TECHNICAL STANDARDS AND INFRASTRUCTURE REQUIREMENTS
Radiocommunications Network Infrastructure (External)

MTSFB 001:2009

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1 FOREWORD

This Technical Standard and Infrastructure Requirements was developed and recommended by the Radiocommunications Network Infrastructure (External) Working Group in order to establish general requirements on the implementation of Radio Base Stations for Wireless Network Service Providers. The development of this Technical Standard was carried out by this working group under the supervision of the Malaysian Technical Standards Forum Bhd (MTSFB) which has been authorized by Malaysian Communications and Multimedia Commission (SKMM).

The Technical Standard and Infrastructure Requirements (TSIR) documentation is intended to be used as reference for Wireless Network Service Providers, property owners and agents, consultant, general public, local authorities and other concerned parties. This is inline with the objective to meet the requirement of end users services (telecommunication) with minimum disruptions to all services offered by the Network Service Providers.

TSIR consists of 5 main modules which are as follows:

Part 1: Fixed Network Infrastructure

Part 2: Broadcast Network Infrastructure

Part 3: Radiocommunications Network Infrastructure (External)

Part 4: Radiocommunications Network Infrastructure (Internal)

Part 5: Occupational, Safety and Health Work Practices (OSHWP)

NOTE:
Compliance with a Technical Standard does not of itself confer immunity from legal obligations.
This technical requirements shall be effective after registration.

Working Group Objectives

a) To provide the minimum technical requirements necessary for the External Radiocommunications Network Infrastructure.

b) To recommend and provide standards for external radiocommunications network infrastructure requirements applicable in Malaysia.

2 COMMITTEE REPRESENTATION

The Radiocommunications Network Infrastructure (External) Sub Work Group operates under the wing of the main Multimedia Network Infrastructure (MNI) Work Group which is supervised by the Malaysian Technical Standards Forum Bhd (MTSFB) authorized by Malaysian Communications and Multimedia Commission (SKMM). The Technical Standard and Infrastructure Requirements (TSIR) - Radiocommunications Network Infrastructure (External) document was developed by representatives from the following organizations:

ASIASPACE Sdn Bhd
Celcom (Malaysia) Berhad
DiGi Telecommunications Sdn Bhd
GTL Network Services Sdn Bhd
Izzinet Sdn Bhd
Malaysia National Computer Confederation (MNCC)
MAXIS Communications Berhad
Packet One Networks (Malaysia) Sdn Bhd
SACOFA Sdn Bhd
Telekom Malaysia Berhad
TIME dotCom Berhad.
Transform Star Sdn Bhd
U Mobile Sdn Bhd

3 EXECUTIVE SUMMARY

The radiocommunication network forms an important and very large part of the service providers' network infrastructure. In fact, there are various design methods, each being adopted by individual service providers. The intention of the document is to gather common best practices from the industry and compiled into a comprehensive set of requirements.

In this document, the general requirements on rooftop sites, tower sites, mobile/portable BTS sites and Operations & Maintenance are described. Design requirements for construction, structural, mechanical & electrical (C&S and M&E) of equipment cabins, antenna mounting structures, towers and power supply are elaborated. Many sample drawings and pictures are included to enhance visualization of the various infrastructures.

Infrastructure sharing amongst service providers is always encouraged. Sharing infrastructure promotes efficient use of physical structures and makes economic sense. Sharing also saves precious natural resources as duplication of infrastructure is seen as wasteful. In certain cases where infrastructure sharing is not required, then the service provider may opt to implement an infrastructure that supports its own equipment, as overdesigning is also seen to be wasteful.

This document was prepared in collaboration with the wireless service providers and also between different disciplines in the telecommunications industry as a whole. It is hoped that this collaboration will form a first step in producing, ultimately a synergistic standards and guidelines that will benefit all parties involved in the telecommunications industry in Malaysia.

Note: In this document, the term "tower" refers to the conventional steel lattice tower with a maximum height of 76m. Tower does not refer to special telecommunication and broadcast towers such as KL Tower or Alor Star Tower.

4 INTRODUCTION

This Technical Standards and Infrastructure Requirements "(TSIR)" has been developed by the Sub-Working Group – Radiocommunications Network Infrastructure (External) based on SKMM's requirement on the need to establish a generic requirement on the implementation of radio base stations for wireless network service providers.

This TSIR is intended as a reference for wireless network service providers, property owners and agents, consultants, general public, local authorities and other concerned parties.

This document forms Part 3 of a 5 part series in the TSIR as outlined below:

Part 1: Fixed Network Infrastructure
Part 2: Broadcast Network Infrastructure
Part 3: Radiocommunications Network Infrastructure (External)
Part 4: Radiocommunications Network Infrastructure (Internal)
Part 5: Occupational, Safety and Health Work Practices (OSHWP)

Part 3 is further broken down into different subsections:

Subsection 1:	Aesthetic Installations
Subsection 2:	Rooftop sites design requirements
Subsection 3:	Mobile Base Tranceiver Station
Subsection 4:	Tower Sites
Subsection 5:	Site Maintenance

Users of this TSIR are advised to refer to "Technical Standards on RF Emission Control of Cellular Radio Site" as a guideline to administer the RF emission levels of cellular radio sites with respect to the general public and workers. The aforesaid document is available and maintained at MTSFB website.

This document does not address the Broadcast Infrastructure. The technical standards and infrastructure requirements for broadcast network can be referred to other documents from MTSFB i.e. MTSFB 006 : 2005 (Revision 1). This infrastructure however can be incorporated in the next revision of this TSIR.

5 SCOPE

This document describes best engineering practices and general requirements necessary for the safe and proper implementation of radiocommunications network infrastructure on landed properties and rooftops.

The design concepts and methodologies used in all the Civil, Structural, Mechanical and Electrical, (C&S and M&E) works involved aesthetic sites, rooftop sites and conventional latticed tower sites are outlined.

The implementation of the guidelines in this document is intended for new sharing and non-sharing sites alike. This document is not intended to be applied to existing sites. There are exceptions for non-sharing sites including hub sites, mini-mast, pole and lamp pole sites. This is due to the either lightweight structure design for use in public areas or high capacity hub sites where large numbers of microwave dishes are located. The sites are not shared for practical reasons.

This document is subject to review from time to time in tune with new industry developments, technical or non-technical.

Infrastructure sharing of physical structures such as physical space and antenna mounting structures is always encouraged. However total equipment loading factors on physical structures and power supply capacity needs to be taken into account. All design calculations and implementation shall be approved by the registered Professional Engineer (P.E).

This TSIR emphasizes the importance of building community friendly radiocommunication structures. When such structures are required to be located near residential areas for the purpose of providing telecommunication services, they should be constructed using camouflaging techniques or aesthetic structures. By doing so significantly reduces the visual impact of unsightly steel lattice structures. Samples of camouflaging and aethestic structures are provided in this document.

This TSIR does not include broadcasting infrastructure. Broadcasting in this context shall mean the transmission of television and/or radio content; whether they are fixed or mobile. This infrastructure requirement can be incorporated into the next revision of this TSIR.

5.1 Reference Documents

The following reference documents contain provisions, which through reference in this text constitute provision of this Technical Standard. For dated references, where there are subsequent amendments to, or revisions of, any of these publications of the Technical Standard shall be amended or revised accordingly.

This standard is based on the following references:

- Malaysian Standards (MS)
- British Standard (BS) and Code of Practice.
- European Telecommunications Standards Institute (ETSI)
- The regulations for the Electrical Equipment of Building 17th Edition as issued by the Institution of Electrical Engineers, London.
- The British Standard Electrical Codes of Practice.
- Suruhanjaya Tenaga (ST)
- Jabatan Kerja Raya (JKR).
- Department of Civil Aviation (DCA)

5.2 Specifications of Criteria

Two categories are specified in these guidelines which are mandatory and advisory.

Mandatory requirements are denoted by the word “shall”, while advisory requirements are designated as “should”, “may” or “desirable” which are used interchangeably in this guideline.

Mandatory terms apply to performance and compatibility requirements while advisory terms represent:

- A performance or compatibility goal towards which future designs should strive for OR;
- A recommended method for adhering to a performance or compatibility requirement.

Note: Recommended rated values maybe adjusted for cost optimized design if it does not affect the overall performance of the infrastructure.

6 AESTHETIC INSTALLATIONS REQUIREMENT

6.1 Introduction

Under special circumstances some radio stations (especially the radio antennas and microwave dishes) are required to blend in with its surrounding or to be aesthetically pleasing to the sight.

This is achieved through various means of treating the main structures inside the station such as the Antenna Mounting Structure (AMS) and/or the equipment enclosure to make them inconspicuous.

Beyond the engineering requirements of designing and implementing aesthetic installations, such stations require a lot of creativity on the part of the designer and any one site can be very different from the next. The associated cost can therefore vary considerably depending on the treatment required. This cost may be prohibitive to the extent that the site may not be economical to construct.

Beyond the standard technical requirements, this section is an ‘idea book’ on the topic of aesthetic installations. It is not a comprehensive guideline and specification for the erection and installation of such radio stations. However, the design of such structure shall comply with the guidelines found in. sub section 4 tower design requirements under clause 9.2

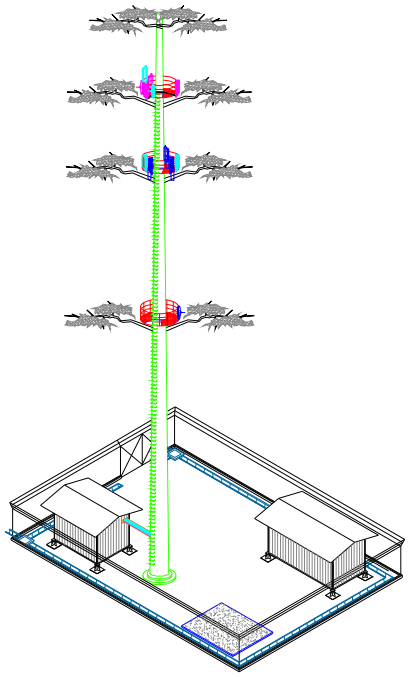


Fig 1. An aesthetic installation with the AMS treated to look like a tree. Equipment cabins are often left untreated due to their low visibility.

6.2 General Requirements

The technical requirements of the aesthetic installation shall conform to the applicable national and/or international standards.

The design of the Antenna Mounting Structure (AMS) and its foundation shall comply with the guidelines found in sub section 4 tower design requirements 9.2

All design documents shall be certified by the Professional Engineer registered with the Board of Engineers Malaysia (BEM).

Any aesthetic design structure should not degrade the quality of the telecommunication services.

The planning and installation of such radio communication infrastructures are based on the following rationale:

- Awareness to highlight the need to maintain the overall integrity (or intactness) of the particular landscape or surroundings.
- The need to minimize visual intrusion or obstruction of views within a particular area.
- The design shall endeavour to minimize public tendency to complain from the aspects of unsightly structures especially in urban or sub-urban areas.

All construction works should be coordinated with the wireless network service providers, property owners and agents, consultants, general public, local authorities and other concerned parties.

The structure built may be allowed for sharing subject to the infrastructure owners' approval. In general, any site can be shared subject to availability of physical space and structural integrity of the aesthetic structure (loading factor). This is besides the availability of cabin/equipment space, sufficient power supply and site acquisition issues.

Aesthetic structures are generally not heavy duty structures unlike lattice tower, therefore they are not intended for use as microwave radio collection hubs. Examples of aesthetic structures are ;

- Monopole / Monopole Tree
- Multipurpose Structures
- Bill board
- Minaret
- Lamp Pole

All pictures shown thereafter are meant to be examples of aethestic structures. Exact as-built structures will be dependent on individual site designs.

6.3 Monopole / Monopole Tree

The structure should have a good appearance with realistic shape, foliage and bark that can provide a good cover for the antennae 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.

All RF feeder cables are installed on the outside of the artificial tree trunk. For monopole lamp structure, the RF feeder cables are running 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 measure. In an unfenced area the foundation should be provisioned for feeder cable ducts to cater for concealed cables between the lamp pole structure and the equipment enclosure.

Figure 2. Arrows in the pictures above indicating the antennas which are installed under the cover of the artificial foliage.

6.3.1 Design Parameters

All designs, materials and workmanship shall, wherever relevant, comply with and be tested to the requirement of the latest editions of the standards listed below together with all the current amendments unless otherwise stated.

ASCE Manual 72:1990	Guide for Design of Steel Pole Structures
AS 3995-1994	Design of Steel Lattice Towers and Masts

BS499-11:1991	Welding Terms and Symbols
BS EN ISO 1461: 1999:	Hot-Dip Galvanized Coatings on Iron and Steel Articles
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 5135:	Metal-Arc Welding of Carbon and Carbon Manganese Steel
BS 5950:	Structural Use of Steelwork in Building, appropriately adopted by using an acceptable material factor in accordance with BS8100: Parts 1, 2 & 3.
BS8100:Part1 & 2	Lattice Towers and Mast – Part 1: Code of Practice for Loading
BS4592:Part 2. 1987	Specification for expanded metal grating panels
BS 5493: 1977	Code of Practice for Protective Coating of Iron and Steel Structure against Corrosion
TIA/EIA-222-G	Structural Standard for Antenna Supporting Structures and Antennas

6.3.2 Basic Design Wind Speeds

The monopole or tree-shaped monopole shall be designed, for the purpose of assessing its structural strength to a Basic Design Wind Speed of 33.33m/s (120 km/hr) 3-second gust speed or 22.22m/s mean hourly wind speed for all sites. This corresponds to a return period of 1 in 50 years. For the purpose of compliance check for maximum deflection (sway) of the monopole, a 1 in 20 years return period wind speed of 30.0m/s (3 second gust) or 20.0m/s mean hourly wind speed shall be used.

