Suruhanjaya Komunikasi dan Multimedia Malaysia

Malaysian Communications and Multimedia Commission

PROPOSAL FOR THE REVISION OF THE MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE

19 July 2021

This Public Inquiry Paper is prepared in fulfilment of Sections 58 and 61 of the Communications and Multimedia Act 1998.

TABLE OF CONTENTS

PREFACE

The Malaysian Communications and Multimedia Commission ('the Commission') is hereby holding a Public Inquiry on the proposal for the revision of Mandatory Standard for Electromagnetic Field Emission from Radiocommunications Infrastructure and invites members of the public and interested parties to participate in this inquiry by making written submissions on any matter they consider relevant to the inquiry. Written submissions, in both hardcopy and electronic form should be provided to the Commission in full by 12 noon, 17 September 2021 and addressed to:

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

Attention : Technology Development Department
Or E-mail : tdd@mcmc.gov.my
Or Fax No : +603 8688 1000

In the interest of fostering informed and robust consultative process, the Commission may make available extracts of or entire submissions for others to read. Any commercially sensitive information should be provided under a separate cover and clearly marked "CONFIDENTIAL". Respondents are encouraged to support their comments with reasons and where appropriate provide or refer to evidence or other relevant information in support of their comments. **Incomplete and/or late submissions will not be considered.**

The Commission thanks the public and all interested parties for their participation in this consultative process and for providing their submissions and feedback.

GLOSSARY

CMA1998	Communications and Multimedia Act 1998 (Act 588)
Commission	Malaysian Communications and Multimedia Commission
EMF	Electromagnetic Field
ICNIRP	International Commission on Non-Ionizing Radiation Protection
MS EMF	Mandatory Standard for Electromagnetic Field Emission from Radiocommunications Infrastructure (Determination No. 1 of 2010)
MTSFB	Malaysian Technical Standards Forum Bhd
PI	Public Inquiry
RF EMF	Radio Frequency Electromagnetic Field
Technical Codes	MTSFB 077, *Final Draft Technical Code on Prediction and Measurement of RF EMF Exposure from Base Station*, and MTSFB 088, *Final Draft Technical Code on Prediction and Measurements of RF EMF Exposure from Terrestrial Radio and Television Broadcasting Transmitter Stations*

PREAMBLE

1. The present Mandatory Standard for Electromagnetic Field Emission from Radiocommunications Infrastructure (Determination No. 1 of 2010) came into force on 1 January 2011.

2. For the purpose of revising the MS EMF, the Commission took into consideration initial feedbacks from the relevant working groups under Malaysian Technical Standards Forum Bhd (MTSFB), inputs from a survey on the current issue and future needs with regards to RF EMF compliance with relevant government agencies and findings from a benchmark study on the regulatory practices in other countries (i.e. United States of America, United Kingdom, Germany, France and Australia).

3. The proposed revision of the MS EMF also takes into the consideration of the following:

   a) **Evolution of Wireless Technology**: The MS EMF was enforced from 1 January 2011 taking into account the landscape and situation at that time. It is timely to revise the MS EMF in view of the rapid deployment of wireless technology in Malaysia since the enforcement of the MS EMF and future rollout of new technology such as 5G.

   b) **Latest Revision of the ICNIRP Guidelines:** The International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued latest ICNIRP Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz) in March 2020, thus it is timely to update the EMF exposure limits in the MS EMF by making reference to the latest guideline.

   c) **Enhancement of RF EMF reporting method**: To address the gap on the compliance to the MS EMF.

PUBLIC INQUIRY PROCESS

4. Section 58(2) of the CMA1998 provides that the Commission may hold a public inquiry if it is satisfied that the matter is of significant interest to either the public or to current or prospective licensees under the CMA1998. The objective of such a public inquiry is to inform as well as to invite views of the public and the licensees under the CMA1998 on the matter at hand.

5. The Commission is of the view that it is appropriate in the circumstances to hold a public inquiry under section 58(2)(b) of the CMA1998 in order to obtain industry and public comment, and to promote transparency in the exercise of its powers.

6. Under section 61(1)(d) of the CMA1998, the Public Inquiry period shall be a minimum of forty-five (45) days, within which public submissions are invited. In the present Public Inquiry, licensees and the public are to formulate and submit their views on the matter within the stipulated period.

7. The Commission shall take into consideration all submissions received within the Public Inquiry period. The Commission is required under section 65 of the CMA1998 to publish a report setting out its findings as a result of any inquiry it conducted, and such report shall be published within thirty (30) days of the conclusion of the inquiry. The Commission shall summarise the submissions received and publish the same in the report.

REVISION OF THE MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE

PART A: THE DEFINITIONS AND INTERPRETATION PART OF THE REVISED MS EMF

8. The following definitions and interpretation are added in the revised MS EMF:

"Compliance Statement" means a statement indicating the site complies with EMF (as defined herein) exposure limits as specified in Table 1 of this Determination;

"EMF" means radiofrequency electromagnetic fields, being the part of the electromagnetic spectrum comprising the frequency range from 100 kHz to 300 GHz;

"EMF Compliance Assessment" means assessment of EMF compliance as described in paragraphs 10 and 11 of this Determination;

"EMF Compliance Declaration" means the declaration of compliance that specifies the location and the Compliance Statement (as defined herein) for each site, as referred to in paragraph 9 of this Determination;

"EMF Compliance Report" means the report in respect of the EMF compliance as referred to in paragraphs 12 and 13 of this Determination;

"EMF Trained Personnel" means a person who may be occupationally exposed to EMF at work and has received necessary information and training relating to the said exposure and made aware of any mitigation measures needed to comply with the EMF exposure limits;

"RCI" means radiocommunications infrastructure;

"Complex RCI" means radiocommunications infrastructure with two (2) or more antennas/transmitter;

"Single RCI" means radiocommunications infrastructure with a single transmitter [including three (3) sectors/panels for coverage in all directions];

"RF Owner" means a party responsible for EMF related works to ensure compliance;

"Service Providers" means all network facilities providers and network service providers operating RCI which emit EMF for the purpose of communications; and

"Shared Sites" means multiple services or systems on the same or different radiocommunications infrastructure within a particular location.

QUESTION 1:	**THE COMMISSION SEEK VIEWS ON THE PROPOSED DEFINITIONS AND INTERPRETATION PART ADDED IN THE MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE.**

PART B: PROPOSED REVISION ON THE MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE

9. The revised MS EMF contains the changes made to the existing MS EMF as follows:
   a) modification of paragraphs;
   b) addendum (addition of new paragraphs); and
   c) deletion of paragraphs.

10. The EMF Exposure Limits in Table 1 and Table 2 of the MS EMF have been replaced with the updated EMF Exposure Limits as per Table 5 of the ICNIRP Guidelines, 2020.

11. The compliance procedure of the MS EMF has been revised with the following addendum:

    a) the requirement to conduct EMF Compliance Assessment under these two conditions:

       i) transmitters with an Effective Isotropic Radiated Power (EIRP) greater than 10 Watt (W); and
       ii) transmitters with an EIRP above 2 W but not greater or equal to 10 W that is installed at the height of below 2.2 meters from public walkway.

b) on-site measurement as another acceptable method for EMF Compliance Assessment in addition to prediction methods;

c) the requirement for the EMF Compliance Report to be verified by the appointed organisation and the validity of the report is two (2) years from the date of submission to the Commission or when there are any configuration changes on the RCI, whichever comes first;

d) the use of the same EMF Compliance Report for sites with similar RCI technical specification(s); and

e) the requirement for EMF Compliance Declaration to comply with the revised EMF exposure limits.

12. The paragraphs for compliance of shared sites have been revised as follows:

a) the description of shared sites is modified and directly refer to the Technical Codes; and

b) the principles for the determination of RF owner for a shared site is modified and directly refer to the Technical Codes.

13. The paragraphs on 'Exclusion Zones Calculation' have been removed and it is included in the Technical Codes.

14. The safety signage requirements have been modified and directly refer to *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields - Part 2: For frequency from 3 kHz to 300 GHz* (MS 2232-2).

15. The addition of new paragraphs on the requirements regarding Submission of EMF Compliance Declaration and EMF Compliance Report are as follows:

a) EMF Compliance Declaration and EMF Compliance Report shall be submitted to the Commission;

b) EMF Compliance Declaration and EMF Compliance Report shall be submitted within the specified timeline;

c) the validity period of EMF Compliance Declaration and EMF Compliance Report are specified; and

d) service providers shall publish and maintain the EMF Compliance Declaration and the EMF Compliance Report in their geospatial mapping website.

16. The addition of new paragraphs on the requirements regarding Precautionary and Safety Preventive Measures are as follows:

a) provision of proper precautionary and preventive measures for protection of the public and workers, from exposure to the EMF;

b) signage with appropriate size for sites using millimetre wave (mm Wave) transmitter(s);

c) statement to guide the public to obtain information regarding EMF at the site; and

d) the need of service providers/site owners to ensure only the EMF trained personnel are allowed into the site.

17. The details of changes and justifications are presented in Table 1 of this PI Paper.

Table 1. Proposed revision to the MS EMF

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
6 7	EMF Exposure Limit	Modification	EMF Exposure Limits in Tables 1 and 2 of the MS EMF have been modified in line with Table 5 of the ICNIRP Guidelines, 2020. *Please note that Table 5 of the ICNIRP Guidelines, 2020 has been inserted in the revised MS EMF.*	The ICNIRP Guidelines provide protection against all scientifically substantiated adverse health effects due to exposure in the 100 kHz to 300 GHz range. The new guidelines provide better and more details exposure guidance in particular for the higher frequency range, above 6 GHz, which is of importance to 5G and future technologies. It also provides new restrictions to better protect against excessive temperature rise in the body. **Reason for selection of Table 5 of the ICNIRP Guidelines, 2020:** a) Table 5 refers to reference level for exposure over the whole body (suitable for transmission from base station to human), meanwhile Table 6 and Table 7 refer to reference levels for local exposure, when the transmitter is in very close distance with the human body. b) The scope of the MS EMF covers base stations transmitters, repeaters and broadcast transmitters. Thus, other devices (user equipment) such as mobile phones or indoor routers are not included, which justifies that local exposure is not required to be included. All outdoor transmitters are positioned higher than a typical human height, which clarifies why whole body exposure is used.

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
				c) The reference levels of Table 6 are higher than in Table 5, which indicates that roughly, if the requirement of Table 5 is met, thus it will comply with Table 6 too. This is due to the basic restrictions for local exposure SAR (head, limb) as shown in Table 2 that are higher as compared to whole-body SAR. *Note: Refer to the ICNIRP Guidelines for Table 2, 5, 6 and 7*
8 9	Compliance Procedures	Modification	6. The EMF Compliance Assessment shall be required for the followings: (a) transmitters with an Effective Isotropic Radiated Power (EIRP) greater than 10 Watt (W); and (b) transmitters with an EIRP above 2 W but not greater or equal to 10 W that is installed at the height of below 2.2 meters from public walkway. 7. The EMF Compliance Assessment is not required for transmitters with an EIRP above 2 W but not greater or equal to 10 W that is installed at a minimum height of 2.2 meters from public walkway, and no further action is deemed necessary. 8. Transmitters with a maximum EIRP of 2 W or less are classified as inherently compliant and no further action is deemed necessary.	Based on theoretical calculation at 1 m from the antenna point, the RF field strength level is far below than the EMF exposure limit. Transmitter with a maximum EIRP of 2 W or less; or transmitter with an EIRP above 2 W but not greater or equal to 10 W which is installed in accordance with IEC 62232 is classified as comply to the ICNIRP exposure limit. Thus, no further RF exposure assessment is required. Based on our benchmark study, the IEC 62232 is one of the key standards referred when specifying the evaluation and calculation methods that should be used when installing radio equipment for use on frequencies from 110 MHz to 100 GHz.

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
New paragraph	EMF Compliance Declaration	Addendum	9. The Service Providers are required to make an EMF Compliance Declaration which shall be based on the EMF Compliance Assessment and the EMF Compliance Report. The EMF Compliance Declaration shall be valid up to two (2) years or when there are any configuration changes on the RCI, whichever comes first.	New requirement to provide confidence to the public that the site is safe and proof of accountability by the Service Providers of such claims with necessary evidence.
10 11 12 13 14 15 16 17	EMF Compliance Assessment	Modification	EMF Compliance Assessment can be either by Prediction methods OR On-site measurement 10. The EMF Compliance Assessment shall be conducted based on the following methods: (a) Prediction methods: (i) calculation for single RCI; (ii) advanced computation using a simulation software for complex RCI; OR (b) On-site measurement.	This paragraph is intended to provide alternative method for RF EMF Compliance Assessment. For complex or shared site, the service provider may opt for either prediction method or on-site measurement, wherever suitable. The service provider shall ensure the means selected is suitable for the task and meet the requirements.
New paragraph	EMF Compliance Assessment	Addendum	11. The details on prediction methods and on-site measurement are described in the *Technical Code on Prediction and Measurement of RF EMF Exposure from Base Station* (MTSFB 077) and the *Technical Code on Prediction and Measurement of RF EMF Exposure from*	The details on both methods are described and referenced to the Technical Codes. Since the methods are procedures in nature, it is more practical for it to be described in the Technical Codes.

