1986) or its equivalent.

For the steel structure, the following standards in Table 3 or any equivalent standards shall be complied with.

Table 3. Steel structure requirements

Structure	Standards
Angles	MS EN 10025-2 or equivalent
Circular hollow sections	MS EN 10210-1, BS EN 10210-1, or equivalent
Bars	BS 4449 MS 146
Welding	a) Class 35 as per BS 5950-2 b) Yield stress, f_y = 355 MPa or other grades may be used where appropriate
Bolts	BS 3692 - ISO metric precision hexagon bolts, screws and nuts
NOTE: ISO is International Organisation for Standardisation.	

7.1.2.5 Aesthetic requirements

Figure 1 until Figure 4 illustrate options of practice to hide the existing Antenna Mounting Structure (AMS) presence on a building roof-top where Radio Frequency (RF) transparent material is used to camouflage the antenna structures. The camouflage design shall be endorsed by PE for safety and method of installation.

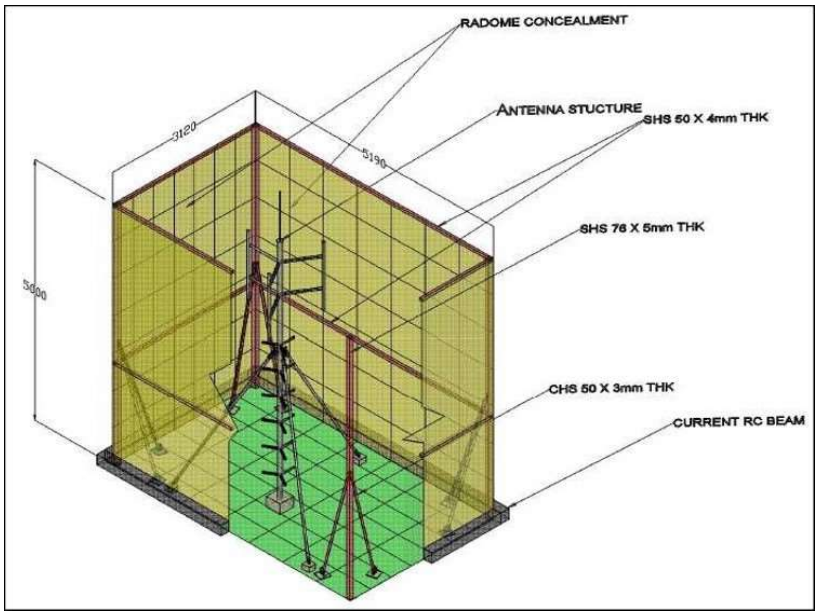


Figure 1. Conceptual design for antenna or radome and boom structure concealment using RF transparent material

Figure 2. Chimney concealment system

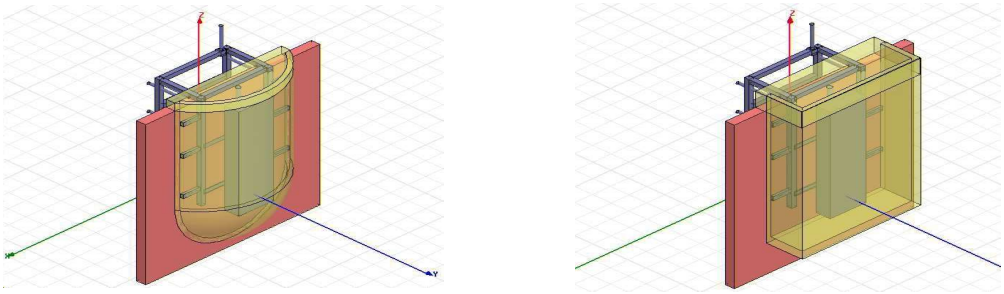


Figure 3. Design using concealment panels

Figure 4. Roof top concealments

7.2 Landed structure

7.2.1 Monopole

This clause sets out the requirements and specifications for monopole structure. The examples of the monopole design are illustrated in Figure 5 until Figure 7.

Figure 5. Steel monopole

Figure 6. Concrete monopole

Figure 7. Monopole tree

7.2.1.1 General requirements

A monopole structure should be self-supported and be made from hot dip galvanised steel or concrete. The structure to be equipped with a climbing ladder and a fall arrest device.

Access ladder should be made from hot dip galvanised steel and attached to the structure. Anti-climbing devices shall be provided on the structure to prevent access except from the climbing ladder.

Monopoles shall comply with all current safety, design, structural and wind loading standards.

Platforms and walkways shall be designed to carry a design load. Railing with intermediate rail shall be provided on all platforms, stairway and horizontal members used as walkway.

Antenna mounting frames shall be designed upon consideration of the tower structure, type of antenna, size and weight.

The foundation of the monopole is to be designed to withstand the load of self-weight, antenna, feeders, wind loading and other attachments to the structure.

7.2.1.2 Technical requirements

7.2.1.2.1 Basic design wind speeds

The monopole shall be designed, for the purpose of assessing its structural strength to a basic design wind speed of 33.5 m/s as stipulated in MS 1553 (120.6 km/h) 3-second gust speed or 22.22 m/s mean hourly wind speed for all sites. This corresponds to a return period of 1 in 50 years. For compliance check for maximum deflection (sway) of the monopole, a 1 in 20-year return period wind speed of 30 m/s (3-second gust) or 20 m/s mean hourly wind speed shall be used.

7.2.1.2.2 General design loads

The structures shall be designed so that no failure or permanent distortion occurs on any part of the structures during the simultaneous application of the loads in their specified loading configuration.

The details on design load requirements for 30 m and 45 m poles are as in Table 4 until Table 6. The following information is applicable to Table 4 until Table 6.

a) Tables are based on maximum requirements for design loading.

b) Table are based on ideal cases and number of antennas that can be added based on the maximum loading calculation.

Table 4. Design loads for 45 m pole (Maximum 5-way) - 3 Tier

Item	Measurement		Weight per unit (kg)	Distance measured upward from the bottom of tower			
Parabolic antenna	-	-	-	43.5 m	40.5 m	37.5 m	34.5 m
	Diameter	1.2 m	70	10 nos	-	-	-
	Dimension	2,600 H x 500 W x 210 D (Passive antenna)	40	-	9 nos	6 nos	-
		795 H x 400 W x 225 D (Active band)	40	-	3 nos	-	-
Radio Remote Unit (RRU)	Dimension	485 H x 400 W x 170 D	30	-	9 nos	6 nos	-

Table 5. Design loads for 45 m pole (Maximum 5-way) - 5 Tier

Item	Measurement		Weight per unit (kg)	Distance measured upward from the bottom of tower			
Parabolic antenna	-	-	-	43.5 m	40.5 m	37.5 m	34.5 m
	Diameter	1.2 m	70	2 nos	2 nos	2 nos	2 nos
	Dimension	2,600 H x 500 W x 210 D (Passive antenna)	40	3 nos	3 nos	3 nos	3 nos
		795 H x 400 W x 225 D (Active band)	40	-	3 nos	-	-
RRU	Dimension	485 H x 400 W x 170 D	30	3 nos	3 nos	3 nos	3 nos

Table 6. Design Loads for 30 m pole (Maximum 4-way) - 2 Tier

Item	Measurement		Weight per unit (kg)	Distance measured upward from the bottom of tower			
Parabolic antenna	-	-	-	28.5 m	25.5 m	22.5 m	19.5 m
	Diameter	1.2 m	70	4 nos	4 nos	-	-
	Dimension	2,600 H x 500 W x 210 D (Passive antenna)	40	6 nos	6 nos	-	-
		795 H x 400 W x 225 D (Active band)	40	3 nos	-	-	-
RRU	Dimension	485 H x 400 W x 170 D	30	6 nos	6nos	-	-

7.2.1.3 Concrete monopole design

Concrete material shall comply with the following requirements as tabulated in Table 7.