6.3.3 General Design Loads

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

Table 1. Design Loads for 45m pole

45m pole

Diameter of parabolic antenna	**Distance measured upward from the bottom of tower (m)**			
	43.5m	**40.5m**	**37.5m**	**34.5m**
1.2m	-	2 nos	2 nos	2 nos
2.6H x 0.26W x 0.16D flat antenna	9 nos	-	-	-

Table 2. Design Loads for 30m pole

30m Pole

Diameter of parabolic antenna	Distance measured upward from the bottom of tower (m)			
	28.5m	**25.5m**	**22.5m**	**19.5m**
1.2m	-	2 nos	2 nos	2 nos
2.6H x 0.26W x 0.16D flat antenna	9 nos	-	-	-

6.4 Multi Purpose Structures

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

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

RF transparent materials are often utilized to hide the antenna at low heights. 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.

The following pictures illustrated typical presence as recommendations for multipurpose aesthetic structures deployment.

Figure 3. Arrow shows a panel antenna on a signage pole with clock (multi-purpose). The antennas go unnoticed among the signages.




Figure 4. Examples of the aesthetic structures that resembled lamp pole for minimal visual impact.

Figure 5. Minaret type (antenna come with integrated cabin) camouflaged by RF transparent materials to minimize visual impact.

Figure 6.1 Site 1 - View 1 (Overall)

Figure 6.2 Site 1 - View 2 (Close-look)

Figure 6.3 Site 2 - View 1 (Overall)

Figure 6.4 Site 2 - View 2 (Close-look)

Figure 6. Outdoor equipment being camouflaged by trees, shrubs and decorative fencing.

Figure 7.1 – View 1

Figure 7.2 – View 2

Figure 7.3 – View 3

Figure 7. Outdoor equipment being camouflaged by trees, shrubs and landscape surroundings

6.5 Billboards

These are sites where the operators make use the existing AMS for the installation of their radio equipment and antennas . The approach is to maximize the infrastructure sharing among the operators covering specific area.

Figure 8. Highest mountable point on the structure

Figure 9. Antenna on top of structure

The co-located site should have adequate land space for an equipment plinth.

There should be a safe access road leading to the site for maintenance crew that is not using part of the highway unless a layby is constructed.

6.6 Aesthetics for Roof Top Structures

The following design illustrates an option of practice to hide the existing AMS presence on building roof-top where RF transparent material is used to camouflage the antenna structures.

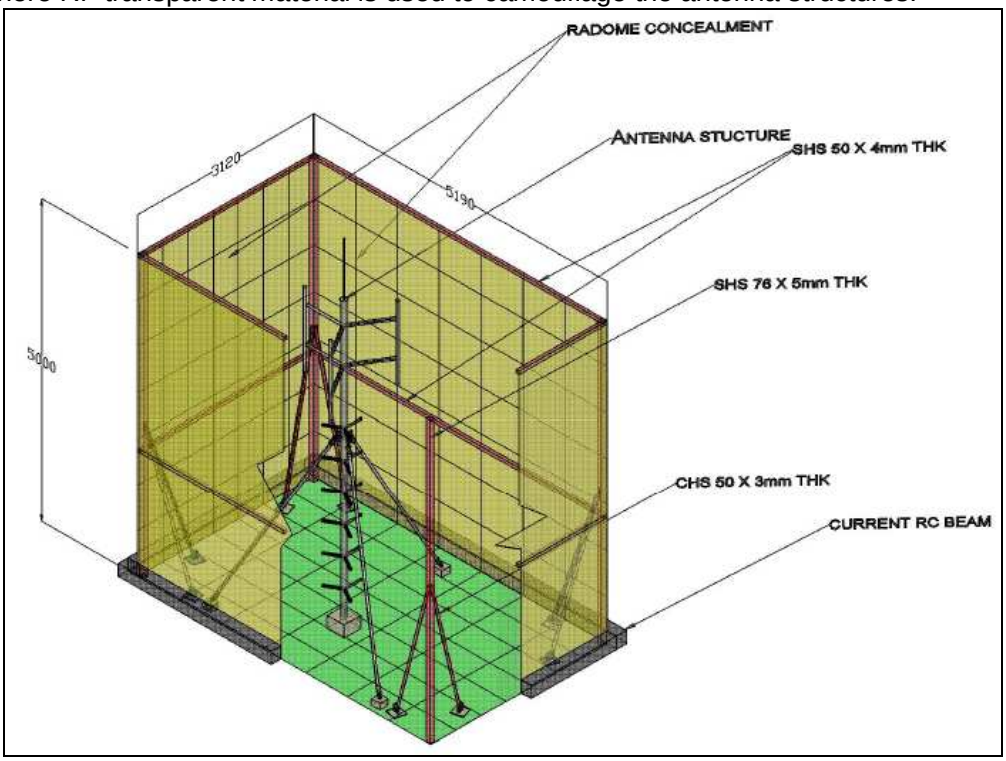


Figure 10. Conceptual design for antenna/radome and boom structure concealment using RF transparent material.

Figure 11. Chimney Concealment System

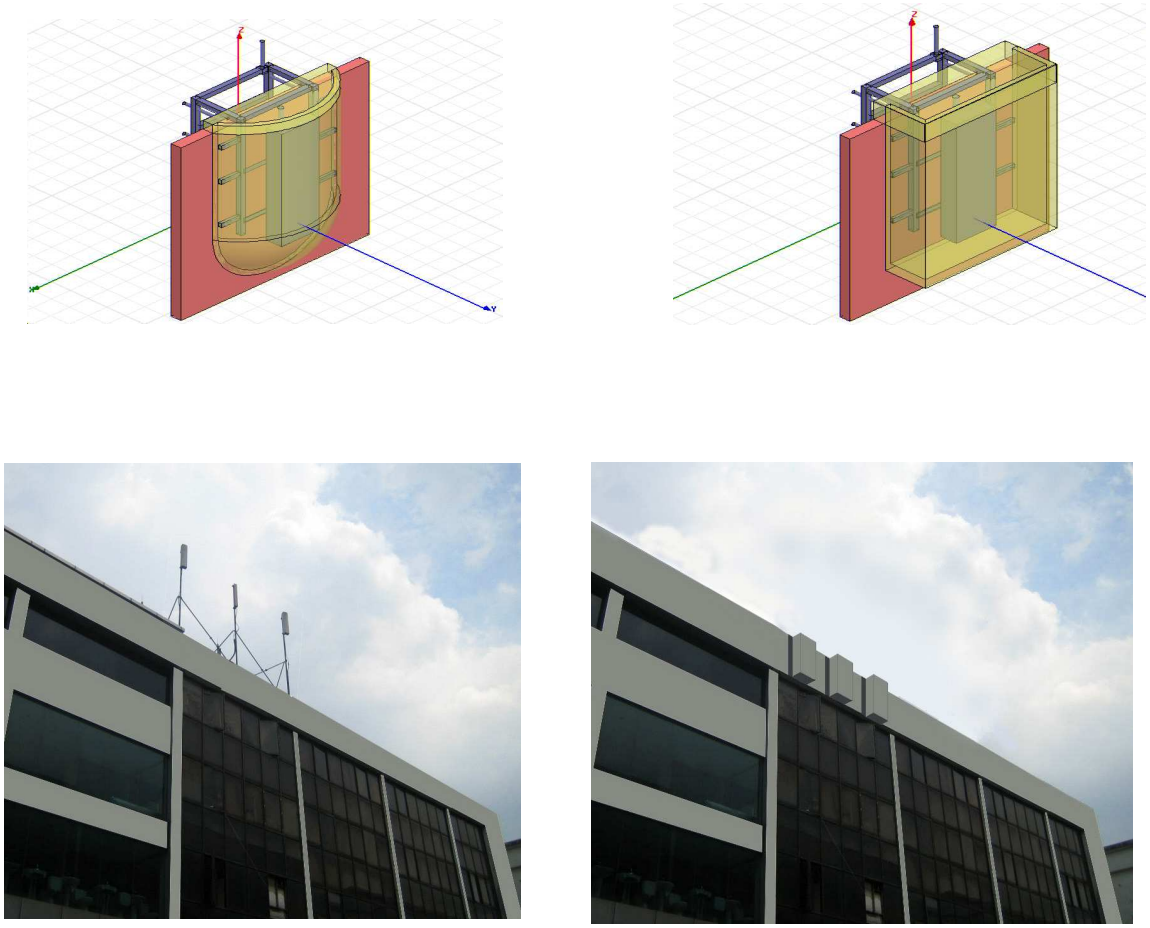


Figure 12. Design using concealment panels

Figure 13. Roof Top Concealments

ROOF TOP DESIGN REQUIREMENTS

6.7 General

The following specification is valid for a room or external rooftop space intended for use as a base transceiver station in an existing building.

The following requirements are the minimum standard according to service provider. In the project, any relevant standards by the Customer or authorities must 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 an experienced Professional Engineer shall be consulted prior to the implementation of project.

6.8 Purpose

This specification sets out the requirements for the design and construction of an internal room and external rooftop space as Equipment Housing for Radio Sites.

6.9 Service Conditions

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 to be in continuous operation.

6.10 Internal Room for Rooftop Sites (Indoor)

6.10.1 Dimensions

The room shall have a minimal internal height of 2.6 m. The floor area should be large enough for the installation of radiocommunication equipments enclosure, mains distribution board, air conditional and etc .

6.10.2 Material

Materials to be used in the room shall be approved by the Service Providers. The exact location will be determined by each Service Provider in the Technical Site Survey (TSS) Report.

6.10.3 Doors

The room shall be equipped with a door, minimum size of 900 x 2100mm and shall be constructed of approved materials. The door shall be possible to operate from both inside and outside.

The doors shall be lockable from the outside by means of a lever tumbler lock approved by the national standards, BOMBA, and/or the customer.

6.10.4 Floor

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

6.10.5 New Walls and Ceilings

All new walls and ceilings shall be constructed from approved materials.

6.10.6 Existing Walls

The walls shall be treated against dust production, e.g. by painting.

6.10.7 Climate Conditions

The requirements for temperature and humidity shall be met in accordance with the environmental specifications for the equipment.

Precautions are to be taken not to lead dust into the building together with the ventilating air stream. When air Conditioning is being used, special measures must be taken to safely dispose of condensed water in the equipment room.

6.10.8 Floor, Ceiling and Walls

The floor, the 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 2.0 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.

6.10.9 Cable Management And Cable Entries.

6.10.9.1 Cable Ladder Racking

Cable ladders and all its mounting ancillaries shall be galvanized to MS739 and MS740 for all external applications. Cable ladders shall be of sufficient width to accommodate all intended cables.

Waveguide/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 200mm space clearance between the ladder and feeder cables shall be maintained.

6.10.9.2 Cable Entries

A cable entry gland type ROXTEC or equivalent as approved by the Service Provider is to be provided and fitted complete with all details.

6.10.10 Mechanical Services

6.10.10.1 Air Conditioning System

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

6.10.10.2 High Temperature Sensor

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

6.10.11 Electrical Services

6.10.11.1 General Arrangement

The electrical installations shall be designed in accordance with Rules and Regulation of Tenaga Nasiional Berhad (TNB), Jabatan Bekalan Elektrik (JBE) and other related authorities.

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

6.10.11.2 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 Service Providers 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 labeling shall comply with the relevant IEE Wiring Regulations.

6.10.11.3 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.

6.10.11.4 Small Socket Power Outlet

A surface mounted twin socket outlet shall be provided.

The socket outlets shall be connected in a radial circuit using 4.0 mm^2 cables and protected by a 30A 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 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 labeled.

6.10.11.5 Earthing Facility and Cross Bonding

The Earthing of the installation shall comply with the requirements of The IEE Wiring Regulations.

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

6.10.11.6 Fire Extinguisher

A fire extinguisher shall be provided; this shall be the minimum 2.0kg CO_2 type that shall be mounted in accordance with the floor plan layout. The fire extinguisher is to have a test label attached with the original date of issue marked on it and the manufacturer's name The fire extinguisher shall be maintained periodically as per manufacturer’s schedule and BOMBA’s requirements.

6.10.11.7 Security Facility

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

6.11 External Roooftop Space for Rooftop Sites (Outdoor)

6.11.1 Dimensions

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

6.11.2 Materials

Materials to be used for the equipment room shall be approved by the Service Provider. The exact location will be determined by the Service Provider in the Technical Site Survey (TSS) Report.

6.11.3 Equipment room specification

The equipment room design and technical specification shall follow the requirements as defined in item 9.3 Cabin Design Requirements.

6.12 Rooftop Typical Site Type

This specification consists of drawings of typical Rooftop sites with minimum standard according to the Service Providers and to outline the typical layout and requirements of each site type.

6.12.1 Site Models

The following typical model sites will be considered in this specification:

- RT1 P – Cabin/Room with 3m/6m Poles
- RT1 M – Cabin/Room with Mast
- RT1 U – Cabin/Room with Unipole
- RT2 P – Outdoor with 3m/6m Poles
- RT2 M – Outdoor with Mast
- RT2 U – Outdoor with Unipole

Detailed drawing of rooftop structures is shown in the Appendix 5.

6.12.2 Technical Specifications

The quality and workmanship of all the works shown in the drawings shall be in accordance with the specifications, outlined within this document.

7 TEMPORARY BASE TRANSCEIVER STATION

7.1 Introduction

The temporary BTS is generally used to provide immediate coverage or capacity relieve. An example of immediate capacity is for hotspot events such as Formula 1 racing at Sepang, religious events (eg. Thaipusam at Batu Caves or Feast of St. Anne at Bukit Mertajam), soccer matches and music concerts.

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.

7.2 Scope

The following technical guideline is used to define the use of a base transceiver station (BTS) on a moveable platform such as a van or lorry. The temporary BTS shall include a retractable mast for the installation of radio antennas (panel type or omni-directional) and a solid microwave dish.

For the portable BTS, the structure is larger and taller than the mobile BTS. The temporary shall include a lightweight tower or mast for the installation of radio antennas (panel type or omni-directional) and a solid microwave dish.

The scope is divided to two (2) types of temporary BTS

- Mobile BTS installed on a movable platform like a truck or van
- Portable BTS, a temporary non-movable structure that can constructed and taken down easily.

A certified Professional Engineer shall be consulted prior to being use in any project.
The following requirements are the minimum standard according to the Service Provider.