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
			Terrestrial Radio and Television Broadcasting Transmitter Stations (MTSFB 088).	The Technical Codes takes into consideration latest technology and requirements. The Technical Codes will be subjected to review from time to time to cater for latest needs.
New paragraphs	EMF Compliance Report	Addendum	12. The EMF Compliance Report as described in the MTSFB 077 and the MTSFB 088 shall be verified by the appointed organisation, as duly notified by the Commission, prior to its submission to the Commission. The EMF Compliance Report shall be valid up to two (2) years from the submission of the same to the Commission or when there are any configuration changes on the RCI, whichever comes first. 13. For multiple sites having RCI with similar technical specification(s), the Service Providers are allowed to use the same EMF Compliance Report if the Service Providers are able to demonstrate the similarity of the sites.	EMF Compliance Report need to be verified by the appointed organisation to ensure the reliability and accuracy of the EMF Compliance Report. The validity of EMF Compliance Report is specified to ensure the EMF Compliance Report is always up to date. Paragraph 13 is introduced to enhance the regulatory requirements for the efficient use of resources. Service providers may not need to conduct simulation or on-site measurement for each site considering that multiple sites may have similar technical specifications and settings. Thus, the same EMF Compliance Report is allowed to be used as evidence, provided that service providers are able to demonstrate the similarity of the sites.
18	Shared Sites	Modification	14. The categories of Shared Sites for base station are described in the MTSFB 077. 15. The Shared Sites for broadcasting transmitter station are described in the MTSFB 088.	The determination of the RF owner for a shared site and its principles have been revised and are referred to the relevant Technical Codes developed by the MTSFB. The modification of paragraph 16 is to give clear definition and guidance on the appointment of RF owner.

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
			16. The RF Owner for each Shared Site shall be decided by the relevant Service Providers that share the same site. The principles of determining the RF Owner for Shared Site depends on the ownership as specified in the MTSFB 077 and the MTSFB 088.	
19 20 21 22	Shared Sites	Modification	17. The responsibilities of the RF Owner shall be as follows: (a) to ensure the EMF Compliance Assessment of the site is conducted; (b) to ensure remedial measures in the event of non-compliance; and (c) to ensure the conduct of the EMF Compliance Assessment, in the event there is a change or addition to the particular site. 18. Service Providers at the Shared Sites shall collaborate with the RF Owner. The responsibility of conducting the EMF Compliance Assessment of Shared Sites lies equally with all Service Providers at the Shared Sites.	Paragraphs 17 and 18 are to clarify the responsibilities of the RF owner and other parties involved in the shared site in complying to the revised MS EMF.
New paragraphs	Submission of EMF Compliance Declaration and EMF Compliance Report	Addendum	19. The Service Providers shall submit the EMF Compliance Declaration and the EMF Compliance Report to the Commission in accordance with paragraph 22 of this Determination.	The addition of these new paragraphs are to: • provide the requirement of submission of EMF Compliance Declaration and EMF Compliance Report;

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
			20. The Service Providers that submit the EMF Compliance Declaration and/or the EMF Compliance Report that is found to be false or misleading, shall be regarded as failing to comply with this Determination and commits an offence. 21. In the case of the EMF exposure level found to exceed the EMF exposure limit as specified in Table 1 of this Determination, the Service Providers shall identify the causes and implement remedial measures to ensure compliance. 22. The EMF Compliance Declaration shall be submitted together with the EMF Compliance Report to the Commission within the following timeline: (a) for existing sites, within six (6) months after this Determination comes into operation; (b) for new sites that have similar technical specification(s) with the existing site(s), within two (2) weeks before the operation of the new sites; (c) for new sites not having similar technical specification(s) with the existing site(s), within two (2) months after the operation of the new sites;	• ensure EMF Compliance Declaration and/or EMF Compliance Report are carried out with integrity; • emphasis on the timeline for the declaration and report submission according to the identified categories; • ensure the validity of EMF Compliance Declaration and EMF Compliance Report are up-to-date; and • provide clarity and procedure for the compliance to the MS EMF.

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
			(d) for any configuration changes on the RCI, within two (2) months after the said changes; and (e) for the renewal of the EMF Compliance Declaration and/or the EMF Compliance Report as specified in paragraph 23 of this Determination, at least one (1) month before the expiry of the existing EMF Compliance Declaration and/or EMF Compliance Report. 23. The EMF Compliance Declaration and the EMF Compliance Report shall be void if there are any configuration changes on the RCI or has exceeded the validity of two (2) years, whichever comes first. Under such circumstances, a new EMF Compliance Declaration and EMF Compliance Report shall be submitted as specified in paragraph 19 and subparagraph 22(e) of this Determination. 24. The EMF Compliance Declaration may be exempted for sites that had already submitted the EMF Compliance Report before this Determination comes into operation, unless there are any configuration changes on the RCI or the EMF Compliance Report has exceeded the two (2) years period from its submission date.	

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
New paragraph	Submission of EMF Compliance Declaration and EMF Compliance Report	Addendum	25. The Service Providers shall publish and maintain the EMF Compliance Declaration and the EMF Compliance Report in the Service Providers' geospatial mapping website containing the EMF exposure level information that is accessible by the public or any interested parties.	This new paragraph is to impose the requirement for service providers to provide geospatial mapping website containing the EMF exposure level information that is accessible by the public or any interested parties. This will allow the public to access EMF information at any identified location.
23 24 25	Exclusion Zones Calculation A. Single Antennas or Sectoral Antenna at Single Pole B. Multiple antennas site	Deletion	-	The detailed requirements for paragraphs on Exclusion Zones Calculation have been removed and it is included in the Technical Codes.
26	Signages A. Exclusion Zones and Implementation of Signage	Deletion	-	The detailed requirements for paragraphs on exclusion zones have been removed and it is included in the Technical Codes.
New paragraph	Precautionary and Safety Preventive Measures	Addendum	26. The Service Providers shall ensure provision of proper precautionary and preventive measures for protection of the public and workers, from exposure to EMF.	This paragraph is added to ensure sufficient consideration has been taken on the safety measures of the general public and workers.

Paragraph no. of existing MS EMF	Item	Type of changes	Proposed revision to the MS EMF	Remark / Rationale / Justification
27 28 29	B. Safety Signage	Modification	27. The Service Providers shall ensure appropriate signages as described in the *Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields - Part 2: For frequency from 3 kHz to 300 GHz* (MS 2232-2) are in place in an appropriate location and manner so that they are clearly visible and legible.	The modification is to make reference to the MS 2232-2 for the implementation of displaying safety signages and maintaining the requirements for the signages to be displayed accordingly.
New paragraphs	Precautionary and Safety Preventive Measures	Addendum	28. For sites using millimetre wave (mm Wave) transmitter(s), the size for signage should be of appropriate size. 29. The following additional information shall be made available at the site for the public: (a) up to date Service Providers' contact details regarding information on EMF; or (b) place or source of information such as the Service Providers' geospatial mapping website as referred to in paragraph 25 of this Determination. 30. The Service Providers/site owners shall ensure only EMF Trained Personnel are allowed into the site.	The new paragraphs are added for the use of millimetre wave transmitter(s) to ensure the required signage is to be placed at appropriate manner. The added paragraph 29 is for the service providers to provide information to the public on EMF matters (e.g. contact information, link to geospatial mapping website, etc.) The new paragraph 30 is to ensure only the EMF trained personnel is allowed into the site for their safety from EMF exposure.

18. The following documents which are attached with this PI Paper are meant for ***Public Inquiry reference purpose only***:

a) MTSFB 077, *Final Draft Technical Code on Prediction and Measurement of RF EMF Exposure from Base Station* (**Annex 1**); and

b) MTSFB 088, *Final Draft Technical Code on Prediction and Measurement of RF EMF Exposure from Terrestrial Radio and Television Broadcasting Transmitter Stations* (**Annex 2**).

QUESTION 2:	**THE COMMISSION SEEK VIEWS ON THE PROPOSED MODIFICATION TO THE MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE AS STATED IN TABLE 1.**

QUESTION 3:	**THE COMMISSION SEEK VIEWS ON THE PROPOSED ADDENDUM TO THE MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE AS STATED IN TABLE 1.**

QUESTION 4:	**THE COMMISSION SEEK VIEWS ON THE PROPOSED DELETION OF PARAGRAPHS FROM THE EXISTING MANDATORY STANDARD FOR ELECTROMAGNETIC FIELD EMISSION FROM RADIOCOMMUNICATIONS INFRASTRUCTURE AS STATED IN TABLE 1.**

ANNEX 1

MCMC MTSFB TC GXXX:XXXX
(MTSFB 077:2020)

TECHNICAL CODE

PREDICTION AND MEASUREMENT OF RF EMF EXPOSURE FROM BASE STATION

Developed by

Malaysian Technical Standards Forum Bhd

Registered by

MCMC

Registered date:

MCMC MTSFB TC GXXX:XXXX
(MTSFB 077:2020)

Development of technical codes

The Communications and Multimedia Act 1998 ('the Act') provides for 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 requirement 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 the Commission pursuant to section 95 of the Act registers it.

For further information on the technical code, please contact:

Malaysian Communications and Multimedia Commission (MCMC)
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OR

Malaysian Technical Standards Forum Bhd (MTSFB)
MCMC Centre of Excellence (MCMC CoE)
Off Persiaran Multimedia
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Contents

Committee representation

This Technical code was developed by Electromagnetic Field Sub Working Group under the International Mobile Telecommunications and Future Networks Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB) which consists of representatives from the following organisations:

Celcom Axiata Berhad

Digi Telecommunications Sdn Bhd

Ericsson (M) Sdn Bhd

Huawei Technologies (Malaysia) Sdn Bhd

International Islamic University Malaysia

Maxis Broadband Sdn Bhd

Multimedia University

Orbitage Sdn Bhd

Rohde & Schwarz Malaysia Sdn Bhd

Tekmark Sdn Bhd

Telekom Malaysia Bhd

U Mobile Sdn Bhd

Universiti Kebangsaan Malaysia

Universiti Teknikal Malaysia Melaka

Universiti Teknologi Malaysia

Universiti Teknologi MARA

Universiti Tun Hussein Onn Malaysia

Webe Digital Sdn Bhd

Wideminds Pte Ltd

Xcelcius Consultancy Sdn Bhd

YTL Communications Sdn Bhd

MCMC MTSFB TC GXXX:XXXX
(MTSFB 077:2020)

Foreword

This technical code for Prediction and Measurements of RF EMF Exposure from Base Station ('this Technical Code') was developed pursuant to section 95 and section 185 of the Act 588 by the Malaysian Technical Standards Forum Bhd (MTSFB) via its International Mobile Telecommunications and Future Networks Working Group.

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

MCMC MTSFB TC GXXX:XXXX
(MTSFB 077:2020)

PREDICTION AND MEASUREMENT OF RF EMF EXPOSURE FROM BASE STATION

1. Scope

This Technical Code provides prediction and measurement methods for the determination of Radio Frequency (RF) field strength and power density in the vicinity of International Mobile Telecommunications (IMT) Base Station (BS) for the purpose of evaluating Electromagnetic Field (EMF) exposure to human.

2. Normative reference

The following normative reference is indispensables for the application of this document. For dated reference, only the edition cited applies. For undated reference, the latest edition of the normative reference (including any amendment) applies.

ITU-T K.100 (07/2019), *Measurement of radio frequency electromagnetic fields to determine compliance with human exposure limits when a base station is put into service*

ITU-T K.61 (01/2018), *Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations*

ITU-T K.52 (01/2018), *Guidance on complying with limits for human exposure to electromagnetic fields*

ITU-T K. Sup 16 (05/2019), *Electromagnetic field compliance assessments for Fifth Generation (5G) wireless networks*

IEC 62232:2019, *Determination of RF field strength, power density and Specific Energy Absorption Rate (SAR) in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure*

ICNIRP Guidelines, Health Phys. 118(5):483–524; 2020; *Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz)*

3. Abbreviations

For the purposes of this Technical Code, the following abbreviations apply .

5G	Fifth Generation
5G NR	5G New Radio
AF	Antenna Factor
AMS	Antenna Mounting Structure
BS	Base Station
CF	Calibration Factor
D	Dimension
DL	Downlink
E-field	Electric field
EIRP	Equivalent Isotropic Radiated Power

EMF	Electromagnetic Fields
FDTD	Finite-Difference Time-Domain
FF	Far-field
H-field	Magnetic field
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
IMT	International Mobile Telecommunications
ITU	International Telecommunication Union
MIMO	Multiple-Input and Multiple-Output
MOM	Method of Moments
MR	Multiple-Region
MR-FDTD	Multiple-Region Finite-Difference Time
NEC	Numeric Electromagnetic Code
NF	Near-field
NR	New Radio
NSA	Non-Standalone
PBCH	Physical Broadcast Channel
PEL	Permissible Exposure Limit
POI	Point of Investigation
PSS	Primary Synchronisation Signal
RE	Resource Element
RF	Radio Frequency
rms	root mean square
SAR	Specific Absorption Rate
SCS	Sub-Carrier Spacing
SI	International System of Units
SINR	Signal-To-Interference-Plus-Noise Ratio
SSB	Synchronisation Signal Block
SSS	Secondary Synchronisation Signal
TDD	Time Division Duplex
UEEUT	User Equipment
UL	Uplink
WHO	World Health Organisation

4. Terms and definitions

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

4.1 Antenna Factor (AF)

Ratio of the electromagnetic field strength incident upon an antenna to the voltage that is produced across a specified impedance (e.g. 50 Ω) terminating the line connection of the antenna.

4.2 Averaging time

Appropriate time over which exposure is averaged for purposes of determining compliance.

4.3 Base Station (BS)

Fixed equipment including the radio transmitter and associated antenna(s) as used in wireless telecommunications networks.

4.4 Compliance zone

In the compliance zone, potential exposure to EMF is below the applicable limits for both controlled/occupational exposure and uncontrolled/general public exposure.

4.5 Directivity

Ratio of the radiation intensity produced by an antenna in a given direction to the value of the radiation intensities averaged across all directions in space.

4.6 Electric field (E-field) strength

Vector field quantity, E which exerts on any charged particle at rest a force, F equal to the product of E and the electric charge, Q of the particle.

4.7 Electromagnetic Field (EMF)

It refers to the RF EMF which is part of electromagnetic spectrum comprising the frequency range from 100 kHz to 300 GHz.