Table 7. Requirements for material

Item	Design
Concrete	a) Minimum grade = 50 MPa b) BS 8500-1-2006, Concrete - Method of specifying and guidance for the specifier c) MS EN 197-1-2014, Cement d) MS EN 1008-2010, Water for Concrete e) EN 12390-3, Compressive strength of specimens f) EN 12390-1-2012, Testing Concrete
Admixture	MS EN 934-2-2012, Admixture
Prestressing tendons	a) BS 5896:2012 b) Prestressing strand
Steel flanges	a) BS 5950-1-1990, Structural steel hot rolled BS 5950-1:2000 b) BS EN 10029, Tolerance for hot-rolled steel plates 3mm and more c) BS EN 10025-1:2019, Hot rolled products of structural steels d) MS EN 10025-2: 2011

Bolts	a) Grade 8.8 to BS3692 b) Bolt shank shall be sufficient long to accommodate nut and washer, such that no connecting part shall bear on the bolt thread.
Reinforcement	a) JIS G 3532, Low Carbon Steel wires JIS G 3532:2011 b) BS 4482, Steel wire for concrete c) MS 144:2014 d) MS ISO 16120-2
Load factor	a) Minimum 1.7

7.2.1.4 Aesthetic requirements

The structure should have a good appearance with realistic shape, foliage and bark that can provide a good cover for the antenna and any associated equipment. The appearance of the tree should look like those found locally in the country. The maintenance of the accessories (foliage and bark) on the structure should be carried out as specified by the manufacturer.

The sample of monopole tree design is illustrated in Figure 8. Arrows in Figure 8 indicate the antennas which are installed under the cover of the artificial foliage.

Figure 8. Sample of monopole tree

All RF feeder cables are installed on the outside of the artificial tree trunk. For a monopole lamp structure, the RF feeder cables run inside the structure.

The structure shall be solidly grounded for lightning protection.

The structure shall be equipped with an access ladder from the base to the platforms and a vertical fall arrest system for maintenance and safety purpose.

For the monopole tree structure, the area is generally fenced up for security measures. In an unfenced area, the foundation should be provisioned for feeder cable ducts to cater for concealed cables between the monopole structure and the equipment enclosure.

The camouflage design shall be endorsed by PE for safety and method of installation.

7.2.2 Lattice tower structure

The lattice tower shall be a self-supporting hot-dip galvanised steel structure. The base of the 3-legged or 4-legged lattice towers shall form an equilateral triangle or square respectively. The base width shall not be more than 1/7th of the lattice tower height and top face width shall be 2,000 mm as measured on plan.

7.2.2.1 General requirements

7.2.2.1.1 Land requirements

The land should be large enough for the installation of an AMS, equipment enclosure, generator set, fuel tank and electrical feeder pillar with metering and mains distribution board.

For maintenance purposes, the compound should cater for a 2-ton lorry to turn around unless this is already catered for outside the gate area.

For predetermined shared sites, cabins or outdoor equipment should be mounted on a concrete plinth designed for the maximum number of intended cabins or outdoor units. This is to avoid disruptive construction works in future upgrades of the plinth.

For this purpose, the plinth shall be equipped with access to power and grounding pits with the use of embedded Polyvinyl Chloride/Galvanised Iron (PVC/GI) ducts and junction pits.

7.2.2.2 Technical requirement

7.2.2.2.1 Lattice tower design requirements

This section deals with the analysis and design aspects of lattice towers and masts.

The tower and mast shall be designed to support the following loads:

a) Tower self-weight including antennas, platforms, ladders, feeders, cables etc.

b) Wind load on the tower at all directions (360 deg. from the Geographic North).

c) Wind load on structures other than tower i.e., antennas, ladders, feeders etc.

7.2.2.2.1.1 Design and analysis assumptions

Design and analysis assumptions shall comply with the requirements defined in 7.1.2.4.1.

7.2.2.2.1.2 Analysis and design standards

Analysis and design standards shall comply with the requirements defined in 7.1.2.4.2.

7.2.2.2.1.3 Grade of steel

Grade of steel shall comply with the requirements defined in 7.1.2.4.3.

7.2.2.2.1.4 Loading and load cases

Loading and load cases shall comply with the requirements defined in 7.1.2.4.4.

7.2.2.2.1.5 Overall stability of structure

The overall stability of the structure against overturning, deflection, sway, and stress ratio needs to be checked by structure owner. The appropriate factor of safety adopted; the relevant forces (due to different loading combinations) should be clearly shown.

7.2.2.2.1.6 Foundation design

The design of foundations shall be in accordance with BS 8004 and should accommodate all the forces (from different load combinations) imposed on them. The forces used for the foundation design shall be strictly in accordance with the recommendations of BS 8100. No reduction in loading due to gustiness should be allowed. When tensile force is present in the foundation, design should be shown to be appropriate to the response of soil in resisting gusty uplift forces. No dispersion of tensile stresses in soil is allowed for footing foundation.

7.2.2.2.1.7 Design of members

Design of members shall comply with the requirements defined in 7.1.2.4.5.

7.2.2.2.1.8 Design of joints

Grade of steel shall comply with the requirements defined in 7.1.2.4.6.

7.2.2.2.1.9 Vertical cable ladders

Design calculations of vertical ladder shall be shown in detail including joints to the main structure.

7.2.2.2.1.10 Design and analysis method

Design and analysis method shall comply with the requirements defined in 7.1.2.4.7.

7.2.2.3 Foundations and support structures

For masts, foundation stiffness, such as beam support to mast, shall be included in the same analysis of the superstructure. Stress concentration and contact pressures from the superstructure onto the supporting structure, where applicable, shall be considered.

Prior to foundation design, the Soil Investigation (SI) Report shall be made available to the designer and owner of the structure. SI shall be conducted using methods of Bore Hole or Mackintosh Probe.

The foundation concrete material design shall comply with the following standards below or any equivalent standards:

a) BS 8500-1 Concrete-Method of specifying and guidance for the specifier; and

b) Gamma factor for steel stress shall be 1.15 for ultimate load design and 1.60 for service stress design.

For towers, the following deliverables shall be provided for the different foundation designs:

a) For pilling foundation, it is to determine:

    i) geotechnical capacity of the pile;

ii) depth of pile (to be estimated from the soil investigation reports); and

iii) design of the pile cap.

b) For pad foundation - design of the pad footing.

All drawings should be prepared, endorsed by PE and submitted in the following order:

a) All drawings in AutoCAD format shall be submitted at various stages

i) Planning and approval stage - design drawings (detailed construction drawings);

ii) Preconstruction (substructure) stage - piling records and foundation design;

iii) Preconstruction (superstructure) stage - erection drawings (detailed erection drawings); and

iv) Handover stage - as built drawings (detailed as-built drawings).