7.3 Mobile BTS

7.3.1 Platform loading specification

The flooring of the truck bed-frame shall be reinforced to allow the placement of a cabin on top of it.

7.3.2 Retractable mini-mast

The mobile BTS shall be equipped with a retractable 10m mini-mast 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.

The general loading configuration of the mini-mast shall, at the minimum, support:

3 nos of 2m GSM Panel Antenna at the top c/w (18) 7/8" coax cable
1 no of 0.6m Solid Microwave Dish at 2m from top

7.3.3 Power specification

The power consumption of the mobile BTS is dependent on base station and microwave equipment make as well as the numbers of radio transceiver (TRX) units. The service provider should consult manufacturer's data sheets to determine the power requirement of the equipment. Power to support a single 2HP air-con must also be taken into consideration.

In general, the power options can be derived from an external 240V source or where mains electricity is not available, a portable AC generator set (gen-set).

- External power source: single phase 240VAC, 10A, 50 Hz
- Gen-set capacity: at least 80% of the loading

The use of genset must comply to all relevant authority requirements, namely:

1. Diesel – KDNHEP
2. Sound & smoke – DOE & OSH (where applicable)
3. Registration – Suruhanjaya Tenaga

7.3.4 Pictures of the Mobile BTS

Figure 14. Mobile BTS showing the use of the retractable mini-mast stabilized with guy-wires.

Figure 15. Rooftop opening to allow the mini-mast to extend through. The opening is for cabling infrastructure connecting antennas/microwave dish to the equipment.

Figure 16. Interior shot of the cabin showing the BTS, rectifier and microwave racks. Also visible is the air-con blower.

7.4 Portable BTS

7.4.1 Applicable Standards

British standards and requirements by the Customer or authorities must be adhered to and adopted when defining the mobile BTS standard.

BS8100: Part 1: 1986, “Code of Practice for Loading – Lattice Towers and Masts”

The portable BTS structure shall be designed to standards to withstand wind forces, recommended loading and safety designs

Power specification

In general, the power can be derived from an external 240V source or where mains electricity is not available, a portable AC generator set (gen-set).

- External power source: single phase 240VAC, 10A, 50 Hz
- Gen-set capacity: a minimum of single phase 10 kVA

7.4.2 Pictures of the Portable BTS

Figure 17. Portable BTS installation

8 TOWER SITES REQUIREMENTS

8.1 Land Requirements

The land should be large enough for the installation of an Antenna Mounting Structure (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 outdoors equipments 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 embeded PVC/GI ducts and junction pits.

8.2 Tower Design Requirements

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

Dead Weight
Total Dead Weight shall be broken down to:

- Tower Self Weight
- Equipment Weight
- Ancillaries Weight

8.2.1 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/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 or dynamic analysis / spectral analysis is to be used should be clearly defined and reference to the appropriate Code clauses. Second order effects may be required to be checked.

8.2.2 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.

8.2.3 Grade of Steel

All Grade of steel used shall be clearly specified. Steel grade, its relevant strength and the relevant BS and/or MS that is being used should be clearly specified. If different grade of steel is to be used in the same structure, method of identification of members after galvanising and control at site should be clearly specified.

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

8.2.4 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.

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 tower and mast structure.

8.2.5 Overall Stability of Structure

The overall stability of the structure against overturning and sliding needs to be checked. The appropriate factor of safety adopted, the relevant forces (due to different loading combinations) should be clearly shown.

8.2.6 Foundation Design

The design of foundations shall be in accordance with BS8004 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 BS8100. 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.

8.2.7 Design of Members

Detailed Design Calculations of all members (primary, secondary and all other related members) shall be shown. Allowances for loss in cross-sectional area of member due to its end/intermediate connection need to be clearly shown.

8.2.8 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.

8.2.9 Vertical Cable Ladders

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

8.2.10 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 BS 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.

8.2.11 Report and Calculation Layout

All calculations should be compiled in the following order and should be endorsed by a professional engineer registered with the Board of Engineers, Malaysia.

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 MS Tower files shall be provided in soft copy.

8.2.12 Towers and Masts

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

- Introduction
- Assumptions
- Design Parameters
- The design standards and codes of practice as listed below
- Derivation of wind resistance and drag coefficient shall be clearly stated
- Loading (Dead Load, Antenna Load, Imposed Load and Wind Load)
- Summary of Tower Analysis
- Summary on Tower Stability
- Summary on Tower Design
- Summary on Tower Deflection

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

- Equivalent static method
- Non-linear analysis

The appendices deliverables shall contain the following items:

- Detailed Structural Analysis Calculations
- Detailed Wind Load Calculations
- Detailed Member Capacity Calculation
- Detailed Design of Joints
- Detailed Design of Base Plate and Holding Down Bolts For Towers

8.2.13 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 taken into account.

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 by way of Bore Hole or/and Macintosh Probe.

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

For Piled Foundation

- Determine the Geotechnical Capacity of Pile
- Depth of Pile (to be estimated from the Soil Investigation Reports)
- Design of the Pile Cap

For Pad Foundation

- Design of the Pad Footing

Drawings

All drawings should be prepared, endorsed by a professional engineer registered with the Board of Engineers, Malaysia and submitted in the following order:
All Drawings in AutoCAD format shall be submitted at various stages.

Planning & Approval Stage	- Design Drawings (Detailed Construction Drawings)
Preconstruction (Substructure) Stage	- Piling Records & Foundation Design
Preconstruction (Superstructure) Stage	- Erection Drawings (Detailed Erection Drawings)
Handover Stage	- As Built Drawings (Detailed As-Built Drawings)

DESIGNS LOADINGS AND STANDARDS

Loadings (Dead and Imposed)

BS6399: Design loading for buildings.
Part 1: 1996 - Code of practice for dead and imposed loads.
Part 3: 1988 - Code of practice for imposed roof loads.

Floor Usage	Design Imposed Load
Roof with no public access	0.75 KPA
Roof with public access	1.50 KPA

A sample of the loads imposed on a tower is shown in Appendix 4.

Wind Loading Derivation

BS8100: 1986 - Lattice towers and masts.
Part 1 - Code of practice for loadings.

BS8100: 1995 - Lattice towers and masts.
Part 4 - Code of practice for loadings of guyed masts.

Specified design wind speed
3 sec gust wind speed 33.33m/s (120km/hr)
Hourly mean wind speed 22m/s

Partial safety factors shall be determined in accordance with:
BS8100: Part 1 for mast and towers
BS8100: Part 4 for guyed masts

Classification of structure: 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 BS8100.

Terrain classification for tower and mast structure design shall follow the recommendations in BS8100 and appropriate to the site of application.

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

Concrete Design

BS8110: 1997 Part 1 - Code of practice for design and construction.

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

Steel Design

BS5950: 2000 Part 1 - Code of practice for design of rolled and welded sections.

Gamma factor for material shall be 1.15.

BS8100: Part 3 - (DD133: 1986) Code of practice for strength assessment of members of lattice towers and masts

BS5950 cannot be used as a direct design reference without giving due considerations as outlined in BS8100: Part 3 - (DD133: 1986).

Materials - Tower & Mast Structure Design

A. Angles
Grade S275 or S355 to BS EN 10025: 1993
Hot rolled products of non-alloy structural steel.
Yield Stress fy = 275 or 355 MPa

B. Circular Hollow Sections
Grade S275 or S355 to BS EN 10210: 1994-1
Hot finished structural hollow sections of non-alloy structural steel.
Yield stress fy = 275 or 355 MPa

C. Bars
Steel bar to BS4449:1978
Yield stress fy = 250 MPa (mild steel) or 460 MPa (hot rolled high yield)

D. Welding
Class 35 as per BS5950-2
Yield stress fy = 355 MPa other grades may be use where appropriate

E. Bolts
Grade 8.8 to BS3692
Bolt shank shall be sufficient long to accommodate nut and washer, such that no connecting part shall bear on the bolt thread.

8.3 Cabin Design Requirements

8.3.1 General

Where cabins are to be used for the housing of radio equipments there should be space for supporting infrastructure such as AC and DC power systems, battery banks, fire fighting equipment cooling system and working space.

Sufficient space shall be allocated for future expansion of radio equipments. Not withstanding this, the allocation of cabin space should take into account the practical maximum loading capacity of the AMS.

The cabin will be required to accommodate radio equipment, multiplexers, interconnect equipment and battery power supply back-up.

The same cabin design may be utilised on both building rooftops and on landed sites.

8.3.2 Design Requirements:

- Designed and fabricated to relevant authority prescriptions.
- Floor loading with a distributed load of 2.0kN/m^2
- Roof to support a minimum load of 1.5kN/m^2 as well as a point load of 1.0kN.
- Roof to be sloped to prevent ponding of rain water with additional metal decked pitched roof.
- Due consideration for thermal load that may affect cabin details whenever great temperature differences exist between the inside and the outside of the cabin.

- Overall strength of the finished cabin when fully equipped, shall not deform, crack or deflect by more than 1mm per m when subjected to long transports by truck, loading and unloading by forklifts, cranes and other normal handling.
- Design wind speed of 33.33 m/s.
- Thermal insulation with total thermal coefficient (K value) equal or less than 0.5 $W/m^2 \times {}^oC$.
- Design life span of 20 years
- No hazardous materials will be allowed in the construction of the cabin. Wooden material will only be allowed in the floor decking.
- Door seals to IP 54 ratings.
- Flooring of 3mm thick antistatic vinyl tiles, 24mm thick cemboard and 0.5mm thick GI sheet.
- Walls made up of Polyurethane (PU) material in modular panels sandwiched by 2 nos 0.5mm thick steel sheets.
- Access for services such as electrical cables, earthing, RF feeders and cable ladders should be provided.

8.4 Compound and Drainage

Compound can consist of either concrete or premix. The recommended thickness is 75mm for both surface types.

The design of the concrete surface should be based on BS8110, Part 1:1985. For the premix surface it should be based on Arahan Teknik JKR or AASHTO.

Drainage design should be based on the hydraulic calculations in the Manual Saliran Alam Malaysia (MASMA) by JPS.

8.5 Cable Ladders and Cable Supports

Cable ladders and all its mounting ancillaries shall be galvanized to MS739 and MS740 for all external applications. Cable ladders shall be of sufficient width to accommodate all intended cables.

Waveguide/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 200mm space clearance between the ladder and feeder cables shall be maintained.

8.6 Fire Extinguisher

A fire extinguisher shall be provided; this should be wall mounted and of the handheld type. The fire extinguisher is to have a test label attached with the original date of issue marked on, the manufacturer's name and the BS designation.

8.7 Security Facility

The room door system should be provided with a reed relay switch door contactor to monitor site access. Additional features would include other detectors like passive infrared detectors, and CCTV systems.

8.8 Climate Control System

This section covers the cooling requirement of the cabin only as outdoor equipment comes with its own climate control system. The requirements for temperature and humidity shall be met in accordance with the environmental specifications for the equipment. The following guidelines are based on the specifications found in the European Telecommunications Standards Institute (ETSI) document on 300 019. The figures indicated below are typical values.

8.8.1 Air-Conditioning

The cabin is equipped with 2 nos split air conditioners operating in alternate mode of 4 hourly cycles each.

Operating temperature is between 20-25℃ with rela tive humidity of 40-80%.

The short-term temperature range of the equipment is between 2-49℃ with short-term relative humidity between 0 - 90% non- condensing. These are considered as environmental extremes which if allowed to persist for any appreciable period of time would result in permanent equipment damage or irreversible performance degradation.

The cooling capacity will depend among other things, on the amount and type of equipment installed inside the cabin.

Stand-alone sites are equipped with 2.0 or 2.5 HP while shared sites are equipped with up to 4HP units. Appendix 1 provide details the dimensioning for the air-cond system.

8.8.2 Forced Air Cooling

As with the AC and DC systems, the cooling system is equipped with redundancy in the form of force air cooling. The ventilation fans are powered by the battery banks. This added redundancy is needed in case of mains failure or air-conditioning failure.

A microprocessor based controller constantly monitors the internal temperature of the cabin and triggers the ventilation fans when the temperature rises above a user defined preset value of 35-38℃. Refer to Appendix 1 for sizing of exhaust fans.

8.9 Power Supply System

8.9.1 AC Supply

The station shall be equipped with three phase supply at the following amperage

- 60A for stand-alone sites
- 100A for shared sites.

The electrical installation shall be registered with Suruhanhjaya Tenaga (ST). All relevant documents for submission should be duly endorsed by a Professional Engineer registered with BEM.

Redundancy in the form of 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 1.

Generator set are recommended at 60kVA for shared sites and 30kVA for stand-alone sites. Appendix 2 shows the sizing of the generator set for a station with cabin and with outdoor equipments.

Table 3. Suggested backup policy for the provision of generator set in the station

Site Category	TNB	Quantity of Generator Set
Rural Trunk & Collection Point [w/ SDH links]	Yes	1
	No	2
Urban Trunk & Collection Point [w/ SDH links]	Yes	---
Non Collection Point	Yes	---
	No	2

8.9.2 Mains Power Distribution System

The mains power distribution system should consists of an intake point located in the floor of the cabin and a power distribution board. This is a Three Phase metal clad type fitted with the necessary MCB's.

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 the relevant IEE Wiring Regulations.

8.9.3 System of Wiring

The system of wiring is comprised of copper/PVC single insulated cables to BS 6004:1990. The cables should generally be installed within a conduit or trunking in a neat and tidy manner.

Sizing of all electrical cables should take into account voltage drop, grouping, and environmental conditions in accordance with the relevant IEE Wiring Regulations.

8.9.4 DC Supply

Telecommunication equipments should utilise DC at -48V. A rectifier system converts the incoming 240V AC supply into the required DC voltage level. There may be legacy equipments utilizing 24V 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 add weight to the cabin. Other advantages are easier 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 fault or AC outages.

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

There should be two nos 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 2. Typical values are 4hrs discharge (backup) and 10hrs recharge. See Appendix 3 for backup battery sizing.