4.8 Equivalent Isotropic Radiated Power (EIRP)

Product of the RF input power to an antenna and the absolute gain of the antenna in a given direction relative to an isotropic radiator.

4.9 Exceedance zone

In the exceedance zone, potential exposure to EMF exceeds the applicable limits for both controlled/occupational exposure and uncontrolled/general public exposure.

4.10 Exclusion zone

Area around an antenna or antennas where the RF field values emanating from the antennas exceed the International Commission on Non-Ionizing Radiation Protection (ICNIRP) public guidelines (public exclusion zone) or the ICNIRP occupational guidelines (occupational exclusion zone).

4.11 Far-field (FF) region

Region of the field of an antenna where the radial field distribution is essentially dependent inversely on the distance from the antenna. In this region, the field has a predominantly plane-wave character, i.e. locally uniform distribution of electric field and magnetic field in planes transverse to the direction of propagation.

4.12 Magnetic field (H-field) strength

Vector quantity obtained at a given point by subtracting the magnetisation, M from the magnetic flux density, B divided by the magnetic constant, μ_0.

4.13 Near-field (NF) region

Region generally in proximity to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The Near-field (NF) region is further subdivided into the reactive NF region, which is closest to the radiating structure and that contains most or nearly all of the stored energy, and the radiating NF region where the radiation field predominates over the reactive field, but lacks substantial plane-wave character and is complex in structure.

4.14 Occupational zone

In the occupational zone, potential exposure to EMF is below the applicable limits for controlled/occupational exposure but exceeds the applicable limits for uncontrolled/general public exposure.

4.15 Shared sites

Multiple services or systems on the same or different radiocommunications infrastructure within a particular location.

5. Exposure limit

All service providers have to individually and jointly comply with the EMF exposure limits for general public and occupational workers according to the relevant Mandatory Standard issued by MCMC. Basic restriction and reference level units are shown in Table 1.

Table 1. Quantities and corresponding SI units used

Quantity	Symbol	Unit
Incident power density	S_{inc}	Watt per square meter, W m^{-2}
Incident electric field strength	E_{inc}	Volt per meter, V m^{-1}
Induced magnetic field strength	H_{ind}	Ampere per meter, A m^{-1}
Incident magnetic field strength	H_{inc}	Ampere per meter, A m^{-1}
Specific energy absorption rate	*SAR*	Watt per kilogram, W kg^{-1}
Electric current	*I*	Ampere, A
Frequency	*f*	Hertz, Hz
Time	*t*	Second, s

For convenience, the limit of EMF exposure from a BS for public and occupational workers are as in Table 2. In the event of any inconsistency with the Mandatory Standard issued by MCMC, the limits

specified by the Mandatory Standard shall prevail. The averaging and integrating time of the relevant exposure quantities are specified to determine whether personal exposure level is compliant with the guidelines. The averaging time is not necessarily the same as the measurement time needed to estimate field strengths or other exposure quantities.

Table 2. Reference levels for exposure from 100 kHz to 300 GHz (unperturbed root means square (rms) values)

Exposure scenario	Frequency range	Incident E-field strength, E_{inc} (V m^{-1})	Incident H-field strength, H_{inc} (A m^{-1})	Incident power density, S_{inc} (W m^{-2})
Occupational workers	0.1 MHz - 30 MHz	$660/f_M^{0.7}$	$4.9/f_M$	N/A
	> 30 MHz - 400 MHz	61	0.16	10
	> 400 MHz - 2 000 MHz	$3\ f_M^{0.5}$	$0.008\ f_M^{0.5}$	$f_M/40$
	> 2 GHz - 300 GHz	N/A	N/A	50
Public	0.1 MHz - 30 MHz	$300/f_M^{0.7}$	$2.2/f_M$	N/A
	> 30 MHz - 400 MHz	27.7	0.073	2
	> 400 MHz - 2 000 MHz	$1.375\ f_M^{0.5}$	$0.0037\ f_M^{0.5}$	$f_M/200$
	> 2 GHz - 300 GHz	N/A	N/A	10

NOTES:

1. N/A signifies not applicable and does not need to be taken into account when determining compliance.
2. f_M is frequency in MHz.
3. S_{inc}, E_{inc}, and H_{inc} are to be averaged over 30 min, over the whole-body space. Temporal and spatial averaging of each of E_{inc} and H_{inc} must be conducted by averaging over the relevant square values.
4. For frequencies of 100 kHz to 30 MHz, regardless of the FF/NF zone distinctions, compliance is demonstrated if neither E_{inc} or H_{inc} exceeds the above reference level values.
5. For frequencies of > 30 MHz to 2 GHz:
   a. within the FF zone: compliance is demonstrated if either S_{inc}, E_{inc} or H_{inc}, does not exceed the above reference level values (only one is required); S_{eq} may be substituted for S_{inc};
   b. within the radiative NF zone, compliance is demonstrated if either S_{inc}, or both E_{inc} and H_{inc}, does not exceed the above reference level values; and
   c. within the reactive NF zone: compliance is demonstrated if both E_{inc} and H_{inc} do not exceed the above reference level values; S_{inc} cannot be used to demonstrate compliance, and so basic restrictions must be assessed.
6. For frequencies of > 2 GHz to 300 GHz:
   a. within the FF zone: compliance is demonstrated if S_{inc} does not exceed the above reference level values; S_{eq} may be substituted for S_{inc};
   b. within the radiative NF zone, compliance is demonstrated if S_{inc} does not exceed the above reference level values; and
   c. within the reactive NF zone, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.

Exposure limits for EMF workers are higher than for the general public because workers are adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions. Anyone who is not at work would be regarded as a member of the public and the public exposure limits apply.

6. Shared sites

BS shared site can be divided into the following categories:

a) tower/pole BS;

Multiple service providers or systems installed within a tower or pole. The tower or pole may be in the form of steel mono leg, 3-legged, 4-legged (Figure 1(a)), guyed wire or in other shape or material specifically built for communication purpose.

b) dual-function BS; and

Multiple service providers or systems installed within an infrastructure meant for certain usage other than communication. The infrastructure may be in form of minaret, street light pole, water tank (Figure 1(b)), advertising board (Figure 1(c)), etc.

c) rooftop BS.

Multiple service providers or systems installed within rooftop (Figure 1(d)) or wall with 60 m to 100 m vicinity radius (depending on the site scenario and location). The building may be a single, double or multi-storey with any size or shape.

Figure 1 shows the examples of shared site.

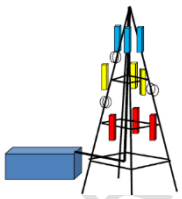


Figure 1a. 4-legged tower

Figure 1b. Water tank

Figure 1c. Billboard

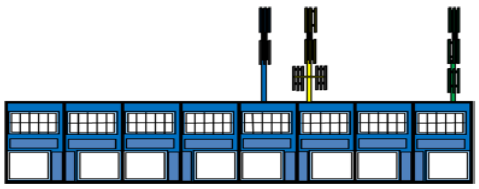


Figure 1d. Rooftop

Figure 1. Illustration of shared sites

6.1 Determination of Radio Frequency (RF) owner at shared site

In view of the existence of multiple service providers at one BS, there is a need to appoint a RF owner to ease EMF compliance related works such as to generate and submit the latest simulation report. Nevertheless, the compliance with EMF exposure limit is the responsibility of all sharing parties whereby any non-compliance should be resolved amicably.

6.2 Principles of determining RF owner for a shared site

The RF owner for each shared site should be decided by the relevant service providers that share the same BS. The list below stipulates the principles of determining a RF owner for a shared site depending on the ownership of the BS:

a) BS owned by network facilities provider that provides network service; and

BS structure owner is designated as the RF owner. The role will be relinquished to subsequent service operator that comes onboard. Ownership will also change to the service operator who performs upgrade with additional antennas or transmitters. However, the BS structure owner has the responsibility to inform all existing service operators that are currently operated at the BS if any new tenant came in or change in transmitter or antenna. This is to allow the current RF owner to handover the responsibility to the new RF owner.

b) BS not owned by the network service provider.

The first comer is designated as the RF owner. The role will be relinquished to subsequent service operator that comes onboard. Ownership will also change to the service operator who performs upgrade with additional antennas or transmitters. However, the BS structure owner has the responsibility to inform all existing service operators that are currently operating at the BS if any new tenant came in or change in transmitter or antenna. This is to allow the current RF owner to handover the responsibility to the new RF owner.

NOTE: While the principles highlighted above are more applicable to new BS that is on-air subsequent to the issuance date of this document, it is encouraged for relevant service providers to deliberate on the RF ownership amicably for existing sites that are on-air prior to this.

7. Exclusion zone

The methods for determining the exclusion zone shall be in accordance with the calculations as described in the ITU-T K.100 and IEC 62232.

7.1 Theoretical calculation for single base station

The theoretical calculation for determining the exclusion zone is derived from NF and FF zone formula.

7.1.1 NF zone

The NF zone formula is used to estimate the power density for distance less than the FF zone distance.

The formula is shown as below:

$$S_m = \frac{4PE}{A}$$

where,

S_m the maximum power density, in watts per square meter, *W/m²*;
E antenna efficiency (in number 0 to 1);
P the power output of the system; and
A the physical aperture area, in square meter, *m²*.

7.1.2 FF zone

The FF zone formula is used to estimate the incident power density for FF zone distance.

The formula is shown as below:

$$S_{inc} = \frac{PG_{\theta,\varphi}}{(4\pi d^2)}$$

where,

S_{inc}	the incident power density;
P	transmitted power;
$G_{\theta,\varphi}$	gain of the antenna in the direction (θ,$\boldsymbol{\varphi}$); and
d	distance from the antenna to the evaluation point.

The associated incident electric field strength, E_{inc}, and incident magnetic field strength, H_{inc}, can be evaluated as follows:

$$E_{inc} = \sqrt{\frac{30PG_{\theta,\varphi}}{d}}$$

$$H_{inc} = \frac{E}{\eta_0}$$

where, $\eta_0 \approx 377\ \Omega$.

If the power density is evaluated in the direction of maximum antenna gain, the formula is as follows:

$$S_{inc} = \frac{EIRP}{(4\pi d^2)}$$

where, Equivalent Isotropic Radiated Power (EIRP) is $PG_{\theta,\varphi}$.

The equation is re-arranged to calculate the minimum safe distance from the antenna, d_{min} or also known as exclusion zone distance as follows:

$$d_{min} = \sqrt{\frac{EIRP}{4\pi S_{inc}}}$$

7.2 Typical exclusion zone distances for BS

Based on the method described in section 7.1.2, the typical exclusion zone distances for IMT bands BS are shown in Table 3. The exclusion zones are calculated for downlink frequency bands to reflect the frequencies transmitted from BS.

Table 3. Typical exclusion zone distances of IMT bands base station based on EIRP calculation

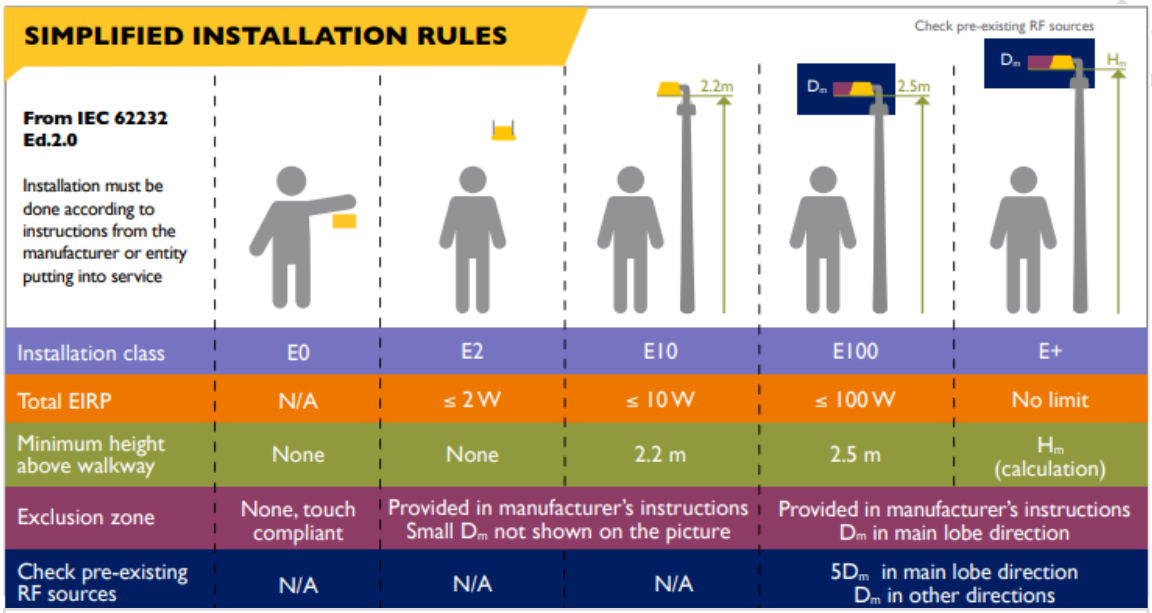
Downlink frequency (MHz)	Transmit power at antenna/ EIRP (dBm)	Transmit power at antenna/ EIRP (Watt)	ICNIRP limit for public, S_{inc} (W/sq m)	ICNIRP limit for occupational exposure, S_{inc} (W/sq m)	Exclusion zone distance for public (m)	Exclusion zone distance for workers (m)
2 110 – 2 170	50	100	10	50	0.89	0.40
1 930 – 1 990	50	100	10	48	0.89	0.40
1 805 – 1 880	50	100	9	45	0.94	0.42
869 - 894	50	100	4	22	1.41	0.60
2 620 – 2 690	50	100	10	50	0.89	0.40
925 - 960	50	100	5	23	1.26	0.59
729 - 746	50	100	4	18	1.41	0.66
758 - 768	50	100	4	19	1.41	0.65
860 - 875	50	100	4	22	1.41	0.60
791 - 821	50	100	4	20	1.41	0.63
1 930 – 1 995	50	100	10	48	0.89	0.41
758 - 803	50	100	4	19	1.41	0.65
717 - 728	50	100	4	18	1.41	0.66
2 350 – 2 360	50	100	10	50	0.89	0.40
2 010 – 2 360	50	100	10	50	0.89	0.40
2 570 – 2 620	50	100	10	50	0.89	0.40
1 880 – 1 920	50	100	9	47	0.94	0.41
2 300 – 2 400	50	100	10	50	0.89	0.40
2 496 – 2 690	50	100	10	50	0.89	0.40
3 550 – 3 700	50	100	10	50	0.89	0.40
1 432 – 1 517	50	100	7	36	1.07	0.47
1 427 – 1 432	50	100	7	36	1.07	0.47