7.2.2.4 Report and calculation layout

All calculations should be compiled in the following order and should be endorsed by a PE registered under Act 138, *Registration of Engineers Act 1967 (Revised - 2015).*

Calculations submitted shall be sufficiently detailed for an independent appraisal to be carried out when required. All calculations shall be submitted in hard and soft copy, in the original format to the owner of the structure for their future reference. All relevant input and output from relevant software files shall be provided in soft copy.

The report shall contain but not limited to, information in the following format:

a) introduction;

b) assumptions; and

c) design parameters, standards and codes of practice as listed below:

i) derivation of wind resistance and drag coefficient;

ii) loading (dead load, antenna load, imposed load and wind load);

iii) summary of lattice tower analysis;

iv) summary on lattice tower stability;

v) summary on lattice tower design; and

vi) summary on lattice tower deflection.

d) appendices section shall contain an appropriate method of analysis, depending on the structure type, which shall be explicitly stated for compliance.

i) Equivalent static method; and non-linear analysis.

ii) Detailed structural analysis calculations.

iii) Detailed wind load and member capacity calculations

iv) Detailed design of joints, base plate and holding down bolts for towers.

7.2.2.5 Designs loadings and standards

7.2.2.5.1 Loadings (dead and imposed)

Loadings shall comply with the requirements defined below:

a) BS 6399: Design loading for buildings; and

b) Part 1: 1996 - Code of practice for dead and imposed loads

A sample of the loads imposed as shown in Annex C.

7.2.2.5.2 Wind loading derivation

The specifications of wind loading derivation are described as per Table 8.

Table 8. Wind load specifications

Standards	Specified design	Wind speed
a) BS 8100:1986, Lattice towers and masts, Part 1 - Code of practice for loadings. b) BS 8100: 1999, Lattice towers and masts, Part 3 Code of practice for strength assessment of members of lattice towers and masts. c) Part 1 - Code of practice for loadings d) BS 8100:1995, Lattice towers and masts, Part 4, Code of practice for loadings of guyed masts. e) TIA-222-G (H), *Structural Standard for Antenna Supporting Structures and Antennas* f) MS 1553*, Code of Practice on Wind Loading for Building Structure*	3 sec gust wind speed	33.5 m/s (120.6 km/h)
	Hourly mean wind speed	22 m/s
NOTE: For dated standards, only the edition cited applies. For undated standards, the latest edition including any amendments applies		

Partial safety factors shall be determined in accordance with BS 8100:Part 1 for masts and towers BS 8100:Part 4 for guyed masts.

Industrial structure classification of Class B shall be adopted as a minimum.

The contractor shall ensure that the design, fabrication, construction, and material used for the tower and mast structures can meet the requirements specified above as defined in BS 8100.

Terrain classification for tower and mast structure design shall follow the recommendations in BS 8100 and appropriate to the site of application.

The design drawings and details of the tower and mast as shown in other parts of this document are strictly for reference and guidance only, with the structure classified as above. A contractor is required

to submit the design of the tower and/or mast to the specified class standard. The contractor and their PE shall be liable for all their designs and subsequent submissions.

7.2.2.6 Steel design

Steel design shall comply with the following standards as below:

a) BS 5950:2000 Part 1, Code of practice for design of rolled and welded sections;

b) Gamma factor for material shall be 1.15;

c) BS 8100: Part 3 - (DD133: 1986), Code of practice for strength assessment of members of lattice towers and masts;

d) BS 5950 cannot be used as a direct design reference without giving due considerations as outlined in BS8100: Part 3 - (DD133: 1986); and

e) Materials - Tower and mast structure design:

For the lattice component, the following standards in Table 9 or any equivalent standards shall be complied with.

Table 9. Lattice component

Lattice component	Design
Angles	a) MS EN 10025-2: 2011 or equivalent b) Product name: Hot rolled products of non-alloy structural steel
Circular hollow sections	a) MS EN 10210-1: 2017; BS EN 10210-1: 2006 or equivalent b) Hot finished structural hollow sections of non-alloy structural steel
Bars	a) BS 4449: 2005 A 2016 b) MS 146 : 2014 c) Hot or cold worked ribbed weldable reinforcing steel
Welding	a) Class 35 as per MS EN 10210-1: 2017; BS EN 10210-1: 2006 b) Yield stress fy = 355 MPa other grades may be use where appropriate
Bolts	a) BS 3692: 2001 b) Specification - ISO metric precision hexagon bolts, screws and nuts
NOTE: For dated standards, only the edition cited applies. For undated standards, the latest edition including any amendments applies	

7.2.2.6.1 Mains power distribution system

The mains power distribution system should consist of an intake point located in the floor of the cabin or power distribution unit for outdoor system and a power distribution board. This is a 3-phase metal clad type fitted with the necessary MCB.

A circuit schedule should be affixed to the inside of the front cover of the distribution board; neatly presented and enclosed within a clear plastic envelope. Labelling should be provided to comply with any relevant wiring regulations.

7.2.2.6.2 Lighting

The cabin should be provided with ceiling mounted high efficiency fluorescent lighting, giving 200 lux to 300 lux at floor level. It may also be provided with emergency lighting or a KELUAR sign. These should be considered as essential loads and powered by the rectifier system.

Switches for the control of light fittings should be provided inside the cabin, which is near the entrance.

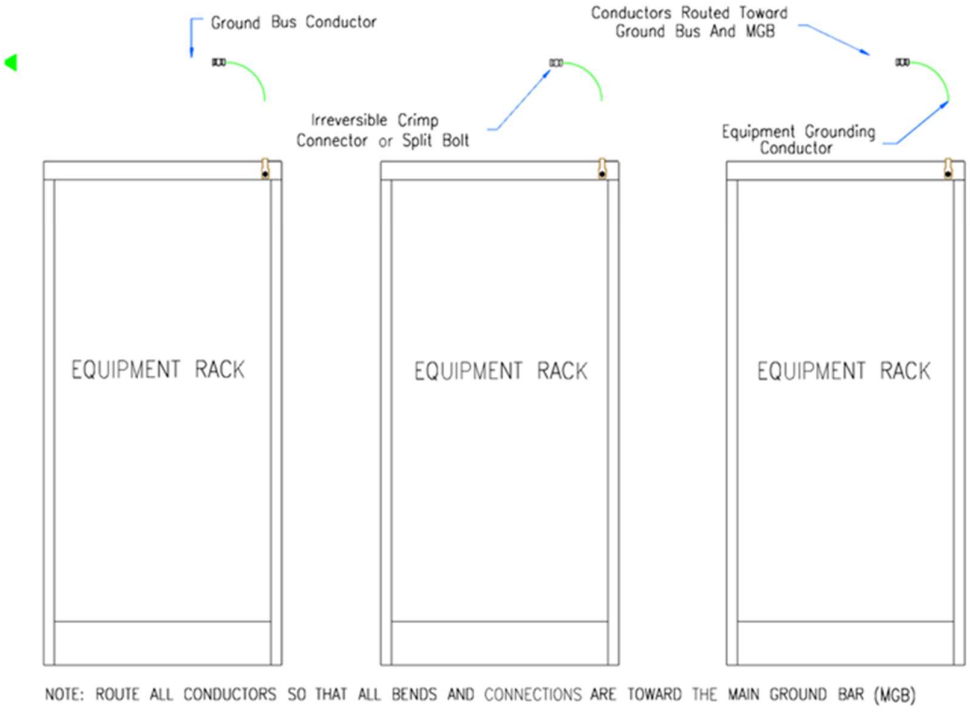
7.2.2.6.3 Small power installation

Surface mounted twin Switch Socket Outlets (SSO) should be provided for test equipment and other maintenance appliances. They should be located on opposite sides of the cabin.