To contain the size and weight of the banks to maneageable values, load shedding may be built into the rectifier system. Equipments 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 MW radios downstream therefore have a higher probability of survival.

Table 4. Suggested backup policy for the provision of battery banks in a standalone site

Equipment	Qty	Unit Load (W)	Load (W)	Output Voltage	Batt Backup
SDH MW Radio	2	150	300	48V	6 Hrs
PDH MW Radio	3	150	450	48V	4 Hrs
Mux	2	165	330	48V	4 Hrs
DXX Cross Connects	1	200	200	24V	4 Hrs
BTS (6+6+6 TRX)	3	1080	3,240	48V	2 Hrs

Table 4. Suggested backup policy for the provision of battery banks in a standalone site *(continue)*

Equipment	Qty	Unit Load (W)	Load (W)	Output Voltage	Batt Backup
Ventilation Fan *	2	100	200	$240V_{AC}$	6 Hrs
Keluar Sign *	1	5	5	$240V_{AC}$	6 Hrs
Emergency lighting *	2	50	100	$240V_{AC}$	6 Hrs
		Total Load (W)	4,540		

NB**. *** Powered from the battery banks

8.10 Aircraft Warning Lights

The Aircraft Warning Lights should be in compliant with the technical requirements by the national Department of Civil Aviation (DCA) and the recommendations of the International Civil Aviation Authority (ICAO).

The light fixtures should be design 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 for lightning protection.

8.11 Lighting

The cabin should be provided with ceiling mounted high efficiency fluorescent lighting giving 200-300 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 from the rectifier system.

Switches for the control of light fittings should be provided at the entrance just inside the cabin.

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

8.12 Small Power Installation

Surface mounted twin Switch Socket Outlets, S/S/O should be provided for test equipments and other maintenance applicances. They should be located one on opposite sides of the cabin.

8.13 M&E Control and Alarm Signalling Cables

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

Alarm contacts should be voltage free relays of the single-pole-double- throw type, operated by 48V DC supplies.

8.14 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 a 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.

8.15 Earthing Facility and Cross Bonding

The Earthing of the electrical installation should comply with the requirements of The IEE Wiring Regulations. Code of Practices for the earthing of equipment and 'system earthing' can be found in BS7430.

Equipotential bonding of structures should be implemented throughout the station for protection against lightning in accordance to BS6651. This entails specification of materials used and procedures to adopt if it is desirable to provide protection for the AMS. The cabin installed close to the AMS and within its 30º zone of protection are 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 its supplied earthing kit.

The collection of all the earting lugs is terminated onto a common earth copper bar installed at 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 Ohms.

8.15.1 Earthing Scheme

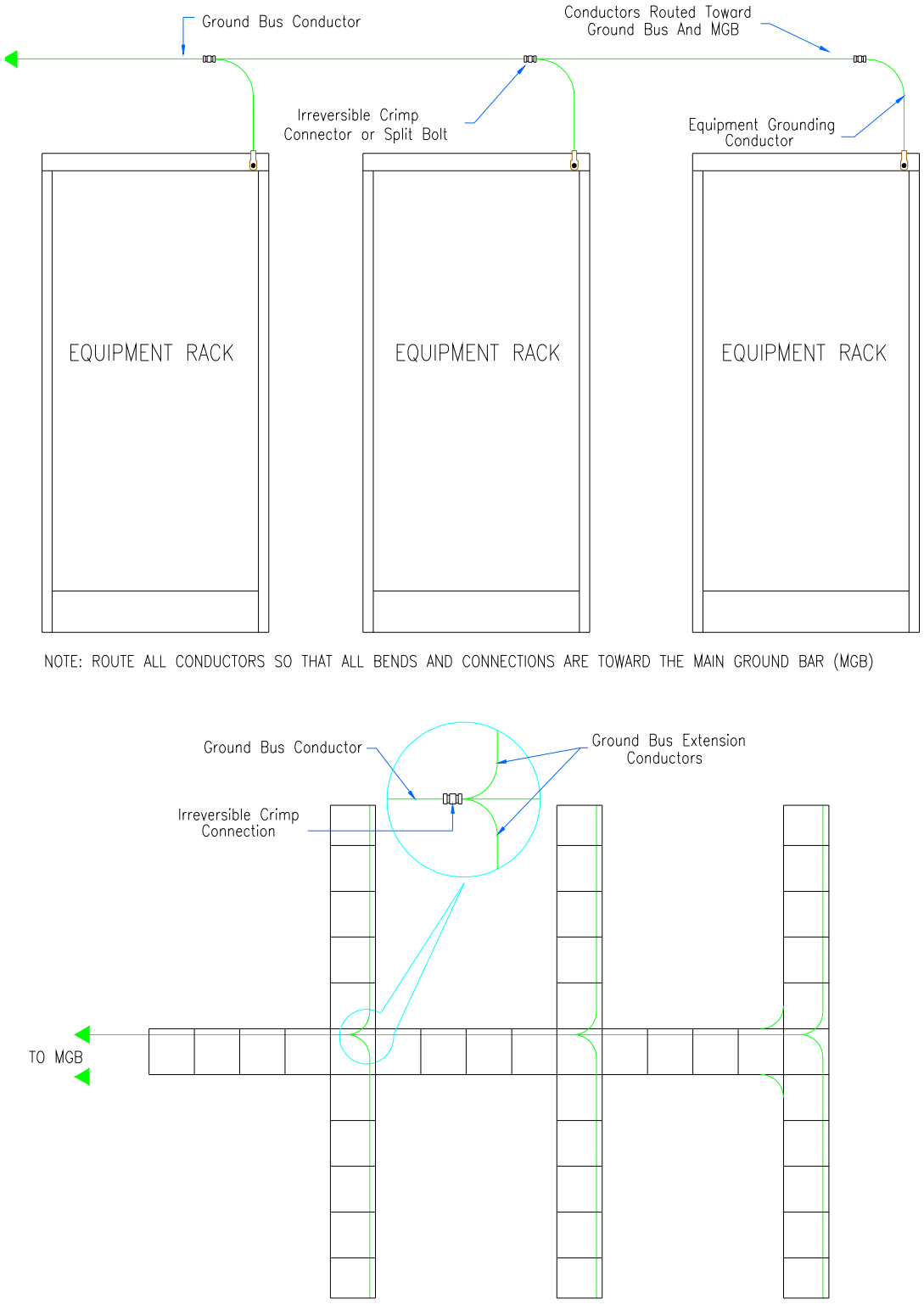


Figure 18. Connecting cabinets and cable ladder to the Gnd Bus Conductor using crimp connectors and following the flow towards the MGB

9 SITE MAINTENANCE RECOMMENDATION

9.1 General

Tower site maintenance shall remain the responsibility of the site owner. Regular site inspection is required to ensure the Tower is structurally sound. This is preventive maintenance where any deterioration can be highlighted ahead of time and corrective work be done to prevent further degradation to the structure. Failure to observe a regular maintenance schedule can create a potentially hazardous working and operating conditions.
Regular check of the structural integrity of all add-on assemblies is recommended to be carried out by trained personnel from the facilities operator.

9.2 Site Access

It is important to ensure that there is twenty-four- (24) hours 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:

- During office hours
- As and when required at the event of 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 is 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 authorized department or personnel(s) 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.

- The Service Provider's employees ID (Identification Data) and/or Pass card
- Authorization letter
- Authorized work permit

Any personnel(s) that have access to the property shall fill-in the visitors log book as per detailing 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(s) that have accessed to the property shall strictly follow the code of conduct as may be outlined while on the property premises.

9.3 Tower Maintenance

This section seeks to establish procedures and guidelines for the inspection and maintenance of tower. It also identifies the deficiencies, the defective items and recommends solutions to keep the towers in good condition and optimum performance.

9.3.1 Inspection Interval

The interval between tower inspections should not be greater than five (5) years and should be maintained in accordance with the findings from the inspection.

9.3.2 Recommendation and Procedures

The following procedures are recommended for inspection and maintenance of the tower and all its ancillaries. The visual inspection works begin when the Field Operations approach to the sites.

Visually inspect the following and jot down your observation:

- Visually inspect the compound from a distance.
- Observe the tower from a distance
- Visually inspect the paint condition of the tower
- External environmental condition (i.e. slope erosion, soil settlement or movement, adjacent development, drainage system, etc)
- Tower surroundings are clear of debris.
- Ground rod present at top of the tower and at least 3 feet above highest antenna.
- Visually inspect whether tower is plumb (straight).
- Visually inspect whether tower is free of twists.
- Visually inspect Aviation Obstruction Light (AOL)

Physical inspection of the tower and its ancillaries, i.e tower members, bolt and nut, paint, climbing and cable ladder and gantry, platform, antennas, electrical components on tower, waveguide, guys, and all associated tower hardware shall be evidenced with color photographs of each tower being taken and incorporated into each tower report.

Antennas shoud be repainted, if required, with specially formulated RF transparent paint

The use of skylifts or elevated platforms/devices is recommended for accessing the antenna on monopoles trees and most other aesthetically treated structures. Cranes shall not be used for access to antennas by personnels.
It is crucial to check and report the structure condition in relation to external environmental condition (i.e. slope erosion, soil settlement or movement, adjacent development, drainage system, etc) duly supported with photographical evidence, at least from four (4) critical angle.

The tower inspection works will include climbing each tower to inspect for damage, performing minor repairs, photographing deficiencies requiring major repairs and preparing detailed reports.

The climbing works shall only be inspected by competent riggers, using proper tools and equipments and inspections shall only be performed when the weather condition is permissible.

Photographic documentation of any deficiencies detected in the inspection shall be highlighted together with clear descriptions, which will trigger repairs, modifications or replacement. Hardcopy and JPEG images are required. Photographs should be labeled with site ID and date, and position and nature of problem should be stated clearly.

The inspection findings shall include comments of the condition as:

- Satisfactory – in accordance with standards and no maintenance works required
- Not Satisfactory – not to standard and maintenance works required
- Critical – immediate response, public health and life-threatening situation
- Not Applicable – not relevant to this site

The inspector will complete and safe keep a hard copy and an electronic version of the following documents.

- Inspection checklist
- Photographic records

Sample Form : Routine Maintenance Checklist for Infrastructure

General Information	
Site Name:	Site ID:
1. Date:	2. Time :
CME Part:	
Earthing measurement at inspection pit:	
3. Inspection pit 1	Ohm
4. Inspection pit 2	Ohm
5. Inspection pit 3	Ohm
6. Inspection pit 4/tower leg	Ohm
Visual check:-	
7. Compound Cleanliness:	☐Clean ☐ Not clean Remark:
8. Compound Condition:	☐OK ☐ Not OK Remark:
9. Perimeter Fence:	☐OK ☐ Not OK Remark:
Drainage system:	☐OK ☐ Not OK Remark:
Plinth Condition:	☐OK ☐ Not OK Remark:
Vegetation condition:	☐OK ☐ Not OK Remark:
10. Access road:	☐OK ☐ Not OK Remark:
11. Tower Leg :	☐OK ☐ Not OK Remark:
12. Condition of tower member:	☐OK ☐ Not OK Remark:
Anti-climb cage to prevent theft:	☐OK ☐ Not OK Remark:
Fall Arrest/Body Harness	☐OK ☐ Not OK Remark:
Compound Lighting:	☐OK ☐ Not OK Remark:
Inspection pit cover:	☐OK ☐ Not OK Remark:
Defects / Remark to be rectified:	

Checked by:	**Verified by:**
13. Name: 14. Date : Contact:	15. Name: 16. Date : Contact:
Co. name & Chop:	**Signature:**

10 Abbreviations and Definitions

For the purposes of this TSIR, the followings abbreviations and definitions apply.

Abbreviations	Definition
AASHTO	American Association of State Highways and Transportation
AC	Alternating current
ADM	Add-drop multiplexer
AMS	Antenna mounting structure. Any structure that is used to mount the whole antenna assembly. Usually made from steel, they may take the form of a lattice tower, monopole, mast or floor mounted poles.
AOL	Aviation Obstruction Light (
BEM	Board of Engineers, Malaysia
BOMBA	Fire and Rescue unit of Malaysia
BS	British Standards
BTS	Base transceiver station
BTU	British Thermal unit, a measure of energy
CCTV	Closed circuit television
CSM&E	Civil, Structural, Mechanical and Electrical
DC	Direct current
DCA	Department of Civil Aviation
DEVELOPER	Any person, body of person, company, firm or society (by whatever name described), who or which engages in or carries or undertakes or causes to be undertaking housing development.
DXX	Digital Cross Connect
ETSI	European Telecommunications Standards Institute
GI	Galvanised Iron
GSM	Global System for Mobile Communication
HP	Horsepower (for air-conditioning power rating)
ICAO	International Civil Aviation Authority
IEE	Institute of Electrical Engineers
JKR	Jabatan Kerja Raya

LED	Light Emitting Diode
MASMA	Manual Saliran Alam Malaysia (MASMA) by JPS
MCB	Mains Circuit Breaker
MGB	Mains Ground Bar
MS	Malaysia Standards
MTSFB	Malaysian Technical Standards Forum Bhd
MUX	Multiplexer
MW	Microwave
NFP	Network Facilities Providers. The owners of facilities such as satellite earth stations, broadband fiber optic cables, telecommunications lines and exchanges, radiocommunications transmission equipment, mobile communications base stations, and broadcasting transmission towers and equipments.
NSP	Network Service Providers. The organization that provide the basic connectivity and bandwidth to support a variety of applications. Network services enable the connectivity or transport between different networks. A network service provider is typically also the owner of the network facilities. However, a connectivity service may be provided by a person using network facilities owned by another.
OSHWP	Occupational, Safety and Health Work Practices
Pa	Pascal, a measure of pressure or force
PDH	Plesi- synchronous digital hierarchy
PE	Professional Engineer
PVC	Polyvinyl carbonate
RF	Radio Frequency
SDH	Synchronous digital heirarchy
Service Provider	A person that is granted a license by the Ministry of Energy, Water and Communications (MEWC) under the Act to establish, maintain and operate a telecommunications network in Malaysia.
SI	Structural Integrity
SKMM	Suruhanjaya Komunikasi dan Multimedia Malaysia
SON	Sodium Lamps
ST	Suruhanjaya Tenaga

TRX	Radio transceiver
TSIR	Technical Standards and Infrastructure Requirement
TSS	Technical site survey
VA	Volt – ampere (a measure of power)

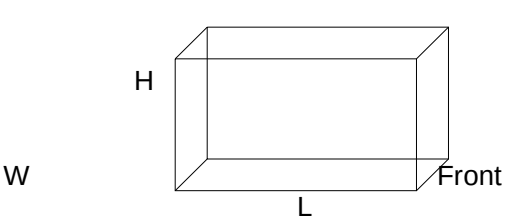
11 **APPENDIX A** (Sizing for cabin air-conditioning)

Table A1. sizing for cabin air-conditioning

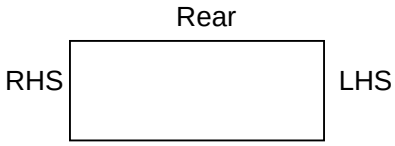
Nos	Wall Description	Face	Power (W)	Area (ft^2)	TΔ	TΦ	Heat Load (BTU / Hr)
1	Wall - Front	1		248.9	26	0.6	3884
2	Wall - Rear	2		248.9	26	0.6	3884
3	Wall – RHS	3		149.3	26	0.6	2329
4	Wall – LHS	4		149.3	26	0.6	2329
5	Roof	5		379.2	40	0.6	9101
6	Floor	6		379.2	36	0.6	8191
7	Equipment		13580		2716	3.4	9234
8	Lighting		160		16	3.4	54
TOTAL							39,007

Air-con Capacity Required: 4HP.