Table 3. Typical exclusion zone distances of IMT bands base station based on EIRP calculation *(continued)*

Downlink frequency (MHz)	Transmit power at antenna/ EIRP (dBm)	Transmit power at antenna/ EIRP (Watt)	ICNIRP limit for public, S_{inc} (W/sq m)	ICNIRP limit for occupational exposure, S_{inc} (W/sq m)	Exclusion zone distance for public (m)	Exclusion zone distance for workers (m)
2 110 – 2 200	50	100	10	50	0.89	0.40
2 110 – 2 200	50	100	10	50	0.89	0.40
1 995 – 2 020	50	100	10	50	0.89	0.40
617 - 652	50	100	3	15	1.63	0.73
1 475 – 1 518	50	100	7	37	1.07	0.46
1 432 – 1 517	50	100	7	36	1.07	0.47
1 427 – 1 432	50	100	7	36	1.07	0.47
3 300 – 4 200	50	100	10	50	0.89	0.40
3 300 – 3 800	50	100	10	50	0.89	0.40
3 300 – 4 200	50	100	10	50	0.89	0.40
4 400 – 5 000	50	100	10	50	0.89	0.40
2 496 – 2 690	50	100	10	50	0.89	0.40
1 427 – 1 432	50	100	7	36	1.07	0.47
1 432 – 1 517	50	100	7	36	1.07	0.47
1 427 – 1 432	50	100	7	36	1.07	0.47
1 432 – 1 517	50	100	7	36	1.07	0.47
26 500 - 29 500	50	100	10	50	0.89	0.40
24 250 - 27 500	50	100	10	50	0.89	0.40
37 000 - 40 000	50	100	10	50	0.89	0.40
27 500 - 28 350	50	100	10	50	0.89	0.40

It shall be noted that the distances in Table 3 are only examples based on practical EIRP and antenna data, and that the proper usage of the formula shall be ensured in calculating the correct exclusion zone distances that must be based on the actual BS specifications.
The EIRP values used in Table 3 are based on the recommendations described in ITU-T K. Sup 16 and IEC 62232. These recommendations assume a macro cell condition, where the antenna height is more than 2.5 m, hence the 100 W EIRP is applied.

However, in real condition, the simplified installation rules in Figure 2 and further examples of simple EMF exposure evaluation for various situations shall be referred to ITU-T K.52.



(Source: ITU-T K Sup 9)

Figure 2. Simplified installation rules and total EIRP determination

The maximum EIRP transmissions for mobile cellular and IMT systems in Malaysia are specified in Table 4.

Table 4. Maximum EIRP limits for mobile cellular and IMT systems in Malaysia

Frequency band (MHz)	Maximum EIRP for base station in-block transmission
824 - 834	61 dBm
869 - 879	61 dBm
880 - 915	61 dBm
925 - 960	61 dBm
1 710 - 1 785	61 dBm/5 MHz
1 805 – 1 880	61 dBm/5 MHz
1 915 – 1 980	65 dBm/5 MHz
2 010 – 2 025	65 dBm/5 MHz
2 110 – 2 170	65 dBm/5 MHz
2 500 – 2 690	61 dBm/5 MHz

Based on Table 4, the maximum exclusion zone distances calculated from the maximum EIRP transmission limits at the centre frequency of each band are shown in Table 5.

Table 5. Maximum exclusion zone distances of typical cellular sites

Frequency band (MHz)	Transmit power at antenna/ EIRP (dBm)	Transmit power at antenna/EIRP (W)	ICNIRP limit for public (W/sq m)	ICNIRP limit for occupational exposure, S_{inc} (W/sq m)	Exclusion zone distance for public, S_{inc} (m)	Exclusion zone distance for workers (m)
869 - 879	61	1,259	4	22	5.0	2.10
925 - 960	61	1,259	5	23	4.5	2.10
1 805 – 1 880	61	1,259	9	46	3.3	1.48
2 010 – 2 025	65	3,162	10	50	5.0	2.24
2 110 – 2 170	65	3,162	10	50	5.0	2.24
2 500 - 2 690	61	1,259	10	50	3.2	1.42

It shall be noted that the distances in Table 5 are only examples based on maximum EIRP and practical antenna data, and that the proper usage of the formulas shall be ensured in calculating the correct exclusion zone distances that shall be based on the actual BS specifications.

8. Prediction methods for EMF compliance assessment

This section describes the calculation and computation methods to assess compliance with the relevant Mandatory Standard issued by MCMC for EMF exposure limit. The selection of numerical methods suitable for EMF exposure prediction in various situations are provided in ITU-T K.61 and IEC 62232.

Compliance procedure is divided into:

a) compliance by calculation for single transmitter BS; and

b) compliance by advanced computation using a simulation software for complex BS (where there are 2 or more antennas/transmitters).

Compliance status shall be revoked for any configuration changes on the BS and requirement for new compliance shall be asserted. Service provider shall submit a revised compliance report with updated configuration parameters.

8.1 Compliance by calculation

In the case of compliance for single transmitter BS (including 3 sectors/panels for coverage in all directions), the basic calculation of EMF exposure is as stipulated in Clause 7. The assessment of the EMF exposure is to be made at various publicly accessible points in the environment surrounding the BS. The EMF exposure calculation report which contains the data and technical parameters as shown in Table 6 shall be submitted.

Table 6. EMF exposure calculation information

Type	Descriptions
BS information	a) BS ID; b) BS address; c) Global Positioning System (GPS) coordinate; and d) date of commission.
Technical parameters	a) BS type - Tower/pole, dual function or rooftop; b) BS height in meter; c) electrical tilt and mechanical tilt in degree; d) antenna transmit gain in dB; e) antenna vertical bandwidth beam in degree; f) antenna side lobe attenuation in dB; g) antenna type, model and manufacturer; and h) transmitter power output in Watt.
Other technical parameters	Uncertainty estimation analysis, consist of: a) cable, connector and combiner loss in dB; b) scattering from nearby object and ground in dB; c) mismatch between antenna and its feed in dB; and d) antenna radiation pattern data.
Calculation tool information	a) version, model and manufacturer (if any); b) operator name and designation; and c) date and time of calculation report.

8.2 Compliance by advanced computation

Advanced computational electromagnetic mapping using a simulation software is required for complex sites where there are 2 or more transmitters or antennas. The simulation results are to be presented in the form of field strength or power densities that are calculated according to the plane of interest, and expressed in terms of numerical values and percentage of the exposure limit. Based on the simulated results, it is required for the EMF measurements to be performed if the power density values are found to exceed the stipulated exposure limit.

8.2.1 Advanced computation methods

For complex scattering environment, exclusion zones for multiple antennas in close proximity are drawn by software simulation based on methodologies as proposed in IEC 62232, ITU-T K.52 and ITU-T K.61.

There are several methods for determining compliance with exposure limits:

a) Finite-Difference Time-Domain (FDTD);

b) Multiple-Region Finite-Difference Time-Domain (MR/FDTD);

c) ray tracing model;

d) hybrid ray tracing/FDTD methods; and

e) NF antenna models such as Method of Moments (MOM) and the Numeric Electromagnetic Code (NEC).

The guidance in selecting appropriate computation methods to assess compliance with EMF levels is shown in Table 7, which shall depend on the following factors:

a) the field zone where the exposure evaluation is required;

b) the quantities being evaluated; and

c) the topology of the environment where the exposure occurs.

Table 7. Selection of numerical techniques

Field zone	Topology	Evaluated quantity	Suitable numerical technique
NF	Open	Field	FDTD, MOM
NF	Open	SAR	FDTD
NF	Closed, multiple scatterers	Field	FDTD, MOM
NF	Closed, multiple scatterers	SAR	FDTD, MR/MOM
FF	Open	Field	Ray tracing, MOM
FF	Multiple scatterers (complex urban environment)	Field	Ray tracing
NOTE: More detailed information on numerical techniques can be found in IEC 62232.			

8.2.2 Software estimation of uncertainty

Every method requires uncertainty analysis report to be submitted together with the simulation report. The software estimation of uncertainty involves 4 tasks:

a) identification of all sources of uncertainty that may reasonably be expected to cause significant variation or uncertainty in the evaluation;

b) for each source of uncertainty, an estimation of the probability distribution type and parameter;

c) specification of how the sources of uncertainty are combined to provide a total uncertainty value (a mathematical model which defines how the influence quantities are combined or added); and

d) determine the best estimate of the evaluation and expanded uncertainty for a 95 % confidence interval.

8.2.3 Validation of EMF simulation report

The simulation software shall be validated with reference example stated in IEC 62232 depending on the choice of computational method used. If the maximum deviation from the reference results is within ± 3 dB, the simulation package has passed the validation. The validation report of the software algorithm for each version and model shall be registered to MCMC. The latest simulation software validation registration is required for the updated version or/and model.

Simulation software operator shall be trained and training certificate shall be provided for verification purpose. Software operator name and designation shall be available in simulation report. A simulation software (EMF estimator) as described in ITU-T K.70 should be used.

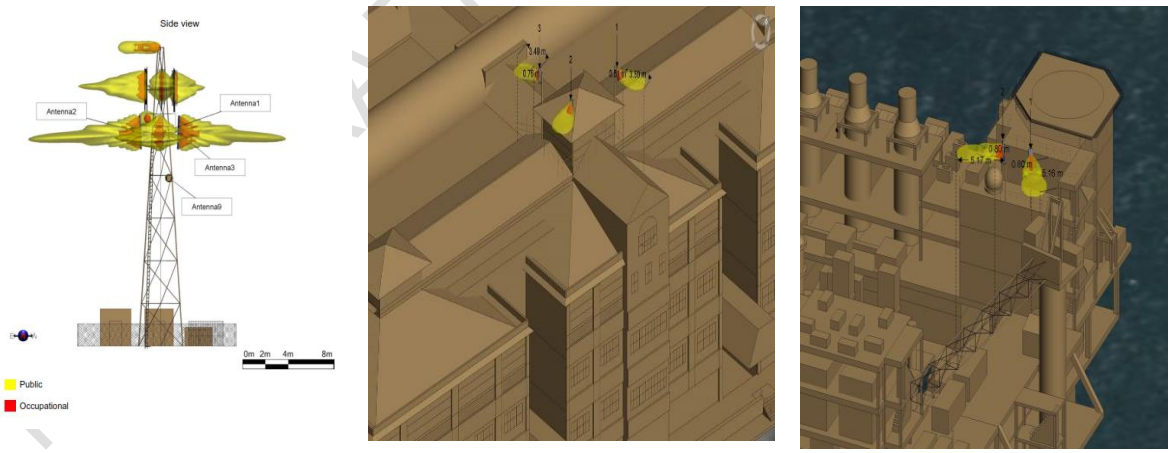
8.2.4 Exclusion zone indicators

The simulation report shall provide clear information on zoning as defined in ITU K.52 that classifies potential exposure to EMF as belonging to one of the three following zones; compliance zone, occupational zone and exceedance zone.

In the examples shown in Figure 3, the red zone indicates the exceedance zone, where no person is allowed into this area without following the appropriate shut-down, power-down or safe pass-through procedures. The yellow zone indicates the occupational zone, where only the RF trained personnel are allowed, on the condition that they follow the relevant site access procedures. The area outside the yellow zone (white zone) is open for public access.

Figure 3. An example of simulated exclusion zone

The examples of simulation models illustrating the exclusion zones for various antenna structures are shown in Figure 4.



Tower/mast **Building rooftop** **Oil and gas platform**

Figure 4. Examples of computed exclusion zone in simulation tool based on real antenna structures

8.2.5 EMF simulation report

The simulation report which contains the following data and technical parameters for technical and public viewers as elaborated and explained in Annex A shall be submitted:

a) base station information;

b) Radiocommunications Infrastructure (RCI) technical parameters;

c) other technical parameters for uncertainty estimation analysis

d) cut-plane figures;

e) simulation software information; and

f) blueprint to scale.

The computations and assessments of the exposure level shall consider the following conditions:

a) the maximum emission conditions (e.g. maximum EIRP, gain and beamwidth of the antenna system;

b) the simultaneous presence of several EMF sources, even at different frequencies; and

c) various characteristics of the installation, such as the antenna location, antenna height, beam direction, beam tilt.

Templates of simulation report are shown in Annex B and C. If there are more than 30 sites of simulation reports, the summary report shall be prepared as in Annex D.

9. On-site measurement

On-site measurement can be performed to analyse and confirm the actual EMF exposure at site and its surrounding areas. The measurement shall comply with the Permissible Exposure Limit (PEL) as stated in the relevant Mandatory Standard issued by MCMC. This clause specifies the techniques and instrumentation for the on-site EMF measurement.

9.1 In-situ EMF measurement

In-situ measurement is a measurement of the RF exposure level in the vicinity of the BS. Measurement or evaluation shall be made in the areas, which are known to be accessible by public and workers, and shall be performed at one location or area, known as the measurement area. The in-situ measurement method shall be in accordance to the IEC 62332.