7.2.2.6.4 Earthing scheme

In all electrical installation or an electricity supply system, an earthing or grounding system connects specific parts of the installation with the earth's conductive surface for safety and functional purposes.

Figure 9 shows the usage of crimp connectors to connect cabinets and cable ladder to the ground bus conductor, which connecting cabinets and cable ladder to the ground.



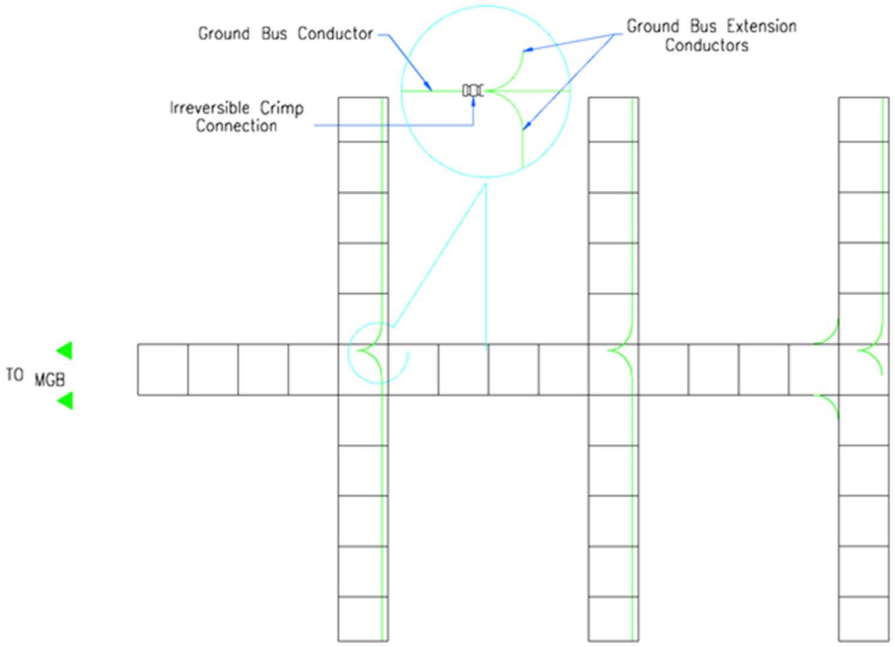


Figure 9. Usage of crimp connectors

7.2.2.7 Power supply system

The radiocommunications equipment is necessarily powered up using a permanent power supply. The electrical installation personnel shall be registered with the authority body. All relevant documents for submission should be duly endorsed by Mechanical and Electrical Systems (M&E) PE registered under Act 138, *Registration of Engineers Act 1967 (Revised - 2015).*

The station shall be equipped with a 3-phase supply at the following amperage:

a) 60 A for stand-alone sites; and

b) 100 A for shared sites.

Redundancy in the form of a generator set is provided depending on site conditions such as the function of the site, availability, and reliability of the utility supply. A backup policy can be observed in the provisioning of generators as shown in Table 11.

Table 11. Suggested backup policy for the provision of generator set in the station

Site category	Grid supply availability	Quantity of generator set
Rural trunk and collection point [w/ SDH links]	Yes	1
	No*	2
Urban trunk and collection point [w/ SDH links]	Yes	-
Non-collection point	Yes	-

	No*	2

Generator sets are recommended at 60 kVA for shared sites and 30 kVA for stand-alone sites. Annex D shows the sizing of the generator set for a station with cabin and with outdoor equipment.
In cases where power grid is not accessible, alternative power solution shall be proposed depending on site suitability.

7.2.2.7.1 Alternative power supply

A generator set, solar panel or hybrid solution can be an alternative power supply in a situation where there is no permanent power supply. The installation of solar panels shall comply with the relevant authority body.

7.2.2.7.2 Direct Current (DC) supply

Radiocommunications equipment should utilise DC supply of - 48 V. A rectifier system converts the incoming 240 V_{AC} supply into the required DC voltage level. There may be legacy equipment utilising a 24 V_{DC} supply in which case a DC-DC converter powered by the same rectifier system should be used.

This is to avoid having additional battery banks that will take up space and adding load to the equipment cabinet, which is also easier for maintenance and system supervision.

The DC supply system should be designed with redundancy in the form of N + 1 rectifier modules and backup battery banks in case of rectifier faults or Alternating Current (AC) outages.

The battery bank is made up of battery cells ranging from 2 V to 6 V, string up in series to achieve the desired - 48 V. Use of 2 V cells provides better battery reliability as failure of one cell only reduces the system voltage to 46 V while only 42 V is left if a 6 V cell fails. Some equipment may be affected by such a fall in system voltage. The advantage of 6 V battery cells is the lower cell count in a battery bank.

There should be 2 numbers of battery bank to allow for any one of them to be decommission for maintenance purposes. The capacity of the banks will depend on some backup policies as shown in Table 12. Typical values are 4 hours discharge (backup) and 10 hours recharge. See Annex E for backup battery sizing.

To contain the size and weight of the banks to manageable values, load shedding may be built into the rectifier system. Equipment with low traffic and high power are shed off after 4 hours affording the high-capacity links and the essential loads with more backup hours. Cascaded sites that are linked by Medium Wave (MW) radios downstream therefore have a higher probability of survival.

Table 12. Suggested backup policy for the provision of battery banks in a standalone site (cabin type)

Equipment	Quantity	Unit load (W)	Load (W)	Output voltage (V)	Battery backup (h)
SDH MW radio	2	150	300	48	6
PDH MW radio	3	150	450	48	4
Mux	2	165	330	48	4
DXX cross connects	1	200	200	24	4
BTS (6 + 6 + 6 TRX)	3	1,080	3,240	48	2

Ventilation fan*	2	100	200	240 V_{AC}	6
KELUAR sign*	1	5	5	240 V_{AC}	6
Emergency lighting*	2	50	100	240 V_{AC}	6
		Total load (W)	**4,540**		

NOTES:

1. SDH is Synchronous Digital Hierarchy.
2. PDH is Plesiochronous Digital Hierarchy.
3. DXX is Digital Cross Connect.
4. BTS is Base Transceiver Station.
5. TRX is Transceivers.
6. * is powered from the battery banks.

7.2.2.7.3 Wiring management

Factors to consider in choosing a wiring system should include its usage, types of installation, environment, and also economic constraints. For safety purposes, all underground and outdoor cables shall be cased with protective conductors. In general, all cables should be installed within a conduit or trunking in a neat, tidy and safe method compliant with any relevant wiring regulations.