Cabin dimensions LxWxH (mm): 7.6 x 4.6 x 3.0



Isometric View



Plan View of Walls

Fig. Shows various views of cabin

Volume (ft^3) = L X W X H
= (7.6 X 4.6 X 3.0) X 3.3^3
= 3769

Air Flow (cfm) = (Vol x Nos if Air Chg) / 60
= (3769 x 30) / 60
= 1885

12 **APPENDIX B** (Gen-set sizing for shared sites)

Table B1. Gen-set sizing for shared sites

Nos	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)	1440	17	24480	0.8	19584
	Air-con Unit	4000	2	8000	0.5	4000
	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					24684
B	Generator Set Sizing					
	Min genset VA req (MD/0.85)	29,040				
	Proposed Gen-set	30kVA				
	Proposed Fuel Tank for 5d backup (5Litre/hr x 5 x 24)	600 L (131gal)				
2	Outdoor Equipment					
A	Electrical Load Schedule					
	Operator 1	6600	2	13200	1.0	13200
	Operator 2	5948	2	11896	1.0	11896
	Operator 3	5600	2	11200	1.0	11200
	Switched Socket Outlet	100	2	200	0.5	100
	Compound Lighting	150	4	600	1.0	600
	Total Load					36996
B	Generator Set Sizing					
	Min genset VA req (MD/0.85)	43,525				
	Proposed Gen-set	50kVA				

13 **APPENDIX C** (Rectifier sizing for shared sites)

Table C1. Rectifier sizing for shared sites

Nos	Load Description	Connected Load (W)	Initial		Final	
			Qty	Total (W)	Qty	Total (W)
1	DC Loads					
a	Operator 1 Equipment					
	BTS	1880	1	1880	2	3760
	SDH	250	2	500	3	750
	PDH	150	1	150	2	300
	ADM	150	1	150	2	300
b	Operator 2 Equipment	1700	1	1700	2	3400
	SDH	250	0	0	1	250
	PDH	150	0	0	2	300
	ADM	150	0	0	1	150
c	Operator 3 Equipment	1700	1	1700	2	3400
	SDH	250	0	0	1	250
	PDH	150	0	0	2	300
	ADM	150	0	0	1	150
d	Misc loads					
	Force air cooling	110	2	220	2	220
	Ceiling mount fan	50	1	50	1	50
	Sub Total (W)			6350		13580
2	Battery Sizing					
	(i) AHr required for **4 hrs** backup Initial 600Ah x 1 bank Final 600Ah x 2 bank Rack/bank: 2285(L)x370(D)x1370(H)			529		1132
	(ii) AHr required for **8 hrs** backup Initial 1000Ah x 1 bank Final 1000Ah x 2 bank Rack/bank: 2285(L)x370(D)x1780(H)			1058		2263
3	Rectifier Sizing					
	Rectifier modules for 8 hrs backup					
	modules for connected equipments			4		9
	modules for battery charging*			3		7
	Total modules required (N+1)			8		17

NB. * Based on 1440W per rectifier module and 10 hrs recharge time

14 **APPENDIX D** (Tower load charts)

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

The actual numbers of operators able to be share the tower is limited by the maximum loading capacity of the tower.

For special cases (eg: Large hub sites with many microwave dishes) where loading capacity exceed the recommendation below then the tables below do not apply.
For special cases where the tower is not shared and meant to serve a single operator; the tables below do not apply.

Table D1. 76m Tower Load Table

76m Light Duty	76m Medium Duty	76m Heavy Duty
9 x GSM	9 x GSM	9 x GSM
2 x 2.4m Dia	2 x 2.4m Dia	2 x 3.6m Dia
2 x 1.8m Dia	6 x 1.8m Dia	4 x 2.4m Dia
2 x 1.2m Dia	4 x 1.2m Dia	7 x 1.8m Dia
		3 x 1.2m Dia

Table D2. 60m Tower Load Table

60m Light Duty	60m Medium Duty	60m Heavy Duty
9 x GSM	9 x GSM	9 x GSM
2 x 2.4m Dia	2 x 2.4m Dia	2 x 3.6m Dia
2 x 1.8m Dia	6 x 1.8m Dia	4 x 2.4m Dia
2 x 1.2m Dia	4 x 1.2m Dia	7 x 1.8m Dia
		3 x 1.2m Dia

Table D3. 45m Tower Load Table

45m Light Duty	45m Medium Duty	45m Heavy Duty
9 x GSM	9 x GSM	9 x GSM
2 x 2.4m Dia	2 x 2.4m Dia	2 x 3.6m Dia
2 x 1.8m Dia	6 x 1.8m Dia	4 x 2.4m Dia
2 x 1.2m Dia	4 x 1.2m Dia	7 x 1.8m Dia
		3 x 1.2m Dia

15 **APPENDIX E** (Model sites for rooftop)