9.1.1 NF measurement

NF measurement is conducted to determine the EMF exposure level for workers. For NF measurement, both E-field and H-field intensities shall be measured and compared to the PEL as specified in the ITU-T K.61.

9.1.2 FF measurement

FF measurement is conducted to determine the EMF exposure for the public. For FF measurement, only electric field strength (E-field) or power density shall be measured and compared to the permissible exposure limit to human, and shall be in accordance to the ITU-T K.61.

FF region can be determined by the following formula:

$$FF = \frac{2D^2}{\lambda}$$

where,

FF	the distance which indicates the beginning of the FF region;
D	the biggest dimension of the antenna in metre, m; and
λ	wavelength of the transmitted radiation in metre, m.

a) However, for the onset of the FF zone, the maximum phase difference of the electromagnetic waves coming from different points on the antenna is 22.5º. For estimating the field strength (worst case scenario), a realistic practical distance from a large antenna (parabolic) at the FF zone begins at:

$$FF = \frac{0.5D^2}{\lambda}$$

b) For small antenna size (e.g. rod/dipole), the FF can be determined using the following formula.

$$FF = \frac{\lambda}{2\pi}$$

The NF and FF regions are illustrated in Figure 5.

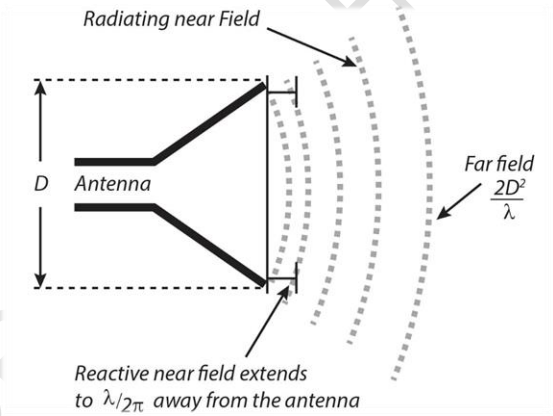


Figure 5. NF and FF regions

9.1.3 Measurement instrumentations

Measurement shall be performed using the most appropriate measuring equipment to obtain the information of transmit electromagnetic fields emitted on-site. According to the ITU-T K.61, there are several considerations in selecting the measurement devices as follows:

a) frequency range

There are two frequency ranges, which are the broadband and narrowband frequency range. Broadband devices will measure the overall frequency available around the site. This measurement will not indicate the individual frequency spectrum, but this is very appropriate for measurement at the public area, to show the overall EMF emission as indication of the public exposure. Measurement devices are generally antennas with big frequency range. Narrowband measurement devices are generally antennas with flat antenna factors over a limited spectrum ranges and can be used for selective frequency measurement.

b) antenna directivity

The antenna response maybe isotropic or directional. For the isotropic devices, the response is expected to be dependent of the direction on the incident EMF. Directional devices are generally polarised and have an axial symmetry in the radiation pattern.

c) quantity measured

The majority of the devices measure either the electric field or the magnetic field. In the FF region, measurement devices for the electric field component are preferred. The equivalent power density within the FF region is obtained from the measured field by calculation shown in Table 1 of the ITU-T K.61, which is based on the following equation.

$$Power\ density, S = \frac{E^2}{Z_0} = Z_0 \cdot H^2$$

where,

E	Electric field
Z_0	Intrinsic impedance
H	Magnetic field

d) device selection

The selection for EMF measurement devices is determined by some factors, for instance:

i) The equipment and device shall comply the following recommendation:

1) The device shall measure electric field (V/m), magnetic field (A/m) and power density (µWatts/cm^2) and comply to the existing standard by ICNIRP; and

2) The equipment should be suitable for the frequency range; i.e. narrowband or broadband measurement to comply to the characteristics of EMF source.

ii) For NF measurement, the EMF personal monitor is required.

iii) The number and the characteristics of EMF sources (which meet the measurement objective).

iv) Equipment or device shall be calibrated and has valid calibration certificate.

v) The field region (i.e. reactive NF, radiating NF or FF) in which the measurement is made.

The accuracy of measurement results depends on the measurement procedures as well on the characteristics of the measurement instrument used. An expanded measurement uncertainty with a 95 % confidence interval less than or equal to 4 dB is deemed sufficient to show compliance.

9.1.4 Calibration requirements

Calibration is very important to ensure the reliability of the equipment used. The objective of the calibration is to minimise any measurement uncertainty by ensuring the accuracy of the test equipment by quantifying and controlling errors within measurement processes to an acceptable level. The calibration requirements shall comply to the ITU-T K.61 and IEC 62232.

a) Calibration Factor (CF)

For the broadband probes, the CF is defined by the following formula:

$$CF = \frac{E_{ref}}{E_{meas}}$$

It is the ratio between the expected electric field reference field strength, E_{ref} and the measured value, E_{meas} displayed on the dedicated receiver unit. This factor is mainly a function of frequency and in the presence of non-linearity error or field strength. The CF is determined as a frequency function. For each frequency, the CF value shall be known with uncertainty less than 1 dB. Errors due to frequency interpolation are included in the tolerable uncertainty on CF.

b) Antenna Factor (AF)

The AF is defined for antennas and frequency selective probe as the ratio of the following formula:

$$AF = \frac{E_{ref}}{V}\,[m^{-1}]$$

where,

E_{ref}	the E-field strength on the probe; and
V	the voltage measured on the spectrum analyser.

This factor is primarily function of frequency but, in presence of non-linearity errors, it may depend on field strength too. The AF is determined as a frequency function. For each frequency, the AF value shall be known with an expanded uncertainty (i.e. 95 % statistical confidence) of less than 2 dB. The maximum tolerable uncertainty includes the error due the frequency interpolation.

c) isotropy

An isotropic probe is needed for compliance measurement of EMF emission. The isotropic response is usually achieved by a three-axial antenna system, where the three axes are arranged to be orthogonal. The deviation from an ideal isotropic response is called isotropic error and in general it is a function of the incident wave direction. It can be evaluated by measuring the difference from a cosine response of each axis if they are spatially identified and a signal from each axis is available or by checking the whole probe response (if it is not possible to clearly define the position of each axis or a single axis signal is not available). The mean deviation from the isotropic response should be less than 1 dB.

d) linearity

A linear response versus the field amplitude is required; a linearity error would mean that the antenna and the calibration factors are functions of the test field strength. Thus, the linearity test should be the starting point of the whole characterisation process of the probe.

9.1.5 Probe selection

General consideration in probe selection is the frequency range. It can be a broadband probe or a narrowband probe. This depends on the EMF sources intended to be measured (single source and multiple EMF sources). Broadband measurement will provide one set of field strength measurement for all frequency range and sources at the measurement area while narrowband measurement will require separate sets of field strength values of each source and frequencies at the measurement area. The choice of the measurement type depends on the objective of the in-situ evaluation as stated in the IEC 62232.

The dimension of probe sensor should be less than a wavelength at the highest operating frequency. According to ITU-T K.61, a non-directional probe is preferred in conducting EMF measurement.

9.1.6 Measurement method

The details of the measurement method in accordance to IEC 62232, ITU-T K.61 and ITU-T K.100 are as follows:

a) measurements shall be conducted by personnel with specific training on EMF instrumentations and techniques;

b) visual inspection shall be conducted before the measurement start;

c) physical condition of the EMF source at the site must be recorded (number of antenna, height of the structure, type of the antenna) and photo of the site must be taken for record on the day of the measurement;

d) the parameters that shall be considered during the assessment are as follows:

   i) frequency range;

   ii) type of antenna;

   iii) transmitting power;

   iv) dimension of the antenna; and

   v) distance.

e) identification of RF source and measurement points;

f) the locations of measurement selected shall be based on the worst-case situation (nearest accessible location facing the antenna beam) and popular public places (residential area, playground, bus stops).

   Distance from the EMF source to the measurement point must be recorded as reference. The NF or FF region shall be determined before selecting the measurement point. EMF measurement shall be conducted at various location points and should be mapped with the exact location (with longitude and latitude coordinate). This process is called EMF mapping and through this, we can see the EMF exposure level variations over the distance and at the selected measurement points. The layout plan must be sketched for any measurement conducted in the building;

g) EMF measurement instruments shall match with the EMF sources frequency range and suit to FF or NF region which appropriate equipment and probes shall be selected based on the intended frequency range;

h) the measurement shall be carried out at 1.5 m to 2 m from the ground/floor which the measurement probe should be mounted on a wooden tripod;

i) inspection or measurement point shall be selected at least 3 probe lengths or 0.2 m away from any conducting or reflecting objects;

j) for each point, measurement shall be taken for 6 min by using broadband and selective spectrum analyser with root mean square (rms) detector using appropriate probe (according to frequency used by each telco service); and

k) results shall be recorded in power density (µWatts/cm^2) to represent the PEL.

Measurement for shared site shall consider the number of RF sources available at the site. Information on the individual frequency of the RF source used by each service provider shall be obtained before the measurement. Broadband measurement is required to determine the total electromagnetic field around the site. Individual frequency measurement using the selective spectrum analyser can be conducted if needed. The PEL calculation for the shared sites shall be determined by using the lowest frequency used by the shared service provider as a consideration of the worst-case scenario.

9.1.7 Measurement report

A template of measurement report is as per Annex E. A measurement report shall consist of the following information:

a) introduction;

b) objective;

c) scope of the measurement;

d) description of survey site and radiation source;

e) safety guideline and exposure limit;

f) standard measurement equipment;

g) method of measurement;

h) results and discussion;

i) conclusion;

j) attachment; and

k) report verification.

9.2 5G New Radio (NR) base station EMF measurement

In 5G New Radio (NR), the signalling and data signals transmit on different beam. Even if the beam width of signalling and data beam are different, a good correlation (constant factor) between signalling and data is in the range of directions, where half power beam width of signalling and data overlap. Towards the maximum angles of the beams, high differences up to 30 dB or more occur between signalling and data field strength. This may result in an underestimation of the maximum field strength, if only the signalling is measured. There are many different modes for the signalling pattern and beam width. The exact mode must be known for any correlation, which should be provided by the network provider.

The assessment method should consider for the maximum emission approach rather than just the current emission approach for 5G on-site EMF measurement. The measurement needs to identify and decode carriers and beams of the 5G site. Estimation/calculation of the worst-case EMF exposure at the 5G site shall be made using extrapolation factor. To evaluate the exposure level for maximum traffic conditions by extrapolation, it is important that the transmitted power of the received signal or channel is not dependent on the amount of traffic. The measurement should be made using a known antenna (where antenna factor is available). A quick survey at the BS should be made to ensure no emissions from other transmitters in the area.

The method described in this section is based on the guidelines stated in the IEC 62232, in which the radiation pattern and the power per Resource Element (RE) for the Synchronisation Signal Block (SSB) are the same as the traffic channels (or any other signal transmitted by the BS). Otherwise, an additional extrapolation factor should be considered in the extrapolation to account for the possible difference in the antenna gain and power. Considerations which should be made for 5G NR EMF measurement are discussed in the following sub-sections.

9.2.1 Beam/gain offset between Synchronisation Signal Block (SSB) and data beams

The 5G NR UE specific beams have a much lower beam width and/or more power as compared to SSB beams to further increase the SINR. The corresponding data either to be measured with the RF scanner or to be requested from the network operators or network vendors. Figure 6 illustrates the multi-beam signals transmitting from the 5G NR base station antenna.

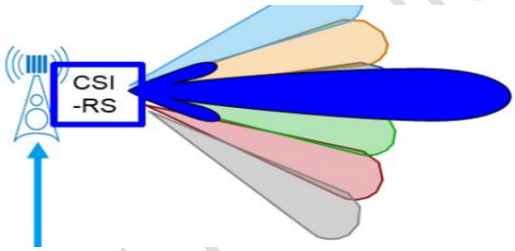


Figure 6. Multi-beam signal from the same antenna sector in 5G NR

9.2.2 Uplink (UL) and Downlink (DL) relation factor

In the case of TDD, the relation between Uplink (UL) and Downlink (DL) significantly affects the radiated power by the 5G NR base station. In the case, if more slots are reserved for UL, the radiated power decreases. The relation factor depends on the network configuration, which may be requested from the network operators. An exception is the 5G NSA networks, where the 5G NR carrier may be used for DL only. An example of Uplink (DL) and Downlink (DL) sequences in the 5G NR TDD network is shown in Figure 7.

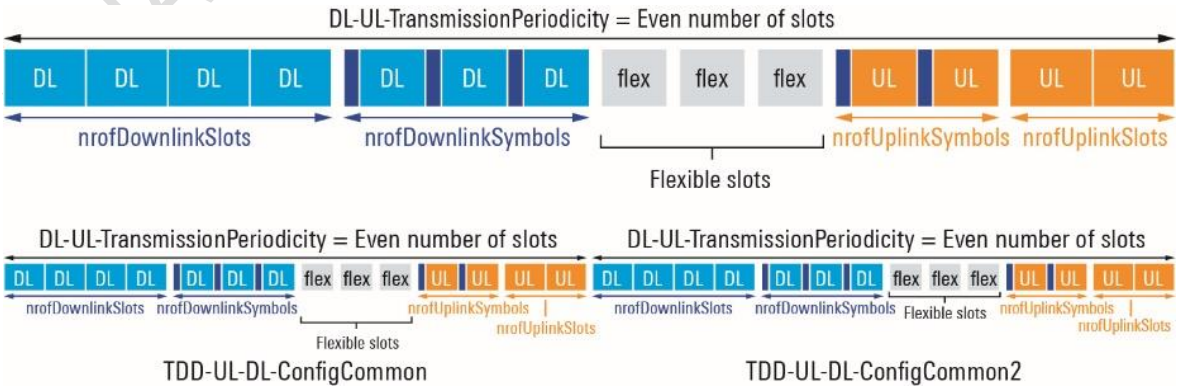


Figure 7. Example of UL/DL sequence in 5G NR TDD standalone network

9.2.3 Projection of synchronisation signal block power on the total 5G NR carrier spectrum

5G NR SSBs only have a bandwidth of 3.6 MHz to 7.2 MHz depending on the subcarrier spacing. The total bandwidth of 5G NR carrier can be up to 400 MHz. An extrapolation factor is then required, which can be requested from the operators or to be determined by using a mobile phone with an active subscription for the 5G NR network. In the 5G NR carrier, the SSB is the only “always on” signal. Since the 5G is packet switch, the total carrier power is only measurable during the time when it is at maximum active traffic. The illustration of the SSB block within the 5G carrier is shown in Figure 8.