7.2.2.8 Aircraft warning lights

All structures should comply with aviation warning lights requirements of the Civil Aviation Authority of Malaysia (CAAM) (formerly known as Department of Civil Aviation (DCA)) and Civil Aviation Directive (CAD) in conjunction with the recommendations of the International Civil Aviation Authority (ICAO) and the Federal Aviation Administration (FAA) regulation.

The light fixtures should be designed to IP65 and capable of remote alarm indications should any of the luminaires fail. Long runs of cables up the tower should be encased in GI pipes and flexible metallic conduits securely grounded to the main ground bar or equivalent for lightning protection.

For solar power type, it shall be equipped with built-in microprocessor-based control, solar cell, battery with 5 days autonomy, volt-free contact for remote monitoring and surge protection. The lamp shall be charged by solar power during daylight hours, even in cloudy conditions and automatically emit a flashing or steady light through the night using only the same charge, which will include high intensity, high-efficiency solar cells and efficient solid-state circuitry. It shall include a tower light control and alarm system to provide “fail-safe” alarming of failure of one or more lamps, lamp flasher failure and power failure to the unit.

7.2.2.8.1 Tower aviation obstruction painting

Where required, all structures shall be painted in horizontal contrasting white and red bands for day marking in accordance with the CAAM and Civil Aviation Directive (CAD) in conjunction with the recommendations of the ICAO and FAA regulations.

7.2.2.9 Compound lighting

Perimeter lighting if desired is of the flood light type using 250 W SON bulbs. Switches for the control should be provided at the pillar box.

7.2.2.10 Small power installation

Surface mounted twin SSO, S/S/O should be provided for test equipment and other maintenance appliances. They should be located one on opposite sides of the cabin.

7.2.2.11 M&E control and alarm signalling cables

A common distribution frame should be used to terminate all control and alarm signalling cables for the station. Individual alarm termination junction boxes are not allowed to avoid clutter and untidy cabling in the cabin.

7.2.2.12 Lightning surge protection system

Surge protectors are required for the protection of the sensitive electronics in the station. A primary and a secondary level of protection should be installed at the mains incoming and at the main distribution board inside the cabin respectively.

All levels of surge suppressors installed in particular site should be fully coordinated to provide maximum protection to the equipment. Visual indicators and remote alarm indication are desirable to indicate loss of protection due to failure of the suppressors.

The ratings of the surge protectors shall be minimal initially and shall be upgraded according to the requirements of the site.

7.2.2.13 Earthing facility and cross bonding

The earthing of the electrical installation should comply with the requirements of any wiring regulations. Code of practices for the earthing of equipment and systems earthing can be found in BS 7430.

Equipotential bonding of structures should be implemented throughout the station for protection against lightning in accordance with BS 6651. This entails specifications of materials used and procedures to be adopted if it is desirable to provide protection for the AMS. The cabin installed close to the AMS and within its 30º zone of protection is considered protected.

The earthing scheme adopted for the internal of the cabin is outlined in the drawing below. All incoming RF feeders into the cabin are earthed using the supplied earthing kit.

The collection of all the earthing lugs is terminated onto a common earth copper bar installed at a high level adjacent to the telecom cabling entry gland. This earth bar is connected to a Mains Ground Bar (MGB) which is another copper bar which collects all the other earth terminations such as chassis and cable ladders.

No connection is made between the MGB and the system earth bar or electrical earth bar. The two earth bars are only bonded below ground level at the earth pits. The total impedance of the connected system should not exceed 10 Ω.

7.2.3 Other structures

7.2.3.1 Multi-functional structure

These structures are sometimes designed as an extension to existing structures or buildings or as road signage, lamp pole, clock tower, light house, minaret etc.

The point of antenna attachment should be as close as possible to the structure to minimise visual obstruction and avoid major deviation from the present aesthetic value of the structure and its surroundings.

RF transparent materials are often utilised to hide the antenna. Such materials should withstand extreme weather conditions while maintaining their original appearance and performance, which meets the RF planner's requirements.

Extensions to structures using RF transparent materials shall be strong enough to withstand the wind load conditions prevalent at the site.

7.2.3.1.1 General requirements

The multi-functional structure shall be designed to meet the specified loading configuration.

Safety measures shall be taken into serious consideration at the construction site during installation to prevent accidents, both to the workers and the general public. Proper coordination is critically essential prior to any installation. The relevant consent and interests of all parties including but not limited to the local council, service providers, consultants, contractors, and landowners shall be considered.

The installation shall observe and adhere to existing guidelines and laws set by the federal, state and local authorities.

Antenna mounts must have structural integrity so as to guarantee public safety.

7.2.3.1.2 Aesthetic requirements

These structures are sometime designed as an extension to existing buildings or as a separate special structure, road signage, lamp pole, clock tower, light house, minaret etc.

The camouflage design shall be endorsed by PE for safety and method of installation.

Figure 10 until Figure 14 illustrated typical presence as recommendations for multipurpose aesthetic structures deployment.

Figure 10. Panel antenna on a signage pole with clock

Figure 11(a). Aesthetic example 1

Figure 11(b). Aesthetic example 2

Figure 11(c). Aesthetic example 3

Figure 11(d). Aesthetic example 4

Figure 11(e). Aesthetic example 5

Figure 11(f). Aesthetic example 6

Figure 11(g). Aesthetic example 7

Figure 11. Examples of the aesthetic structures that resembled lamp pole for minimal visual impact

Figure 12(a). Minaret type 1

Figure 12(b). Minaret type 2

Figure 12(c). Minaret type 3

Figure 12. Minaret type camouflaged by RF transparent materials

Figure 13(a). Site 1 - View 1 (Overall)

Figure 13(b). Site 1 - View 2 (Close-look)

Figure 13(c). Site 2 - View 1 (Overall)

Figure 13(d). Site 2 - View 2 (Close-look)

Figure 13. Outdoor equipment being camouflaged by trees, shrubs and decorative fencing

Figure 14(a). View 1

Figure 14(b). View 2

Figure 14(c). View 3

Figure 14. Outdoor equipment being camouflaged by trees, shrubs and landscape surroundings

7.2.4 Smart pole

The requirements for smart pole shall comply with the requirements defined in MCMC MTSFB TC G010.

7.2.5 Street furniture

The requirements for street furniture shall comply with the requirements defined MCMC MTSFB TC G026.

7.2.6 Minor Communications Infrastructure (MCI)

The requirements for MCI shall comply with the requirements defined in MCMC MTSFB TC G035.

7.3 Temporary - Base Transceiver Station (BTS)

Temporary BTS is generally used to provide immediate coverage or capacity relief for immediate or temporary events. Other usage includes providing temporary cellular coverage in new residential areas while waiting for a permanent BTS site or in disaster areas or remote locations to cater for special events.

Example of temporary BTS as illustrated in Figure 15 and Figure 16.

Figure 15. Mobile BTS

Figure 16. Portable BTS

Figure 17 illustrates the rooftop opening to allow the mini mast to extend through. The opening is for cabling infrastructure connecting antennas or microwave dish to the equipment.

Figure 17. Rooftop opening

Figure 18 illustrates the interior shot of the cabin showing the BTS, rectifier and microwave racks. Also visible is the air-con blower.