15.1 RT1 P – Cabin/Room with 3m/6m Poles

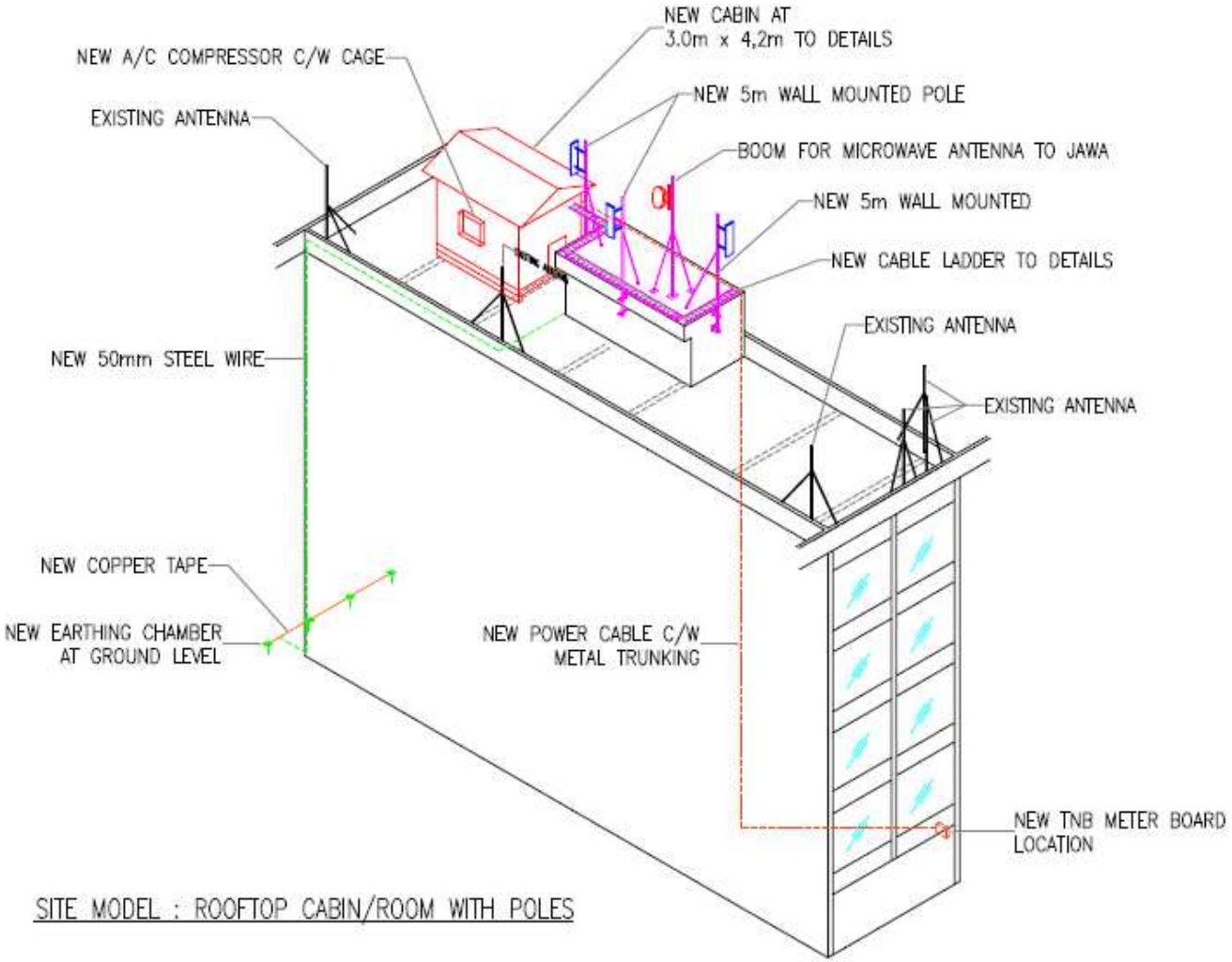


Figure E1. Examples of RoofTop Cabin/Room with 3m/6m Poles

15.2 RT1 M – Cabin/Room with Mast

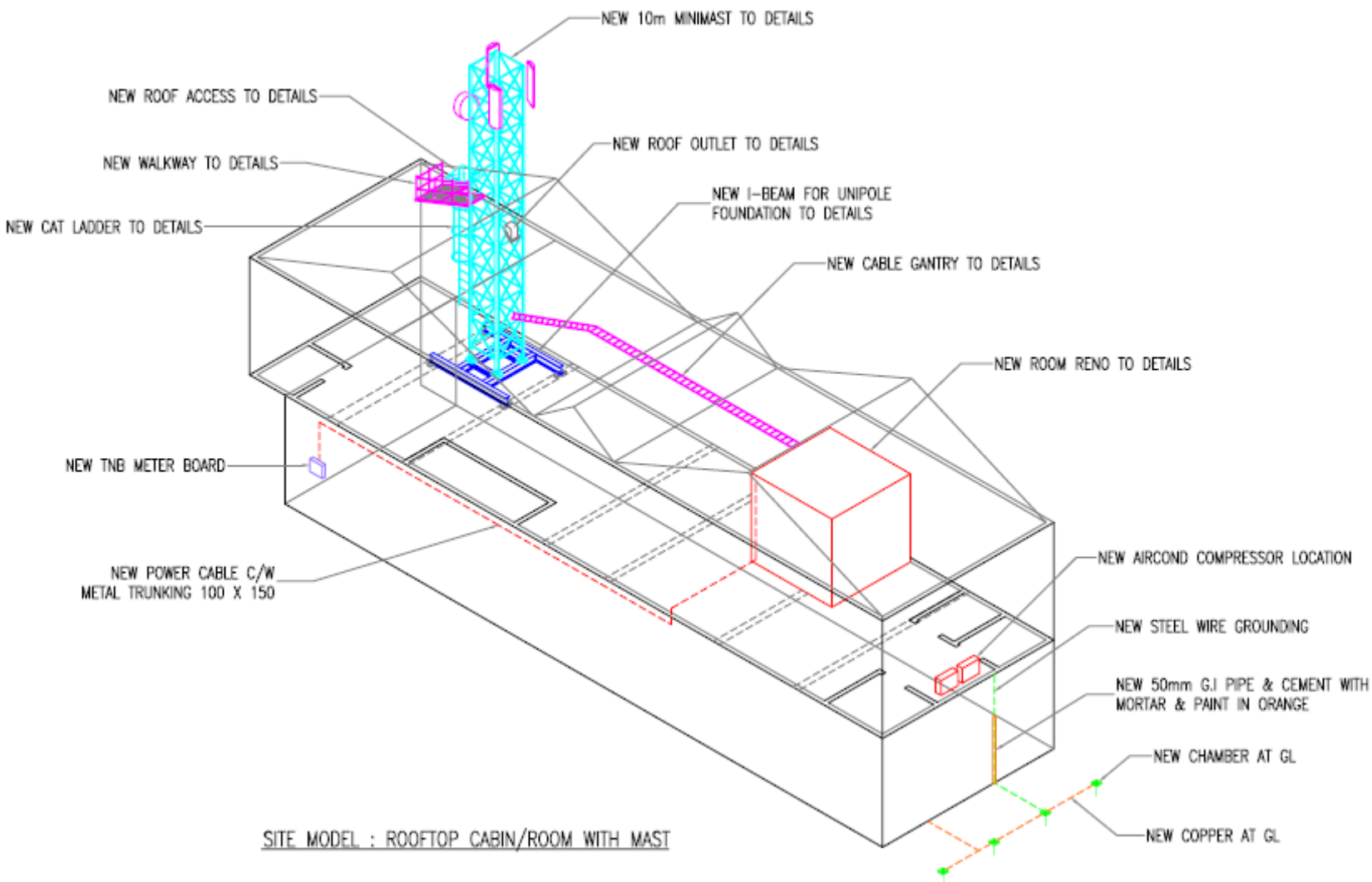


Figure E2. Examples of RoofTop Cabin/Room with Mast

15.3 RT1 U – Cabin/Room with Unipole

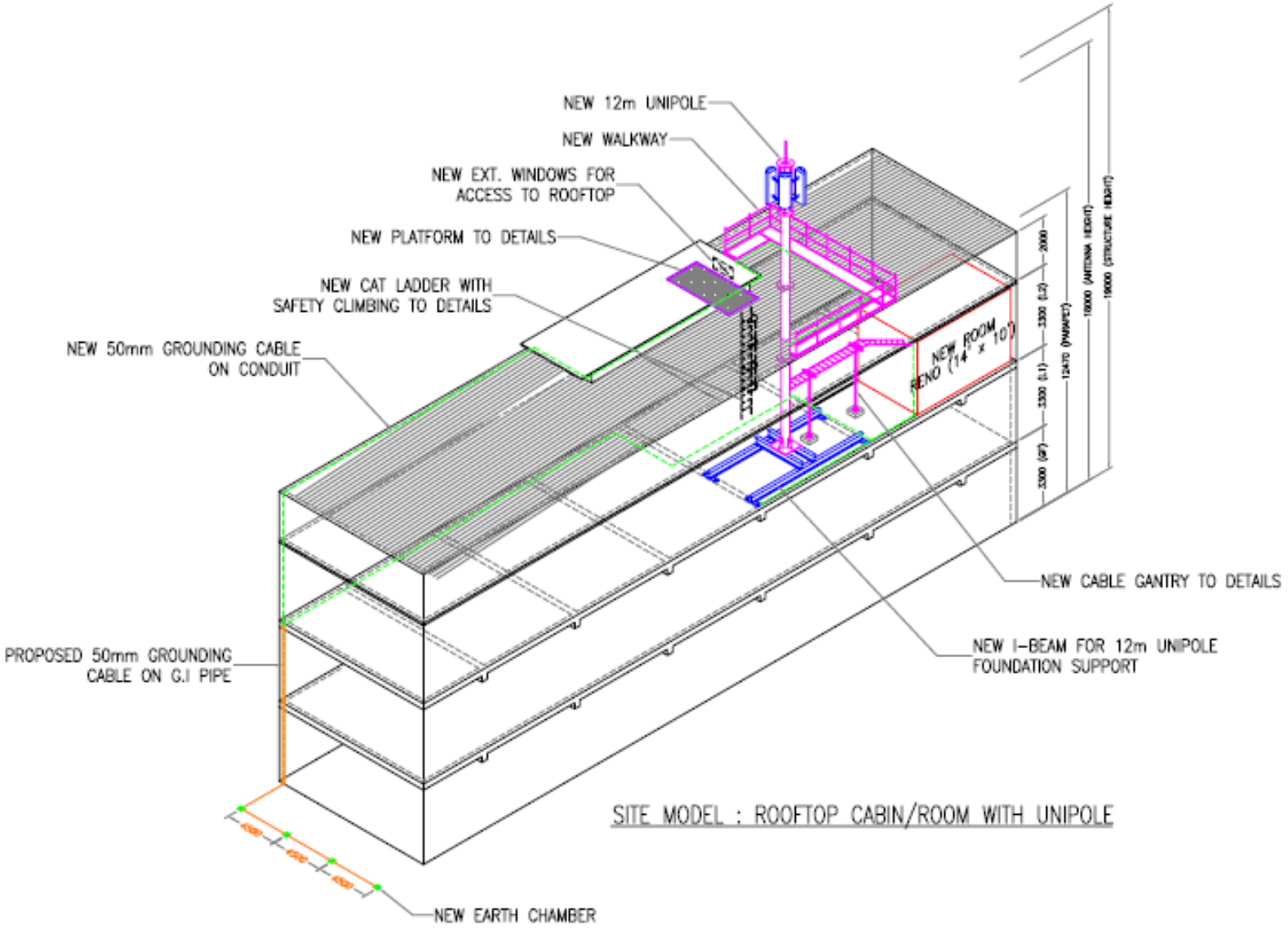


Figure E3. Examples of RoofTop Cabin/Room with Unipole

15.4 RT2 P – Outdoor with 3m/6m Poles

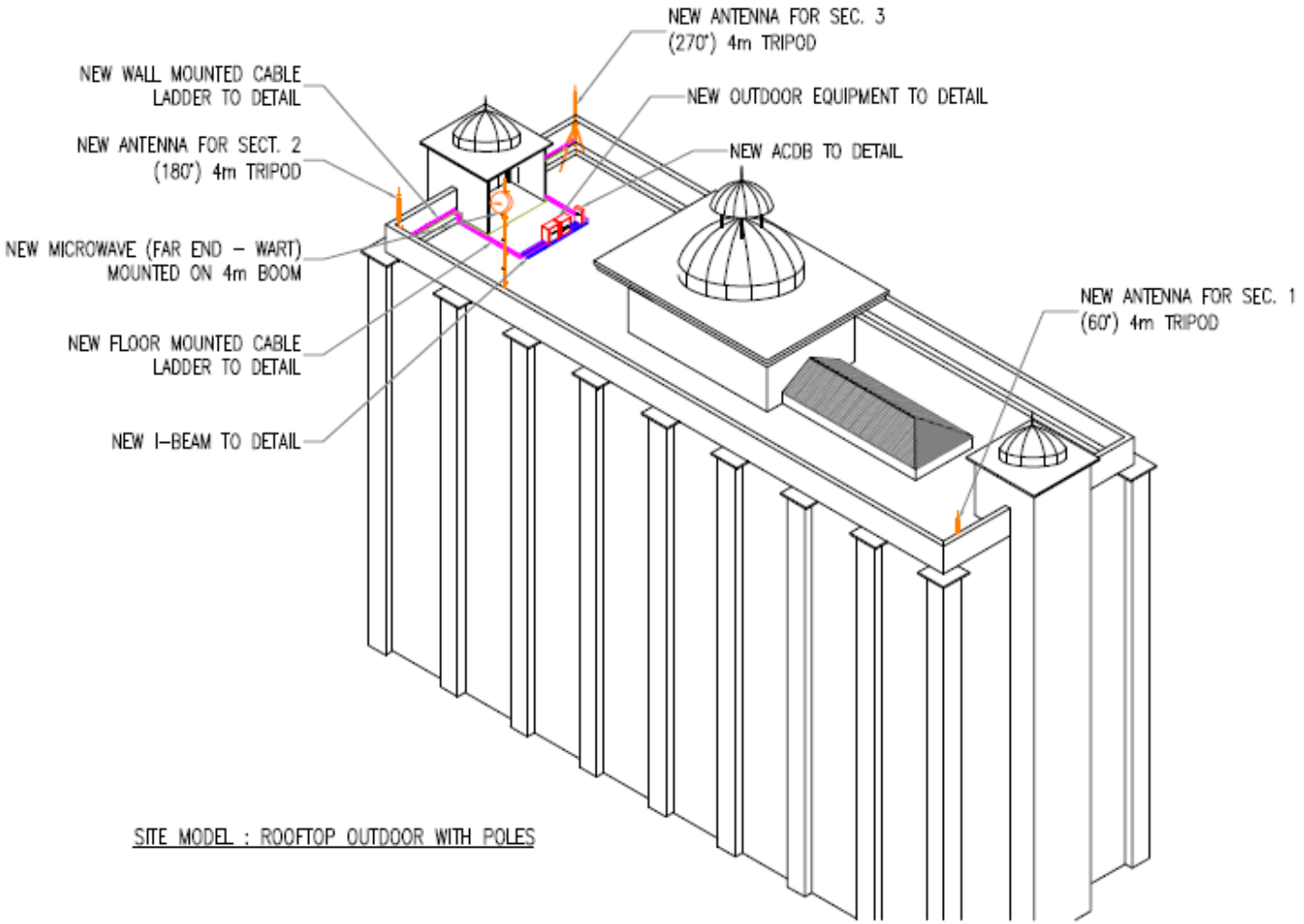





Figure E4. Examples of RoofTop Outdoor with 3m/6m Poles

15.5 RT2 M – Outdoor with Mast

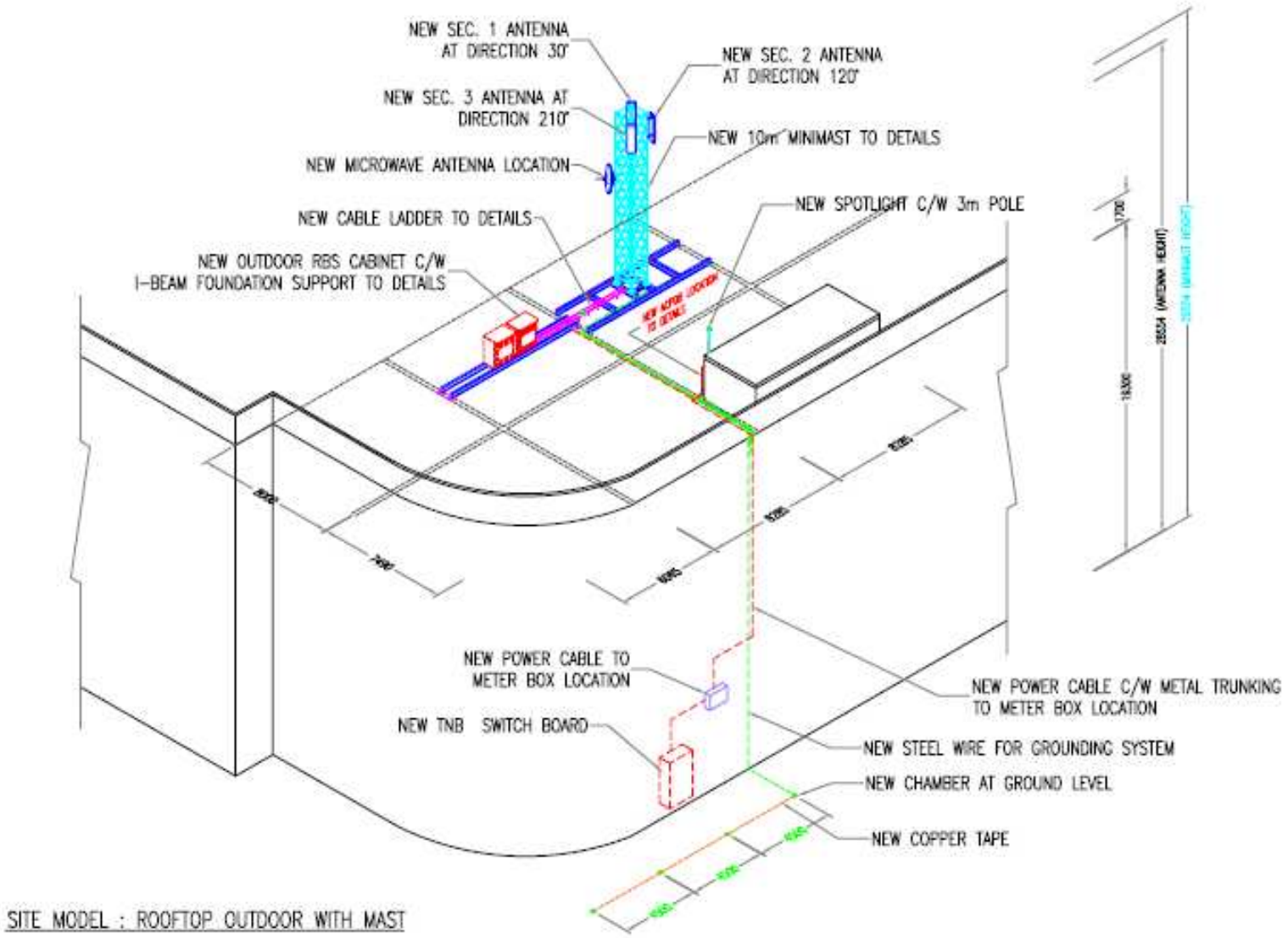


Figure E5. Examples of RoofTop Outdoor with Mast

15.6 RT2 U – Outdoor with Unipole

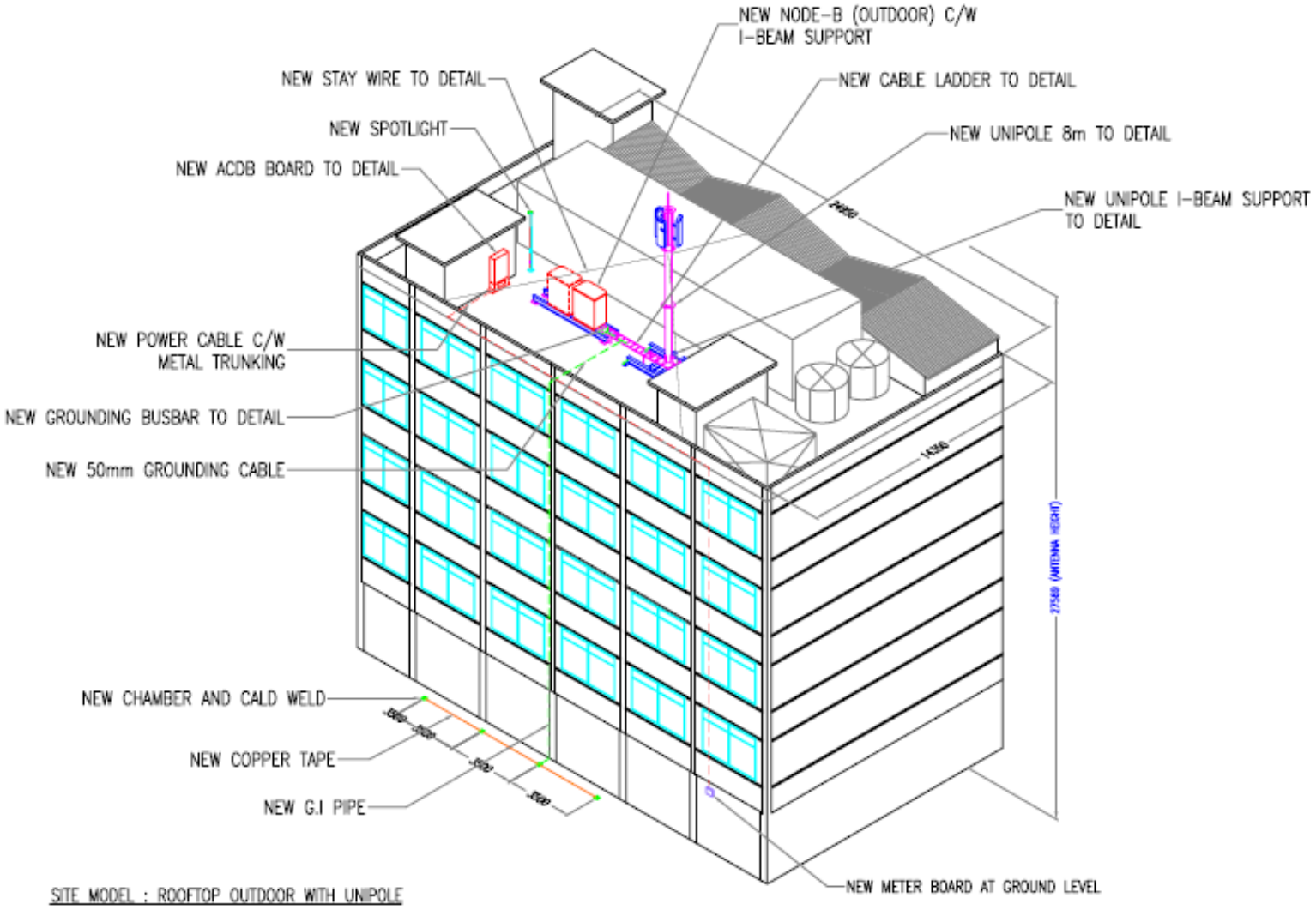
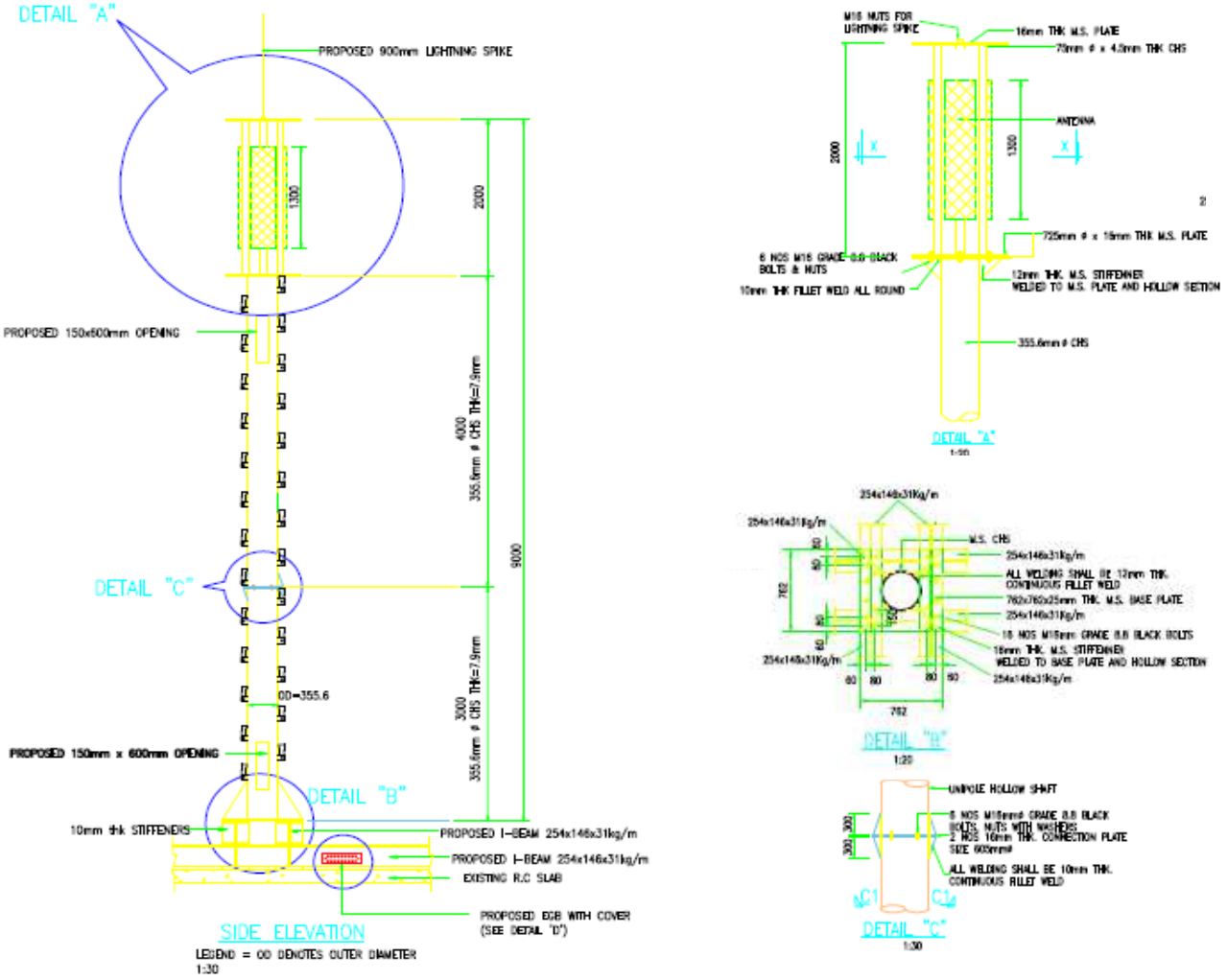


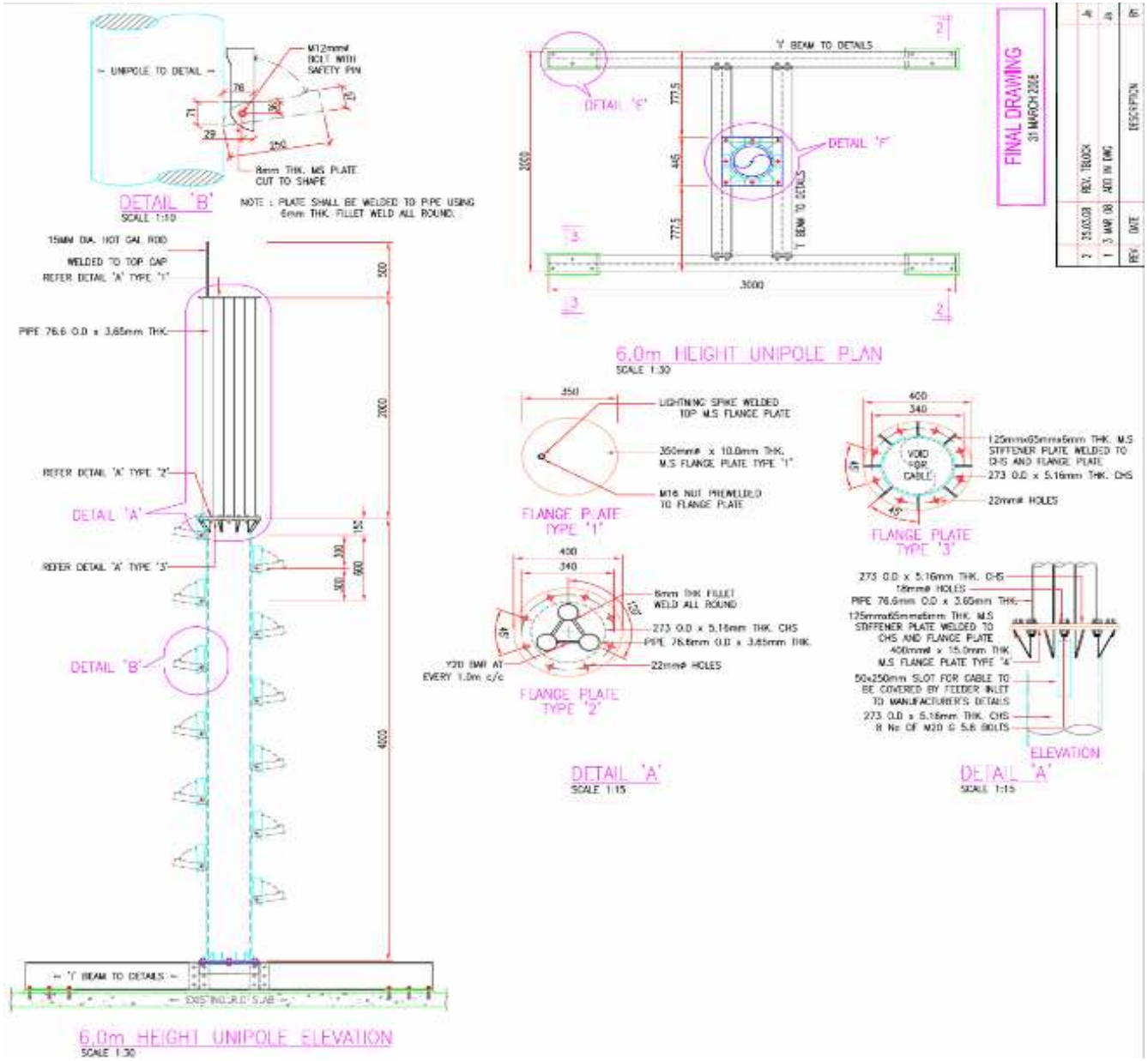
Figure E6. Examples of RoofTop Outdoor with Unipole

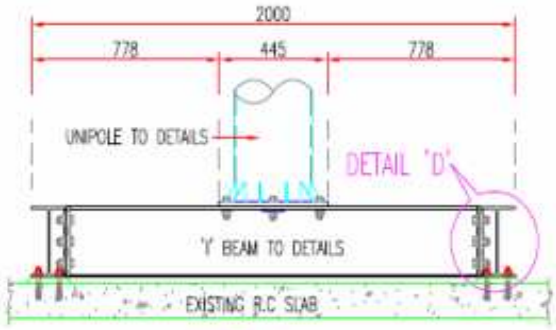
APPENDIX F (Samples of antenna mounting structure)

15.7 Unipole Design Example

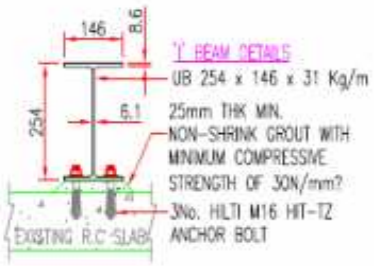


Unipole design (Option 1)

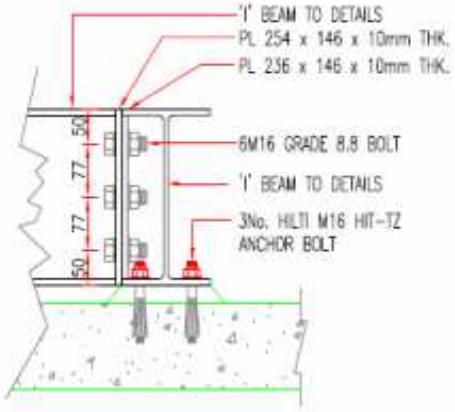

FINAL DRAWING