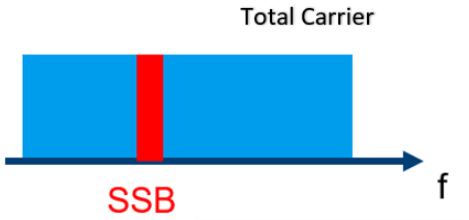


Figure 8. Illustration of the SSB from the total 5G NR carrier spectrum

9.2.4 Maximum 5G NR exposure evaluation

An evaluation method based on extrapolation is needed to assess the maximum exposure level from 5G NR BS using the Secondary Synchronisation Signal (SSS), Primary Synchronisation Signal (PSS) and Physical Broadcast Channel (PBCH), all of which form the signal SSB. The extrapolation is possible by decoding of the SSS to extrapolate the maximum exposure for each cell ID separately.

5G NR uses beamforming to overcome the path loss at higher frequencies. Intelligent antenna arrays create very narrow but high-gain beams to focus the power on a certain area to increase SINR and received power. This can create field strength hotspots in the very narrow main lobes of the beams. Figure 8 shows the different SSB beams transmitting from the same antenna sector of the 5G NR base stations.

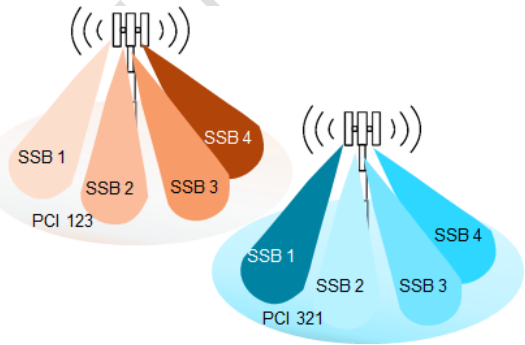


Figure 8. Multiple SSBs beam from same antenna sector

9.2.5 Method of 5G EMF measurement using dedicated 5G NR decoder/scanner

The maximum exposure from the 5G NR BS can be determined by measuring the SSB EMF and extrapolate to full bandwidth and consider the maximum gain as compensation factor. The measurements require that the system bandwidth and centre frequency of the target 5G NR carrier is set. The maximum electric field strength (V m-1), E_{asmt}, is defined by the following equation:

$$E_{asmt} = E_{SSB} \times \sqrt{F_{extSSB}} = E_{SSB} \times \sqrt{F_{BW} \times F_{PR} \times F_{TDC}}$$

where,

E_{asmt}	the extrapolated electrical field strength, V m^{-1};
E_{SSB}	the field level, V m^{-1} per RE of the SSB;
F_{TDC}	the technology duty cycle;
F_{PR}	the power reduction if the actual maximum approach is used, otherwise it is set to 1;
F_{BW}	the total number of subcarriers within the carrier bandwidth; and
F_{extSSB}	the extrapolation factor for the SSB.

Figure 9 illustrates the test setup to measure the 5G EMF using a dedicated 5G NR decoder/scanner.

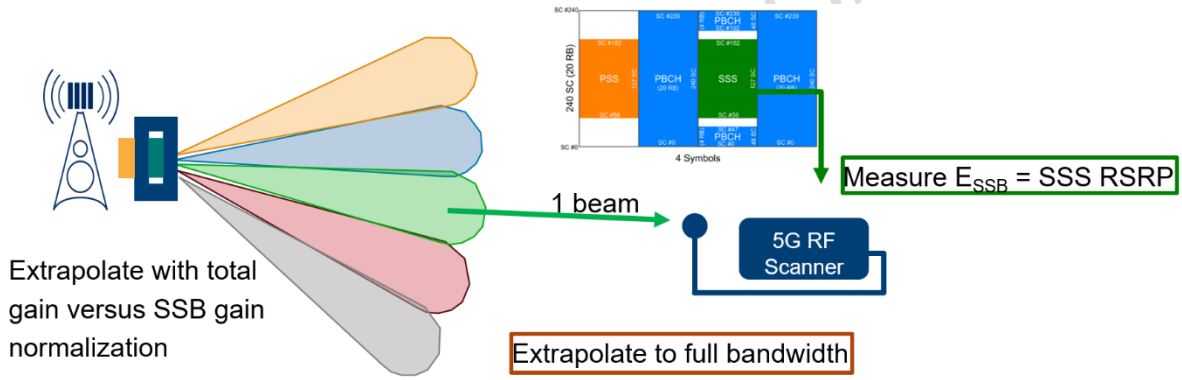


Figure 9. Measurement of the 5G NR base station antenna SSB E-field and the extrapolation method

When the power allocated to any subcarrier is the same, F_{BW} corresponds to the number of resource elements for the system bandwidth of the target BS, the technology duty cycle and a power reduction factor. The extrapolation factor, F_{BW} for each system bandwidth is shown in Table 9 for sub-6 GHz and Table 10 for mm-Wave, assuming that all subcarriers are transmitted with the same power level.

Table 9. F_{BW} for each combination of BS channel bandwidth and SSB Subcarrier Spacing (SCS) for sub 6 GHz signals

SCS (kHZ)	Bandwidth (MHz)												
	5	10	15	20	25	30	40	50	60	70	80	90	100
15	300	624	948	1,272	1,596	1,920	2,592	3,240	N/A	N/A	N/A	N/A	N/A
30	132	288	456	612	780	936	1,272	1,596	1,944	2,268	2,604	2,940	3,276
60	N/A	132	216	288	372	456	612	780	948	1,116	1,284	1,452	1,620

Table 10. F_{BW} for each combination of BS channel bandwidth and SSB subcarrier spacing (SCS) for mm-Wave signals

SCS (kHz)	Bandwidth (MHz)			
	50	100	200	400
60	792	1,584	3,168	N/A
120	384	792	1,584	3,168

In order to distinguish between the contribution of different cells, E_{SSB} should correspond to the field strength per RE of the decoded SSB. Figure 10 shows the setup to measure the total sum of the SSB beams electric field.

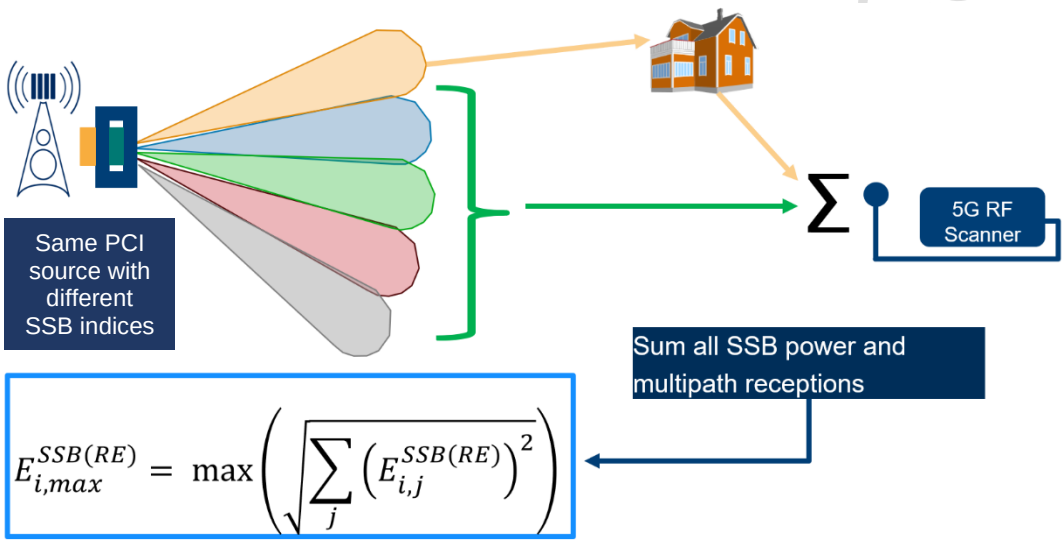


Figure 10. Total sum up measurement for all SSBs beams electric field

In general, the EMF measurement method for 5G NR can be summarised into 5 steps:

a) 5G NR signal scan overview to identify the channels;

b) identification of the reference frequency position of the SSB, which contains the 5G NR always on signals, SCS of the SSB and the channel bandwidth of the signal under test;

c) measurement of the electric field strength per RE of the SSB;

d) measurement of the time averaged instantaneous exposure level; and

e) extrapolation of the electric field strength per RE to the (theoretical) maximum electric field level, based on a fully occupied 5G NR channel.

9.2.6 Massive MIMO beamforming

In 5G, different signals can be transmitted on multiple beams. The power, gain, steering direction, beam shape and polarisation plane of the different beams may vary over time. By measuring the signal SSBs, 2 EIRP envelopes shall be known for implementing the corresponding extrapolation methods. In general, these 2 EIRP envelopes are functions of the azimuth, ϕ and elevation angle, θ and depend on the configuration of the cell:

a) the first EIRP envelope is the EIRP envelope of the SSB. It is defined as the maximum EIRP due to the broadcast signal for all beams which are used to transmit the broadcast signal. For the EIRP envelope of the broadcast signal it is assumed that all resource elements of the complete resource grid transmit the same power as a resource element which is indeed transmitting a part of the broadcast signal; and

b) the second EIRP envelope is the EIRP envelope of all signals. It is defined as the maximum EIRP due to all signals for all beams which may be used to transmit all signal types. This EIRP envelope describes the configured maximum EIRP as a function of the azimuth and elevation angle.

The ratio of the EIRP envelope of all traffic beams to the EIRP envelope of the broadcast signal at a given azimuth and elevation angle is the extrapolation factor $F_{ExtBeam}$ at this azimuth and elevation angle.

From IEC 62232, if azimuth and elevation direction from the BS to the Point of Investigation (POI) is known and the received power of the reflected waves is not dominant, the extrapolation factor for 5G massive MIMO corresponding to the ratio of the EIRP envelope of all traffic beams to the EIRP envelope of the SSB signal ($F_{ExtBeam}$) can be applied as the following:

a) $F_{ExtBeam}$ is selected as the value for that particular azimuth and elevation;

b) for high gradients of $F_{ExtBeam}$ the uncertainty of the current azimuth and elevation position shall be taken into account for the total assessment uncertainty; and

c) if the spatial maximum of the broadcast signal in a certain volume around a nominal azimuth and elevation position is used as the base for the extrapolation process the minimum extrapolation factor $F_{ExtBeam}$ inside this volume should be used to avoid overestimation.

If the radiation pattern of the SSB is different from that of other signals transmitted by the antenna, the extrapolation factor shall take into account for the possible difference in the antenna gain, in order to ensure that maximum possible field strength is obtained. Based on IEC 62232, the maximum electric field strength (V m^{-1}), E_{max}, is defined by equation below.

$$E_{asmt} = E_{SSB} \times \sqrt{F_{ExtBeam} \times F_{BW} \times F_{PR} \times F_{TDC}}$$

where,

E_{asmt}	the extrapolated E-field strength;
E_{SSB}	the E-field level of the measured SSB beam;
$F_{ExtBeam}$	the extrapolation factor corresponding to the ratio of the EIRP envelope of all traffic beams to the EIRP envelope of the broadcast signal at the direction to the measurement location;
F_{TDC}	the technology duty cycle;
F_{PR}	the power reduction if the actual maximum approach is used, otherwise it is set to 1; and
F_{BW}	the total number of subcarriers within the carrier bandwidth.

Figure 11 illustrates the test flow to measure the 5G EMF of a massive MIMO 5G NR base station.