Figure 18. Interior of mobile BTS

7.3.1 General requirements

The following technical guideline is used to define the use of a BTS on non-moveable platform without foundation and moveable platform such as van or lorry. The temporary BTS shall include a retractable mast as portable BTS, the structure is larger and taller than the mobile BTS. The temporary BTS shall include a lightweight tower or mast for the installation of radio antennas (panel type or omni-directional) and a solid microwave dish.

A certified PE shall be consulted prior to any project deployment. The following requirements are the minimum standards according to the service provider.

The temporary BTS shall be designed, for the purpose of assessing its structural strength to a basic design wind speed of 33.5 m/s as stipulated in MS 1553 (120 km/h) 3-second gust speed or 22.22 m/s mean hourly wind speed for all sites. This corresponds to a return period of 1 in 50 years. For compliance check for maximum deflection (sway) of the temporary BTS, a 1 in 20-year return period wind speed of 30 m/s (3-second gust) or 20 m/s mean hourly wind speed shall be used.

If any use of generator set must comply with all relevant authority requirements for the below items:

a) diesel source;

b) sound and smoke of generator set; and

c) registration of generator set.

7.3.2 Technical requirements

7.3.2.1 Platform loading specification

The flooring of the truck bedframe or structure installed bedframe shall be reinforced to allow the placement of a cabin on top of it.

7.3.2.2 Retractable structures

The temporary BTS shall be equipped with a retractable 10 m - 20 m mini mast or telescopic pole or hydraulic pole which is used for the installation of antennas and microwave dishes. These will be used to provide the radio access signals and the transmission backhaul respectively. BS 8100:Part 1 and requirements by the customer or authorities shall be adhered to and adopted when defining the mobile BTS standard.

The temporary BTS structure shall be designed to withstand wind forces, recommended loading, and safety designs as per specified standard.

The general loading configuration of the mini mast, telescopic pole or hydraulic pole shall, at the minimum as detailed out in Table 13.

Table 13. Design loads for Temporary BTS

Size of antenna (mm)	Nos	Weight per unit (kg)
600 (diameter) (Microwave antenna)	2	30
2,600 H x 500 W x 210 D (Passive antenna)	3	40
795 H x 400 W x 225 D (Active band)	3	40

7.3.2.3 Power specification

The power consumption of the temporary BTS is dependent on the base station and microwave equipment, as well as the number of radio TRX units. The service provider should consult manufacturer's data sheets to determine the power requirements of the equipment. Power consumption includes supporting a single 2 Horsepower (HP) air-conditioning in mobile BTS if any, must also be taken into consideration.

In general, the power options can be derived from an external 240 Vac source or where mains electricity is not available with power specification below:

a) external power source: single phase 240 V_{ac}, 10 A, 50 Hz;

b) generator set capacity at least 80 % of the loading; and

c) MS IEC 60038.

7.4 Standards requirement

All designs, materials and workmanship shall, wherever relevant, comply with and be tested to the requirements of the latest editions of the following standards, but not limited to with all the current amendments unless otherwise stated.

a) ASCE Manual 72, *Guide for Design of Steel Pole Structures*

b) AS 3995, *Design of Steel Lattice Towers and Masts*

c) BS499-11, *Welding Terms and Symbols*

d) BS EN ISO 1461, *Hot-Dip Galvanized Coatings on Iron and Steel Articles*

e) BS 2901, *Filler Rods and Wires for Gas Shielded Arc Welding: Part 1 Ferritic Steels*

f) BS 3692, *ISO Metric Precision Hexagon Bolts, Screws and Nuts*

g) BS 4360, *Weldable Structural Steel*

h) BS 5135, *Metal-Arc Welding of Carbon and Carbon Manganese Steel*

i) BS 5950, *Structural Use of Steelwork in Building, appropriately adopted by using an acceptable material factor in accordance with BS8100: Parts 1, 2 and 3*

j) BS8100 Part1 and 2, *Lattice Towers and Mast – Part 1: Code of Practice for Loading*

k) BS4592: Part 2, *Specification for expanded metal grating panels*

l) BS 5493, *Code of Practice for Protective Coating of Iron and Steel Structure against Corrosion*

m) TIA/EIA-222-G, *Structural Standard for Antenna Supporting Structures and Antennas*

n) BS8110: 1997 Part 1, Code of practice for design and construction

o) EN 12843, Precast concrete products - Masts and poles

p) PCI Committee Report: Specification Guide for Prestressed Concrete Poles

q) JIS A5373 2010: precast prestressed concrete products

r) BS 8437:2005, Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace

7.5 Safety features

Structure safety features installation requirement shall comply with JKKP DP/G 127/379/4-35 or at least recommendation and endorsed by PE (i.e., fixed ladders, safety devices, climber attachment anchorages, platforms, railing, lifeline and cages).

8. Site maintenance

Site maintenance shall comply to the requirements for audit exercise as specified in MCMC MTSFB TC G041.

8.1 Site Access

It is important to ensure that there is twenty-four (24) hour access availability to the station. However, for Highly Sensitive Area for example ‘Sasaran Penting Kerajaan’, prior approval must be obtained for site access. Site access should be made available:

a) During office hours; and

b) As and when required in the event of an emergency.

Any arrangement on the site access should be commercially agreed by both parties as spelled out in the Mandatory Standard on Access Sec 5.13.

The service provider's employees, contractor, vendor and/or agent are responsible to ensure that access members do not violate any service provider's policies, do not perform illegal activities, and do not use the access to property for outside business interests. The service provider's employee(s), contractor, vendor and/or agent bears responsibility for the consequences should the access be misused.

For any other access permission request that the service provider's employees, contractors, vendors and/or agents may deem would lead to the violation of access given, the service provider's employees, contractors, vendors and/or agents shall directly refer to the relevant authorised department or personnels of the service provider for further verification.

Site access shall be strictly controlled. Control will be enforced via the following identification or authentication verification and log record.

a) The service provider's employees ID (Identification Data) and/or Pass card.

b) Authorization letter.

c) Authorized work permit.

Any personnel that have access to the property shall fill-in the visitors' log book as per the detailed requirement.

At no time should any service provider's employee provide their access ID, access key and/or access password to anyone, not even service provider's members.

Any personnel that have accessed to the property shall strictly follow the code of conduct as may be outlined while on the property's premises.