31 MARCH 2008
REVISION
DATE
REV
M12mmø BOLT WITH SAFETY PIN
UNIPOLE TO DETAIL
8mm THK. MS PLATE CUT TO SHAPE
DETAIL 'B'
SCALE 1:10
NOTE : PLATE SHALL BE WELDED TO PIPE USING 6mm THK. FILLET WELD ALL ROUND.
'Y' BEAM TO DETAILS
DETAIL 'E'
DETAIL 'F'
6.0m HEIGHT UNIPOLE PLAN
SCALE 1:30
15MM DIA. HOT GAL ROD
WELDED TO TOP CAP
REFER DETAIL 'A' TYPE '1'
PIPE 76.6 O.D x 3.65mm THK.
REFER DETAIL 'A' TYPE '2'
DETAIL 'A'
REFER DETAIL 'A' TYPE '3'
DETAIL 'B'
'Y' BEAM TO DETAILS
EXISTING R.C. SLAB
6.0m HEIGHT UNIPOLE ELEVATION
SCALE 1:30
LIGHTNING SPIKE WELDED TOP M.S FLANGE PLATE
350mmø x 10.0mm THK. M.S FLANGE PLATE TYPE '1'
M16 NUT PREWELDED TO FLANGE PLATE
FLANGE PLATE TYPE '1'
8mm THK FILLET WELD ALL ROUND
273 O.D x 5.16mm THK. CHS
PIPE 76.6mm O.D x 3.65mm THK.
22mmø HOLES
Y20 BAR AT EVERY 1.0m c/c
FLANGE PLATE TYPE '2'
DETAIL 'A'
SCALE 1:15
125mmx65mmx6mm THK. M.S STIFFENER PLATE WELDED TO CHS AND FLANGE PLATE
VOID FOR CABLE
FLANGE PLATE TYPE '3'
18mmø HOLES
400mmø x 15.0mm THK M.S FLANGE PLATE TYPE '4'
50x250mm SLOT FOR CABLE TO BE COVERED BY FEEDER INLET TO MANUFACTURER'S DETAILS
8 No OF M20 G 5.6 BOLTS
ELEVATION
DETAIL 'A'
SCALE 1:15