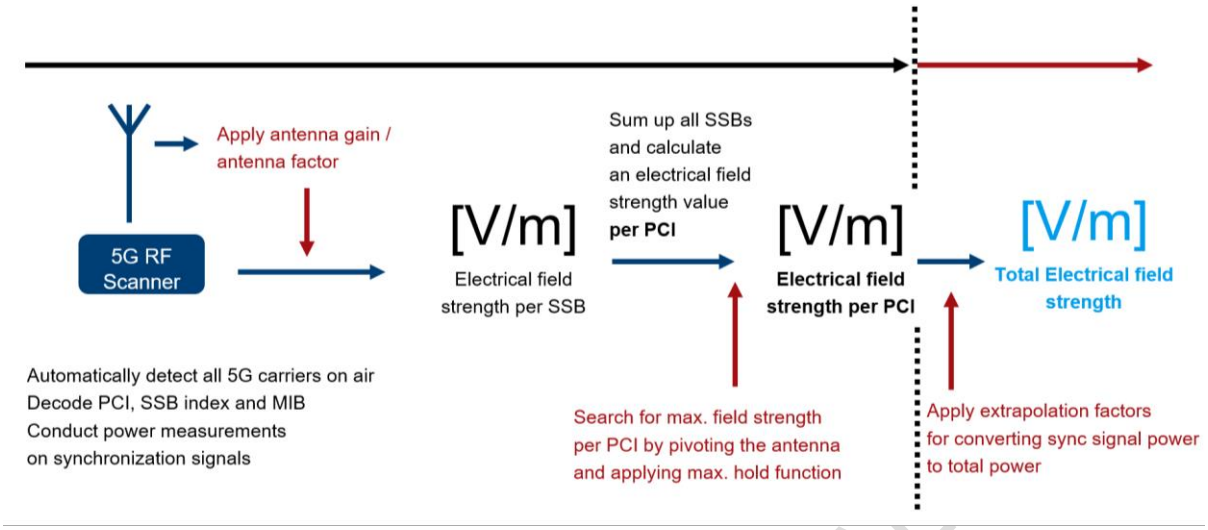


Figure 11. The process flow of the 5G EMF base station measurement and maximum exposure extrapolation with massive MIMO consideration

Annex A
(normative)

Technical requirements in EMF simulation report

The following data and technical details are required in the EMF simulation report:

a) base station information

   i) Radiocommunication Infrastructure (RCI) ID;

   ii) RCI address;

   iii) GPS coordinate; and

   iv) date of commission.

b) RCI technical parameters

   i) RCI type - Tower/pole, dual function or rooftop;

   ii) RCI height in meter;

   iii) electrical tilt and mechanical tilt in degree;

   iv) antenna transmit gain in dBi;

   v) antenna vertical bandwidth beam in degree;

   vi) antenna side lobe attenuation in dB;

   vii) antenna type, model and make;

   viii) antenna GPS position; and

   ix) transmitter power output in Watt.

c) other technical parameters for uncertainty estimation analysis

   i) cable, connector and combiner loss in dB;

   ii) scattering from nearby objects and ground in dB;

   iii) mismatch between antenna and its feed in dB; and

   iv) antenna radiation pattern data.

d) cut-plane figures as described in Table A.1 and Figure A.1

   i) orthoslice at ground level;

   ii) orthoslice at rooftop level; and

   iii) exclusion zone crossover with adjacent building.

Table A.1. The description of the required cut-plane figures

Cut-plane type	Description
Orthoslice at ground level	Horizontal plane 2 m above ground level in term of power density or emission percentage against exposure limits. Legend with logarithmic rainbow colour scale shall be marked clearly.
Orthoslice at rooftop level (not applicable for tower BS)	Horizontal plane 2 m above rooftop level in term of power density or emission percentage against exposure limits. Legend with logarithmic rainbow colour scale shall be marked clearly.
Exclusion zone crossover with adjacent building:	At antenna height level to analyse the crossover within adjacent nearby building in close vicinity, in term of power density or emission percentage against exposure limits. Legend with logarithmic rainbow colour scale shall be marked clearly.
NOTE: Public, occupational, and exceedance exposure limits shall be marked clearly.	

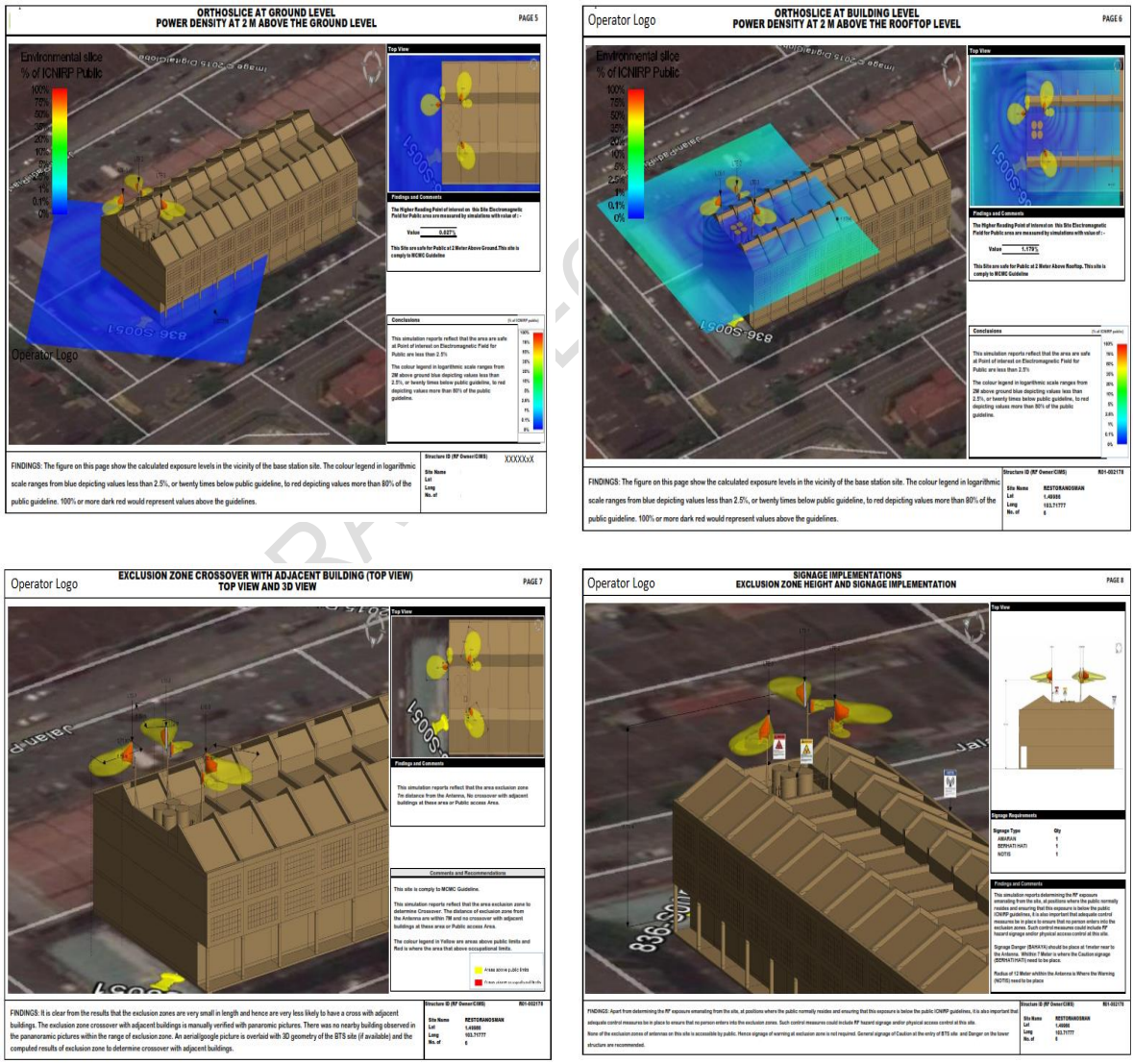


Figure A.1. Othoslice method

e) simulation software information

   i) simulation software's version, model and manufacturer;

   ii) simulation software operator's Name and designation; and

   iii) date and time of simulation report.

f) blueprint to scale as shown in Figure A.2.

   i) simulation must be based on actual size of the building and area;

   ii) the actual size of blueprints and aerial pictures in any format (JPEG, PDF, PNG and BMP) must be imported

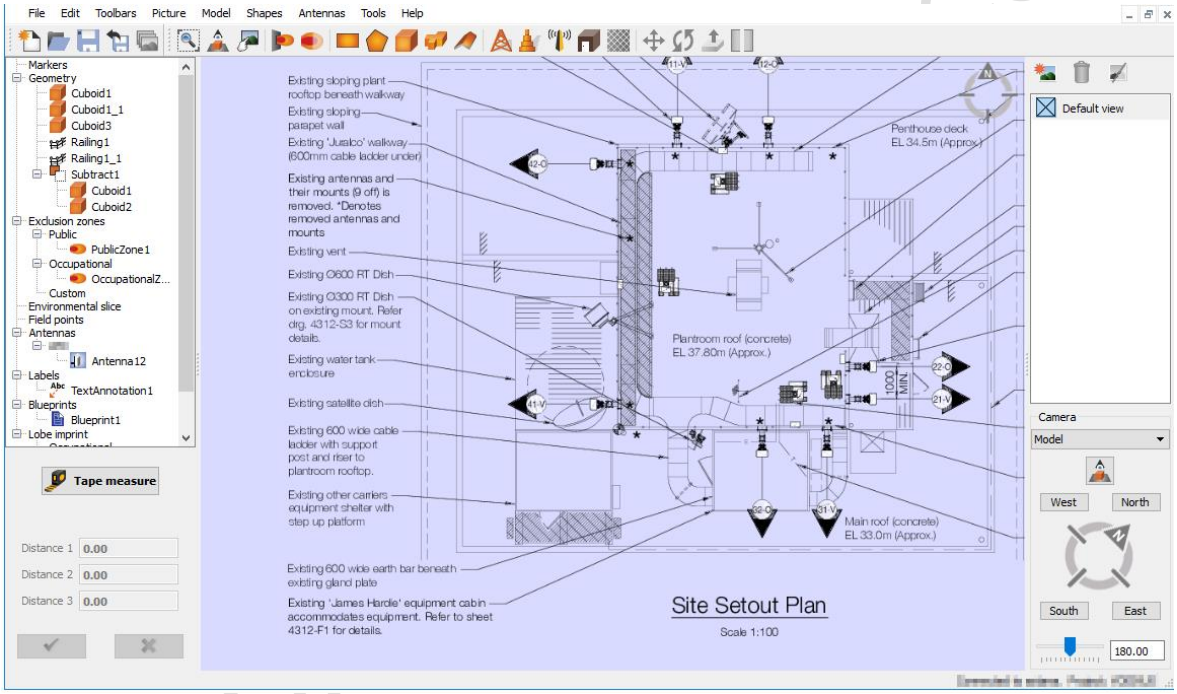
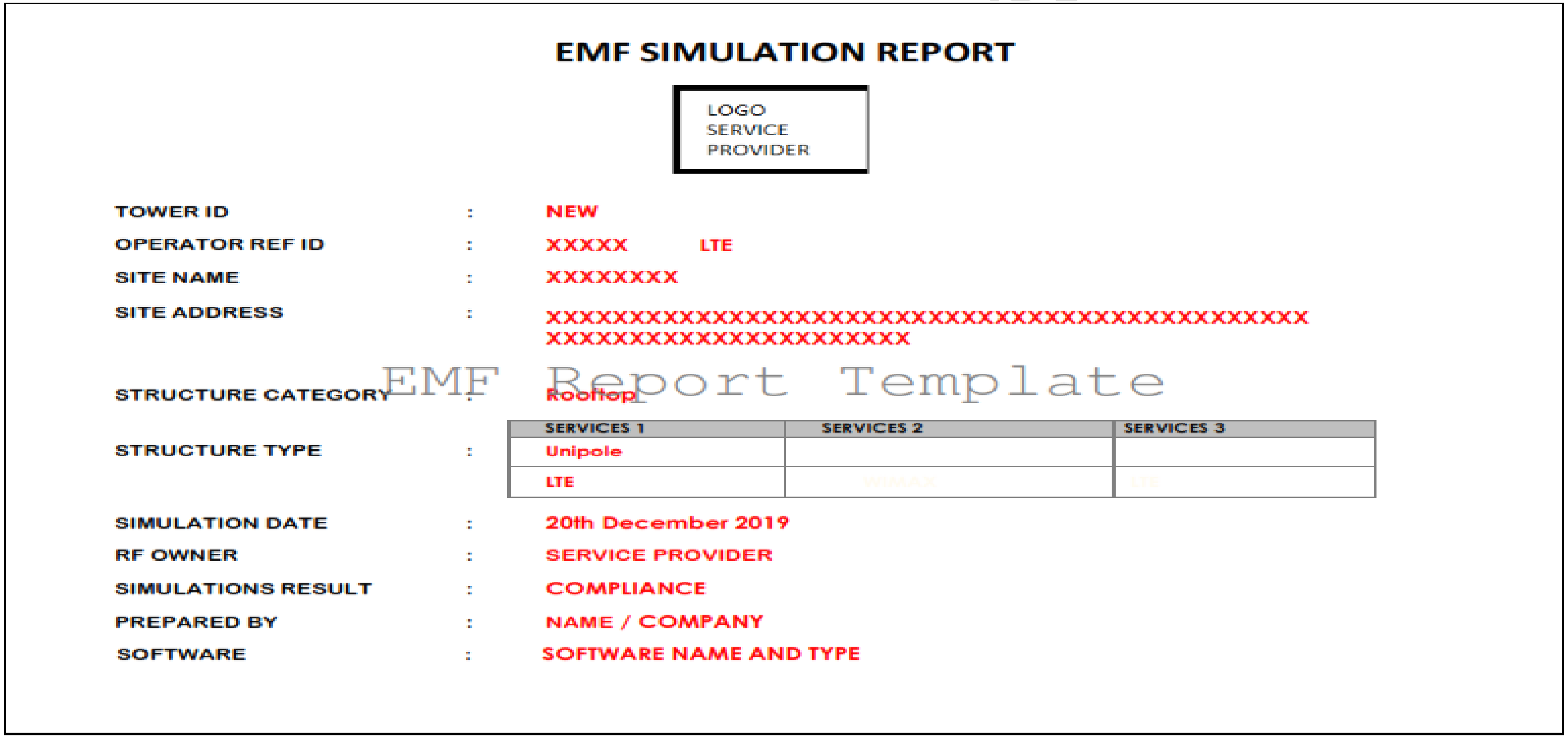


Figure A.2. Blueprint sample

Annex B
(informative)

EMF simulation report sample for rooftop

The EMF simulation report sample for rooftop are as follows.



EMF SIMULATION REPORT

LOGO
SERVICE
PROVIDER

TOWER ID : NEW
OPERATOR REF ID : XXXXX LTE
SITE NAME : XXXXXXXX
SITE ADDRESS : XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXX
STRUCTURE CATEGORY : Rooftop
STRUCTURE TYPE :

SERVICES 1	SERVICES 2	SERVICES 3
Unipole		
LTE	WIMAX	LTE

SIMULATION DATE : 20th December 2019
RF OWNER : SERVICE PROVIDER
SIMULATIONS RESULT : COMPLIANCE
PREPARED BY : NAME / COMPANY
SOFTWARE : SOFTWARE NAME AND TYPE

LOGO
SERVICE
PROVIDER

TABLE OF CONTENT

Introduction:

In this report maximum cumulative radio-frequency (RF) exposure calculations are presented for the above mentioned cellular base station site. Results are shown 2m above ground level and/or roof top level, unless specified otherwise, and expressed in terms of the ICNIRP guidelines. The actual RF exposure levels will generally be significantly less than the simulated values, due to automatic power control used by cellular base stations as well as reduction in exposure levels due to environmental factors such as the presence of buildings, trees and other objects. The simulated values are aimed towards the analytic worst case scenario for the peak traffic conditions.