Annex A
(normative)

Normative references

MCMC MTSFB TC G041, *Radiocommunications Network Facilities - Compliance Audit for Radiocommunications Structure*

MS 144, *Steel wire for the reinforcement of concrete products – Specification*

MS 146, *Steel for the reinforcement of concrete - Weldable reinforcing steel - Bar, coil and decoiled product - Specification*

MS 739, *Specification For Hot - Dip Galvanized Coatings on Iron Threaded Fasteners*

MS 740, *Specification for hot dip galvanized coatings on iron and steel articles*

MS 1553*, Code of Practice on Wind Loading for Building Structure*

MS EN 10025-2, *Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*

MS EN 1008, *Water for Concrete*

MS EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain structural steels - Part 1: Technical delivery requirements*

MS EN 197-1, *Cement*

MS EN 934-2, *Admixture*

MS ISO 16120-2, *Non-alloy steel wire rod for conversion to wire - Part 2: Specific requirements for general purpose wire rod*

AS 3995, *Design of Steel Lattice Towers and Masts*

BS 2901, *Filler Rods and Wires for Gas Shielded Arc Welding: Part 1 Ferritic Steels*

BS 3692, *ISO Metric Precision Hexagon Bolts, Screws and Nuts*

BS 4360, *Weld able Structural Steel*

BS 4449, *Steel for the reinforcement of concrete - Weldable reinforcing steel - Bar, coil and decoiled product - Specification*

BS 4482, *Steel wire for concrete*

BS 4592, *Part 2 - Specification for expanded metal grating panels*

BS 499-11, *Welding Terms and Symbols*

BS 5135, *Metal-Arc Welding of Carbon and Carbon Manganese Steel*

BS 5493, *Code of Practice for Protective Coating of Iron and Steel Structure against Corrosion*

BS 5950, *Part 1 - Code of practice for design of rolled and welded sections*

BS 5950, *Structural Use of Steelwork in Building, appropriately adopted by using an acceptable material factor in accordance with BS8100: Parts 1, 2 and 3*

BS 5950-1, *Structural steel hot rolled*

BS 5950-2, *Structural Use of Steelwork in Building - Part 2: Specification for Materials, Fabrication and Erection -Rolled and Welded Sections*

BS 6399: *Design loading for buildings; and Part 1 - Code of practice for dead and imposed loads*

BS 6651, *Code of practice for protection of structures against lightning*

BS 8004, *Code of practice for foundations*

BS 8100, *Part 1, Part 3 and Part 4 - Lattice Towers and Masts*

BS 8110, *Part 1 - Code of practice for design and construction*

BS 8437, *Code of practice for selection, use and maintenance of personal fall protection systems and equipment for use in the workplace*

BS 8500-1, *Concrete - Method of specifying and guidance for the specifier*

BS EN 10025-1, *Hot rolled products of structural steels*

BS EN 10029, *Tolerance for hot-rolled steel plates 3mm thick and above*

BS EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain steels Part 1: Technical delivery conditions*

BS EN ISO 1461, *Hot-Dip Galvanized Coatings on Iron and Steel Articles*

EN 12390-1, *Testing hardened concrete Shape, dimensions and other requirements for specimens and moulds*

EN 12390-3, *Compressive strength of specimens*

EN 12843, *Precast concrete products - Masts and poles*

JIS A5373, *Precast prestressed concrete products*

JIS G 3532, *Low Carbon Steel wires*

ASCE Manual 72, *Guide for Design of Steel Pole Structures*

JKKP DP/G 127/379/4-35, *Guidelines for the prevention of falls at workplaces*

PCI Committee Report, *Specification Guide for Prestressed Concrete Poles*

TIA/EIA-222-G, *Structural Standard for Antenna Supporting Structures and Antennas*

Annex B
(informative)

Abbreviations

AC	Alternating Current
AMS	Antenna Mounting Structure
ASD	Airport Standards Directive
BS	British Standards
BTS	Base Transceiver Station
CAAM	Civil Aviation Authority of Malaysia
CME	Civil, Mechanical, and Electrical
DC	Direct Current
DCA	Department of Civil Aviation
DXX	Digital Cross Connect
FAA	Federal Aviation Administration
GSM	Global System for Mobile communication
HP	Horsepower
ICAO	International Civil Aviation Organisation
ISO	International Organisation for Standardisation
M&E	Mechanical and Electrical Systems
MCB	Mains Circuit Breaker
MCI	Minor Communication Infrastructure
MGB	Mains Ground Bar
MICC	Mineral-Insulated Copper-clad Cable
MW	Medium Wave
NFP	Network Facilities Providers
NSP	Network Services Providers
PDH	Plesiochronous Digital Hierarchy
PE	Professional Engineer
PVC	Permanent Virtual Circuit
PVC/GI	Polyvinyl Chloride/Galvanised Iron
RF	Radio Frequency
RRU	Radio Remote Unit
SDH	Synchronous Digital Hierarchy
SI	Soil Investigation
SSO	Switch Socket Outlets
TRX	Transceiver
TSS	Technical Site Survey

Annex C
(informative)

Load imposed

The tables below represent the typical loads imposed on a free standing 3-legged tower shared among 3 multiple NSP.

The actual number of NSP able to share the tower is limited by the maximum loading capacity of the tower.

For special cases (e.g., large hub sites with many microwave dishes) where loading capacity exceeds the recommendation below, then the tables below do not apply.

In special cases where the tower is not shared and meant to serve a single operator; the tables below do not apply.

Table C.1. 76 m tower load

76 m light duty	76 m medium duty	76 m heavy duty
9 x (2,600 H x 500 W x 210 D) - Panel	9 x (2,600 H x 500 W x 210 D) - Panel	9 x (2,600 H x 500 W x 210 D) - Panel
2 x 2.4 m Dia	2 x 2.4 m Dia	2 x 3.6 m Dia
2 x 1.8 m Dia	6 x 1.8 m Dia	4 x 2.4 m Dia
2 x 1.2 m Dia	4 x 1.2 m Dia	7 x 1.8 m Dia
-	-	3 x 1.2 m Dia

Table C.2. 60 m tower load table

60 m light duty	60 m medium duty	60 m heavy duty
9 x (2,600 H x 500 W x 210 D) – Panel	9 x (2,600 H x 500 W x 210 D) – Panel	9 x (2,600 H x 500 W x 210 D) – Panel
2 x 2.4 m Dia	2 x 2.4 m Dia	2 x 3.6 m Dia
2 x 1.8 m Dia	6 x 1.8 m Dia	4 x 2.4 m Dia
2 x 1.2 m Dia	4 x 1.2 m Dia	7 x 1.8 m Dia
-	-	3 x 1.2 m Dia

Table C.3. 45 m tower load table

45 m light duty	45 m medium duty	45 m heavy duty
9 x (2,600 H x 500 W x 210 D) – Panel	9 x (2,600 H x 500 W x 210 D) – Panel	9 x (2,600 H x 500 W x 210 D) – Panel
2 x 2.4 m Dia	2 x 2.4 m Dia	2 x 3.6 m Dia
2 x 1.8 m Dia	6 x 1.8 m Dia	4 x 2.4 m Dia
2 x 1.2 m Dia	4 x 1.2 m Dia	7 x 1.8 m Dia
-	-	3 x 1.2 m Dia

Annex D
(informative)

Generatorset sizing for shared sites

Table D.1. Generator set sizing for shared sites

No	Load description	Connected load (W)	Qty	Total load (W)	Diversity	Max demand (W)
1	**Cabin (indoor equipment)**					
A	**Electrical load schedule**					
	Rectifier (ref rectifier sizing)	1,440	17	24,480	0.8	19,584
	Air-con unit	4,000	2	8,000	0.5	4,000
	Room lighting	40	8	320	1.0	320
	Switched socket outlet	100	6	600	0.3	180
	Compound lighting	150	4	600	1.0	600
	Total load	-	-	-	-	**24,684**
B	**Generator set sizing**					
	Min gen-set VA req (MD/0.85)	29,040	-	-	-	-
	Proposed gen-set	30 kVA	-	-	-	-
	Proposed fuel tank for 5d backup (5 ℓ/hr x 5 x 24)	600 ℓ (131 gal)	-	-	-	-
2	**Outdoor equipment**					
A	**Electrical load schedule**					
	Operator 1	6,600	2	13,200	1.0	13,200
	Operator 2	5,948	2	11,896	1.0	11,896
	Operator 3	5,600	2	11,200	1.0	11,200
	Switched socket outlet	100	2	200	0.5	100
	Compound lighting	150	4	600	1.0	600
	Total load	-	-	-	-	**36,996**
B	**Generator set sizing**					
	Min genset VA req (MD/0.85)	43,525	-	-	-	-
	Proposed Gen-set	50 kVA	-	-	-	-