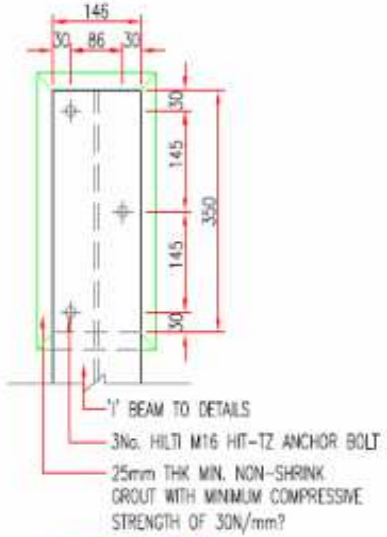
SECTION 1-1
SCALE 1:25



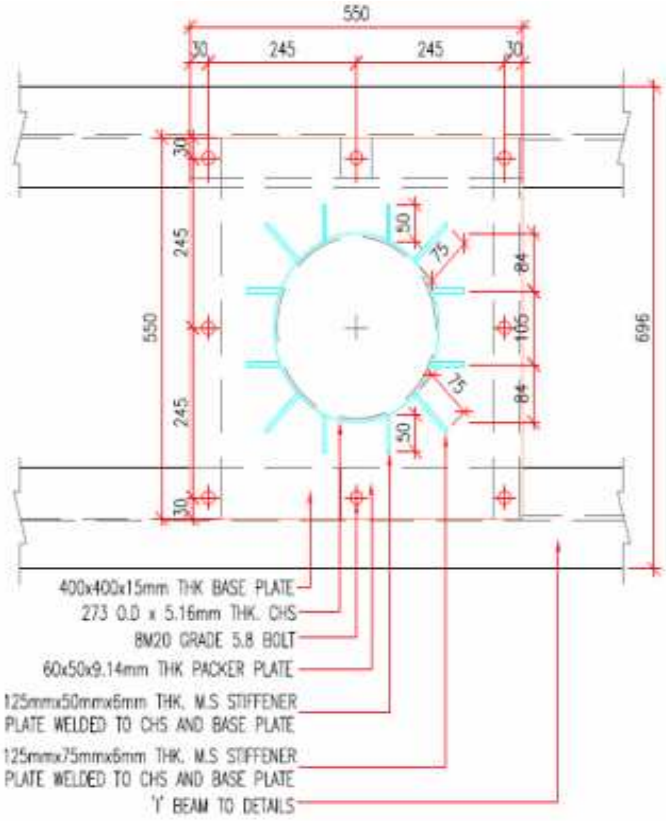
SECTION 2-2
SCALE 1:15



DETAIL 'D'
SCALE 1:10
NOTE : PLATE SHALL BE WELDED TO UB ALL ROUND
AND BOTH SIDES USING 6mm THK. FILLET WELD ALL ROUND.



DETAIL 'E'
SCALE 1:10



DETAIL 'F'
SCALE 1:10

Unipole design (Option 2)

15.8 Minimast Design Example

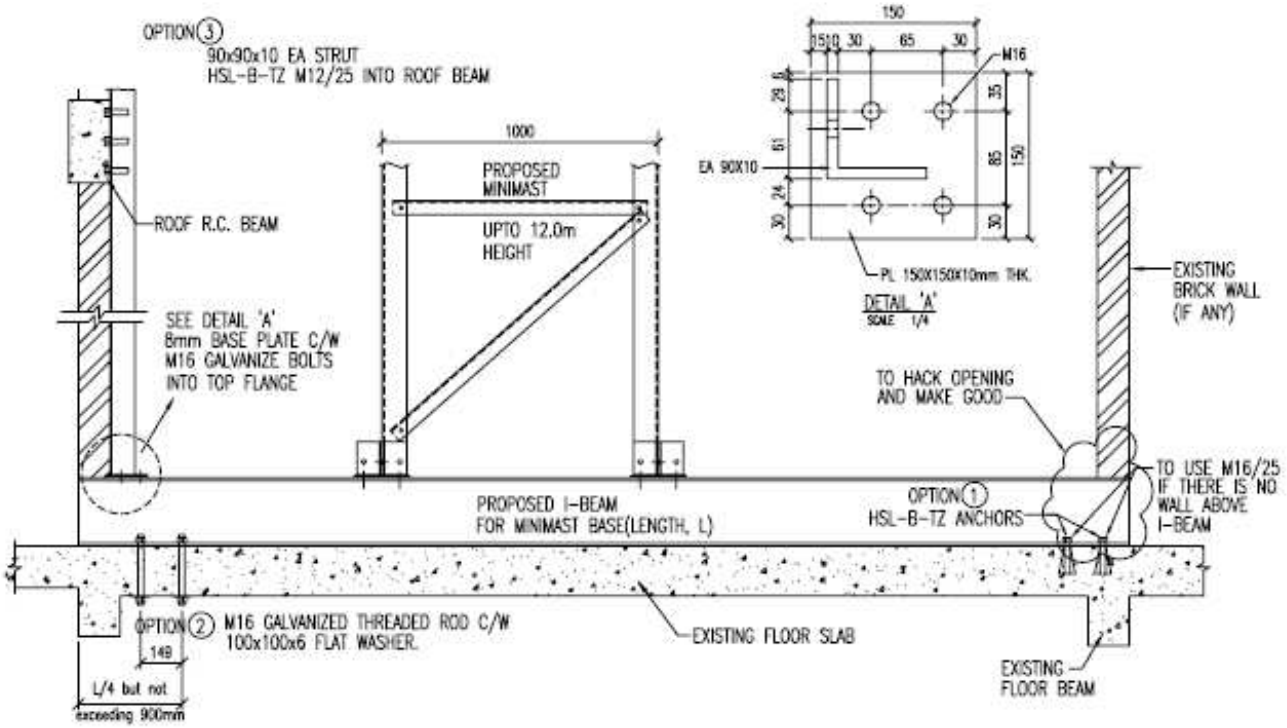
Notes:

Option(1)– 4 nos HSL –B–TZ Anchor Bolts on each end.
(M16/25 for open ends & m12/25 if ends sit under existing brickwall)

Option(2)– Punch through slab existing with M16 Galvanized threaded rod c/w. 100x100x6mm plate beneath slab.This to be fixed into bottom flange of I–beam or saddled using 90x90x10 EA on top flange (subjected to owner's approval)

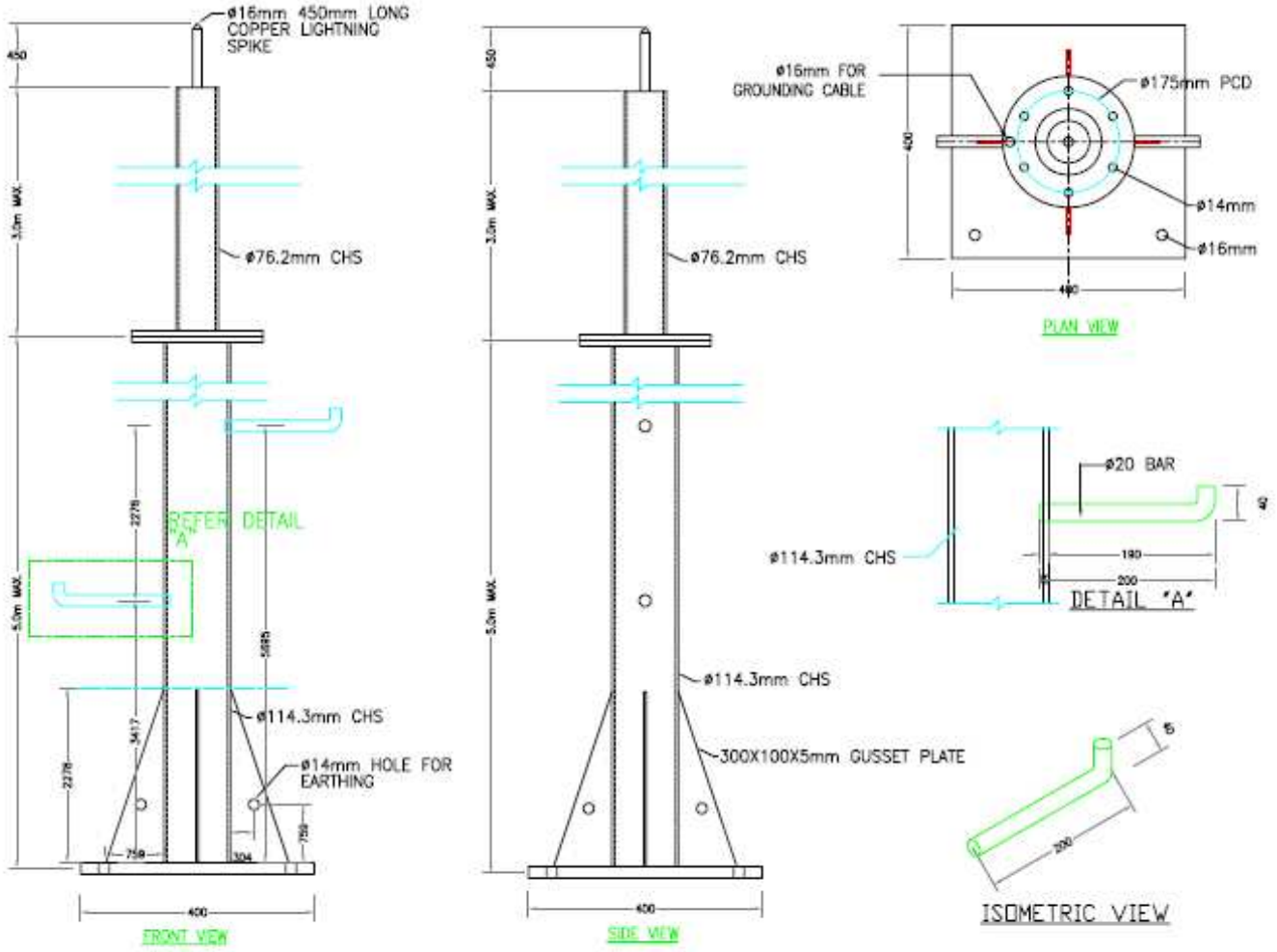
Option(3)– Vertical strut to overhead beam.(subject to Owner's approval)

** A combination of all 3 option can be applied at site as long as each bolt is supplemented.



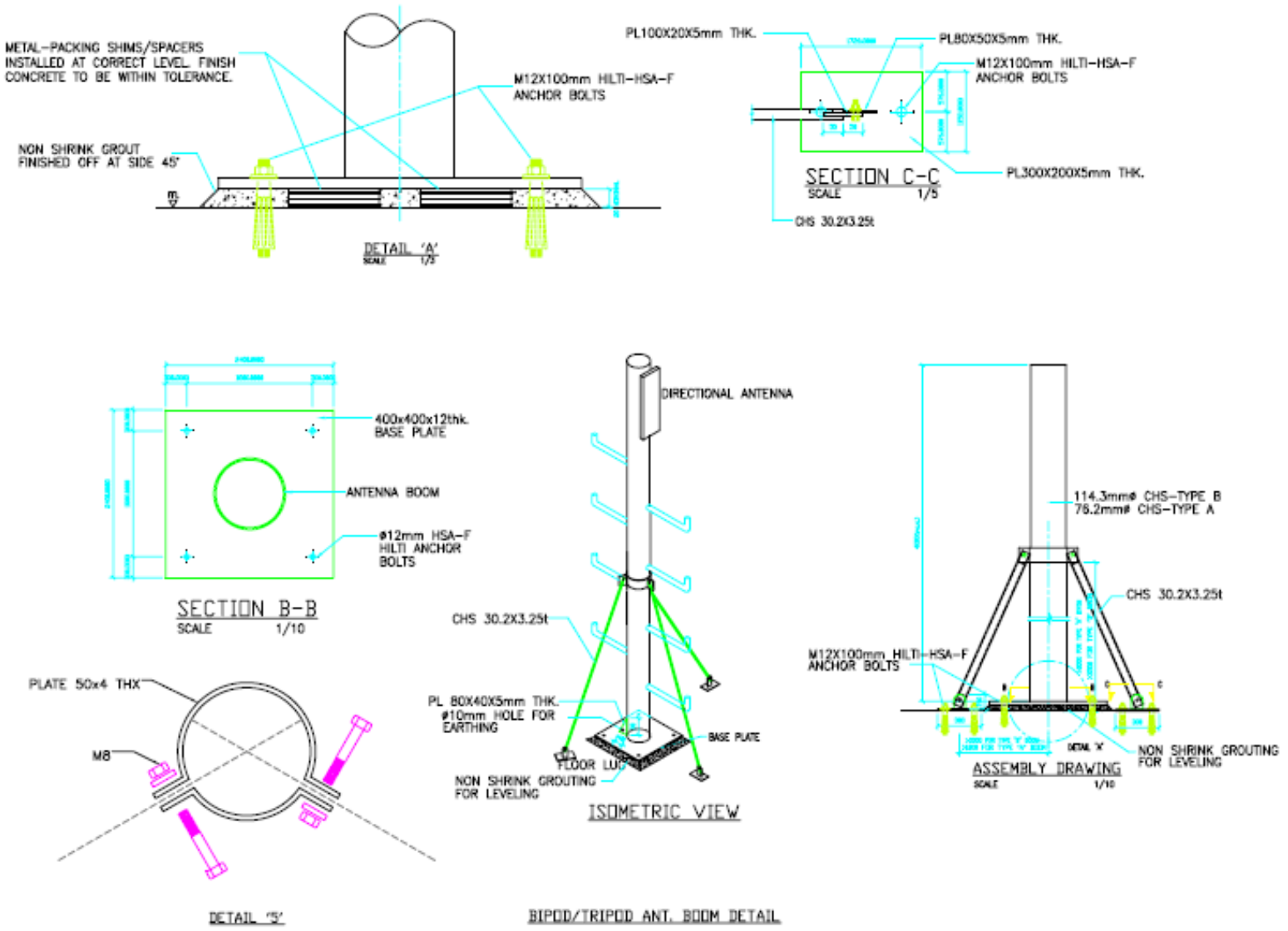
Minimast design

15.9 Antenna Boom with Steps



Antenna boom design

15.10 Bipod/Tripod Boom Design Example



ACKNOWLEDGEMENT

The Working Committee that developed this Technical Standadrs Infrastructure and Requirements consists of the following representatives:

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Saidi Hanafiah /	
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Md Najmuddin Ibrahim /	Telekom Malaysia Bhd
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Published by:

The Malaysian Technical Standards Forum Bhd

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