Annex E
(informative)

Rectifier sizing for shared sites

Table E.1. Rectifier sizing for shared sites

No	Load Description	Connected load (W)	Initial		Final	
			Qty	Total (W)	Qty	Total (W)
1	**DC loads**					
a	**Operator 1 equipment**					
	BTS	1,880	1	1,880	2	3,760
	SDH	250	2	500	3	750
	PDH	150	1	150	2	300
	ADM	150	1	150	2	300
b	**Operator 2 equipment**	1,700	1	1,700	2	3,400
	SDH	250	0	0	1	250
	PDH	150	0	0	2	300
	ADM	150	0	0	1	150
c	**Operator 3 equipment**	1,700	1	1,700	2	3,400
	SDH	250	0	0	1	250
	PDH	150	0	0	2	300
	ADM	150	0	0	1	150
d	**Miscellaneous loads**					
	Force air cooling	110	2	220	2	220
	Ceiling mount fan	50	1	50	1	50
	Sub Total (W)			**6,350**		**13,580**
2	**Battery sizing**					
a	AHr required for 4 hours backup Initial 600 Ah x 1 bank Final 600 Ah x 2 bank Rack/bank: 2,285 (L) x 370 (D) x 1,370 (H)	-	-	529	-	1132
b	AHr required for 8 hours backup Initial 1,000 Ah x 1 bank Final 1,000 Ah x 2 bank Rack/bank: 2,285 (L) x 370 (D) x 1,780 (H)	-	-	1058	-	2263

Table E.1. Rectifier sizing for shared sites *(continued)*

No	Load description	Connected load (W)	Initial		Final	
			Qty	Total (W)	Qty	Total (W)
3	**Rectifier sizing**					
	Rectifier modules for 8 hrs backup					
	modules for connected equipment			4		9
	modules for battery charging*			3		7
	Total modules required (N+1)			8		17
NOTE: * is based on 1,440 W per rectifier module and 10 hours recharge time						

Bibliography

[1] Act 138, *Registration of Engineers Act 1967 (Revised - 2015)*

[2] MS IEC 60038, *IEC Standard Voltages*

[3] BS 6004, *Electric cables*

[4] BS 7430, *Code of practice for protective earthing of electrical installations*

[5] ETSI 300 019, *Environmental Engineering*

Acknowledgements

Members of the Radiocommunications Network Facilities Working Group

Mr Ratnam N. A. (Chairman)	TeleSystem Electronics Sdn Bhd
Mr Muhammad Nur Syafiq Aziz (Vice Chairman)	Digi Telecommunications Sdn Bhd
Mr Vasanthan Pachiappan (Secretary)	Maxis Broadband Sdn Bhd
Mr Mohd Khairil Anuar Mohamad (Draft Lead)	Maxis Broadband Sdn Bhd
Mr Mohamad Norzamir Mat Taib /	Malaysian Technical Standards Forum Bhd
Mr Muhaimin Mat Salleh (Secretariat)	
Mr Rahim Garing/	Celcom Axiata Berhad
Mr Rohaizad Embong/	
Mr Syahrir Abdul Wahid	
Mr Muhammad Rezza Alui/	Digi Telecommunications Sdn Bhd
Mr Yesu Christy Antuny Samy	
Mr Ahmad Razman Mohd Rashid/	Digital Nasional Berhad
Mr Sukhdev Singh Mokhtiar	
Mr Mohd Asyraf Karim/	edotco (M) Sdn Bhd
Mr Mohd Azfar Mohd Saad/	
Mr Mohd Fadhlie Muhammad Sutan Mudo/	
Mr Syamsyul Annuar Abdul Rahman	
Mr Mohd Kasyful Azim Ab Rahman/	Maxis Broadband Sdn Bhd
Mr Mohd Khaizir Said/	
Mr Muhammad Saffa Abqari Azmi/	
Mr Suzamri Salleh	
Mr Amrul Halim Gan/	REDtone Telecommunication Sdn Bhd
Mr Eddie Chew Chin Siang/	
Mr Nadzmi Haniff Samadi	
Mr Mohamad Izzat Saiful Bahri/	SIRIM QAS International Sdn Bhd
Mr Mohd Haziq Mohd Nasir	
Dr Zawiyah Hj Abdul Razak/	Telekom Malaysia Berhad
Ms Erliz Rizuan/	
Mr Mohd Sabri Mohd Jamil	
Mr Inderjit Singh/	TIME dotCom Bhd
Mr Ong Kiat Boon/	
Ms Noor Nabila Huda Yacob	
Mr David Lim Teck Huat/	U Mobile Sdn Bhd

Mr Norzalee Mohd Rozali/ Mr Paul Yii Huong Hoe	
Mr Muhammad Zharif Mohd Anwal/ Mr Shahrul Afendi Mohd Shah	Webe Digital Sdn Bhd
Ms Siti Hawa Iskandar	YTL Communications Sdn Bhd

By invitation:

Mr Dzulhusne Fikri Mohammed Sabraa / Mr Mohd Fairus Salehen	Azamas Engineering Consultant
Mr Ramli Hassan/ Ts Wan Mohd Fadzil Wan Sapiansori	Department of Occupational Safety and Health
Mr Mohd Nor Ariffin Abdul Hamid	D'Harmoni Telco Infra Sdn Bhd
Mr Mohammad Safuan Shafie	EdgePoint Towers Sdn Bhd
Mr Mohammad Fairuz Bazin	Iskandar Regional Development Authority
Mr Muhamad Hafiz Izwan Faizan/ Mr Muhamad Izwan Zainal	Majlis Bandaraya Ipoh
Mr Mohd Syamim Mohd Dzilal/ Mr Yong Woo Soon	Majlis Bandaraya Pulau Piang
Mr Nadia Faradila Jalawi	Majlis Bandaraya Seberang Perai
Mr Zaharin Mohd Nadzri	Menteri Besar Selangor Incorporated
Mr Azhar Ahmad/ Ts Hj Mohd Esa Hj Baruji	National Institute for Occupational Safety and Health
Mr Mohd Syahir Abdul Rahman/ Mr Lai Wei Yang	OCK Setia Engineering Sdn Bhd
Mr Norden Zakaria/ Mr Mohd Fauzi Jaafar	Pejabat Setiausaha Kerajaan Negeri Pahang
Ms Nur ‘Aishah Md Norodin	Pejabat Setiausaha Kerajaan Negeri Pulau Pinang
Mr Haslan Hamzah	PLANMalaysia
Mr Amirahmad Khamesipour/ Mr Yusof Yeop Ahmat	PMW Concrete Industries Sdn Bhd