Exposure Standards:

Results are expressed in terms of the ICNIRP'98 general public guidelines. These guidelines are reviewed on a regular basis by ICNIRP and specify the limits for continuous exposure of the general public to RF transmissions at frequencies used by cellular phone base stations.

Report Format:

The report in this document is as per MCMC standard "Commission Determination on the mandatory standard for Electromagnetic field emission from telecommunication infrastructure- Determination no. 1 of 2010".
Electromagnetic mapping of BTS site and nearby clutter is done, based on ray tracing computational method as per ITU-T Recommendation K.52 (2004), 'Guidance on complying with limits for human exposure to electromagnetic fields' and K.61 'Guidance to measurement and numerical prediction of Electromagnetic fields for compliance with human exposure limits for telecommunication installations' documents. This report is published in the form prescribed in MCMC Standard document.

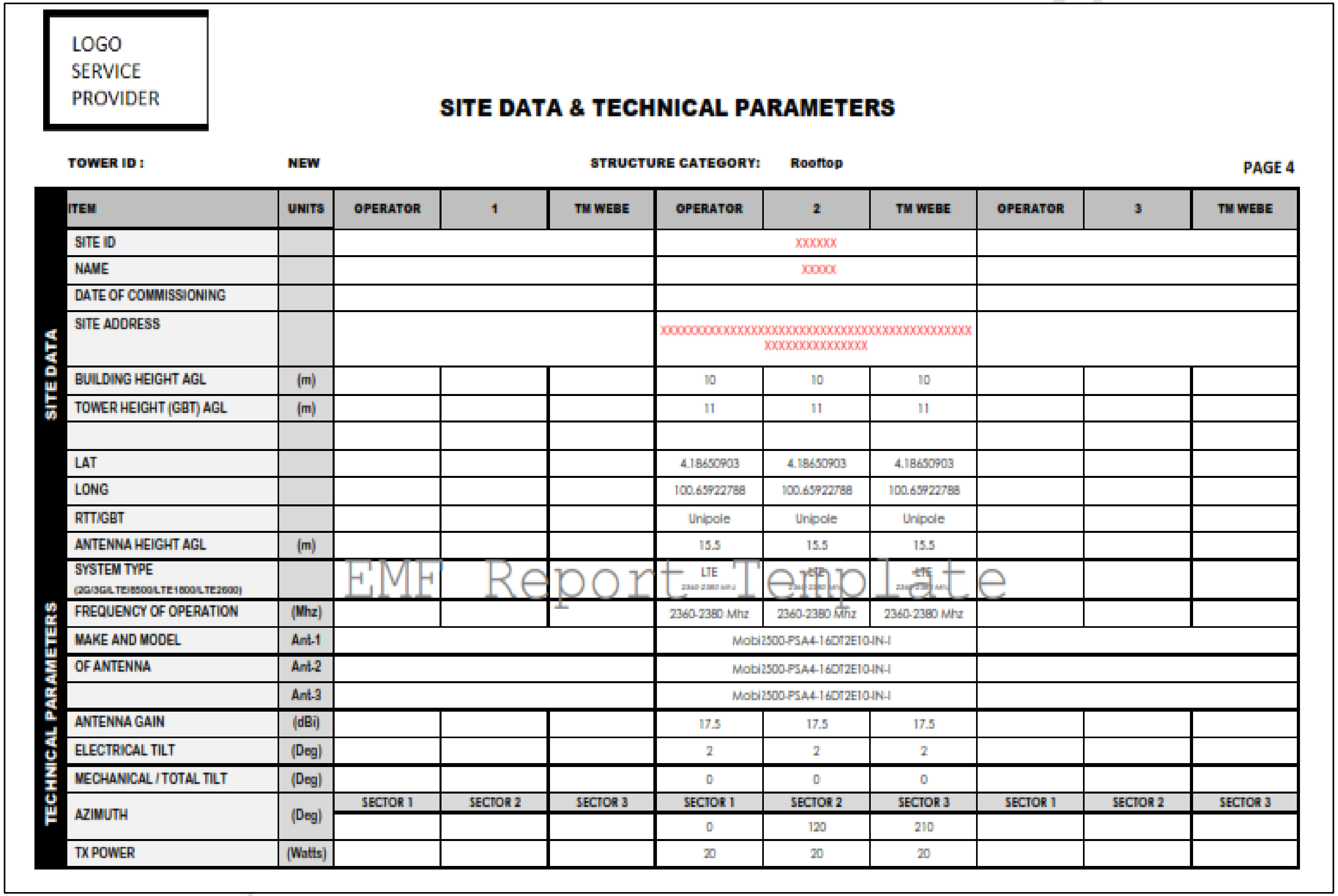
Glossary of Terms Used

Exclusion Zone: Area around an antenna or antennas where the RF field values emanating from the antennas exceed the ICNIRP public guidelines (public exclusion zone) or the ICNIRP occupational guidelines (occupational exclusion zone). Red zone indicates no access without following appropriate shut-down, power-down or pass through procedures. Yellow zone indicates access only allowed for RF trained personnel. No access for general staff, maintenance personnel or the public, whereas white zone is free access to everybody.
Orthoslice: Colour representation in form of power density values calculated in a plane of interest, expressed as a percentage of ICNIRP general public reference level with logarithmic legend. The standard dimension/area of Orthoslice of 60mX60m is used in the report as per Malaysian Standard document.

Vendor Logo

Vendor Detail address and tel number

LOGO
SERVICE
PROVIDER

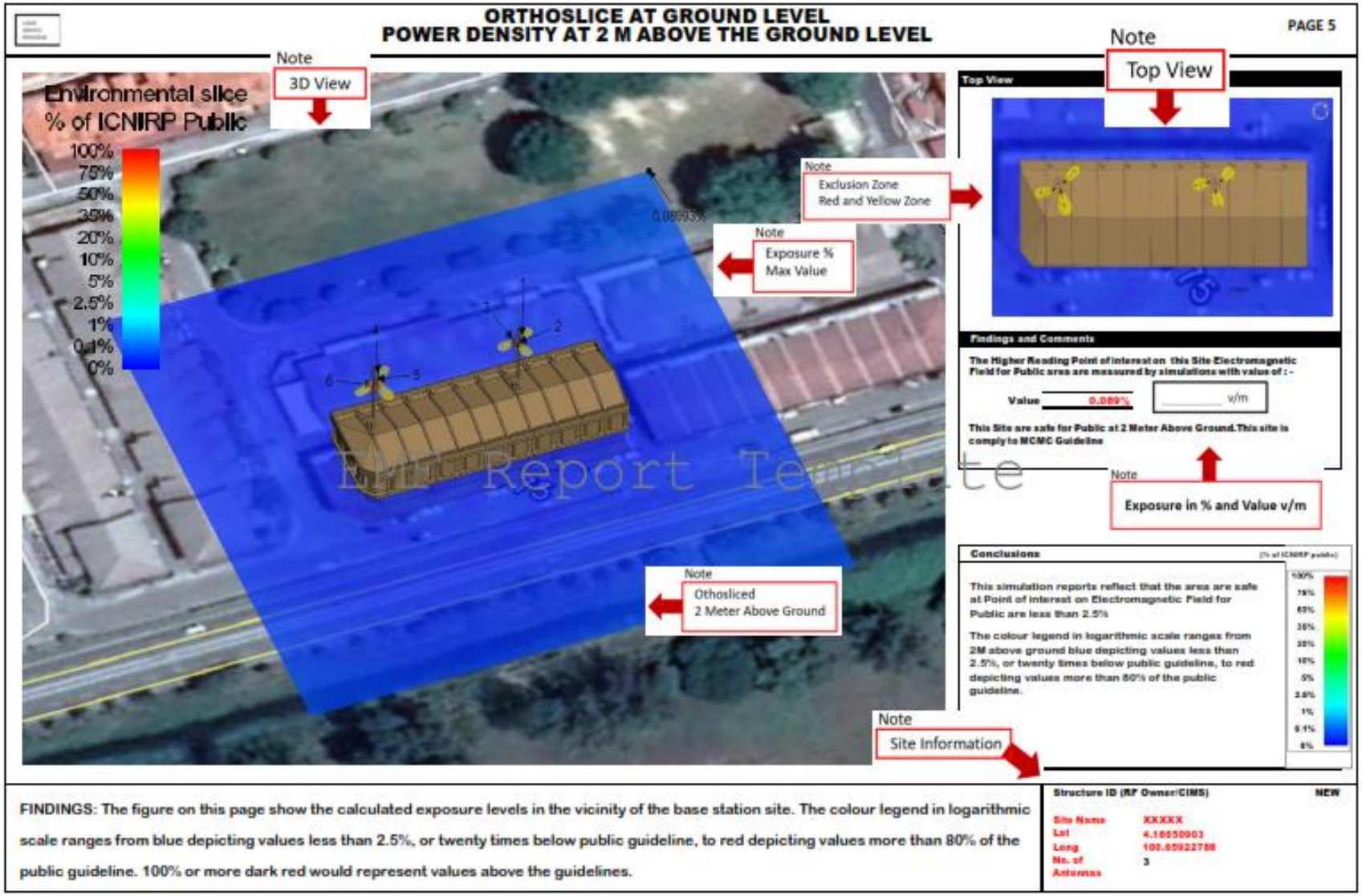


LOGO
SERVICE
PROVIDER

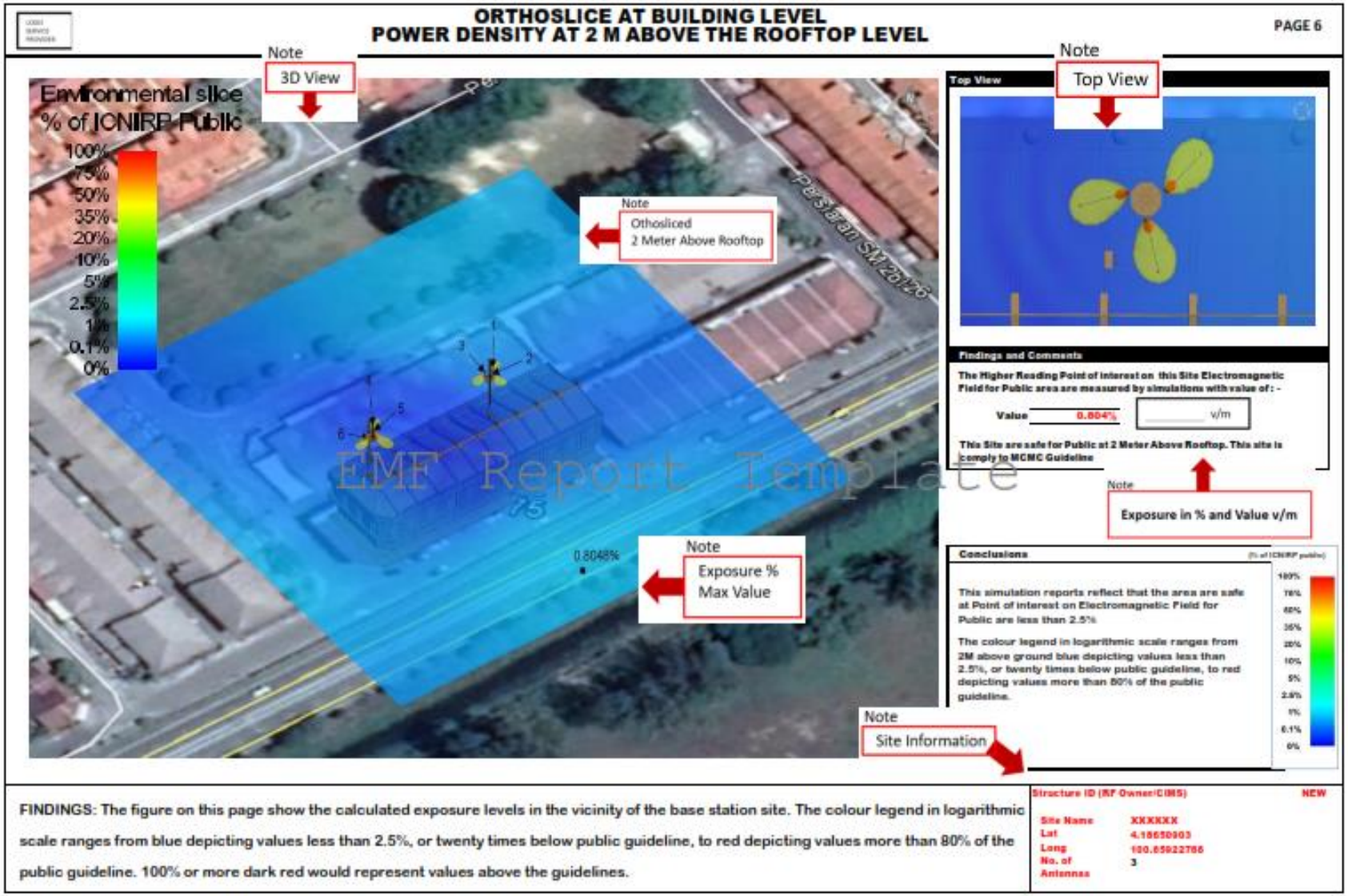
SITE DATA & TECHNICAL PARAMETERS

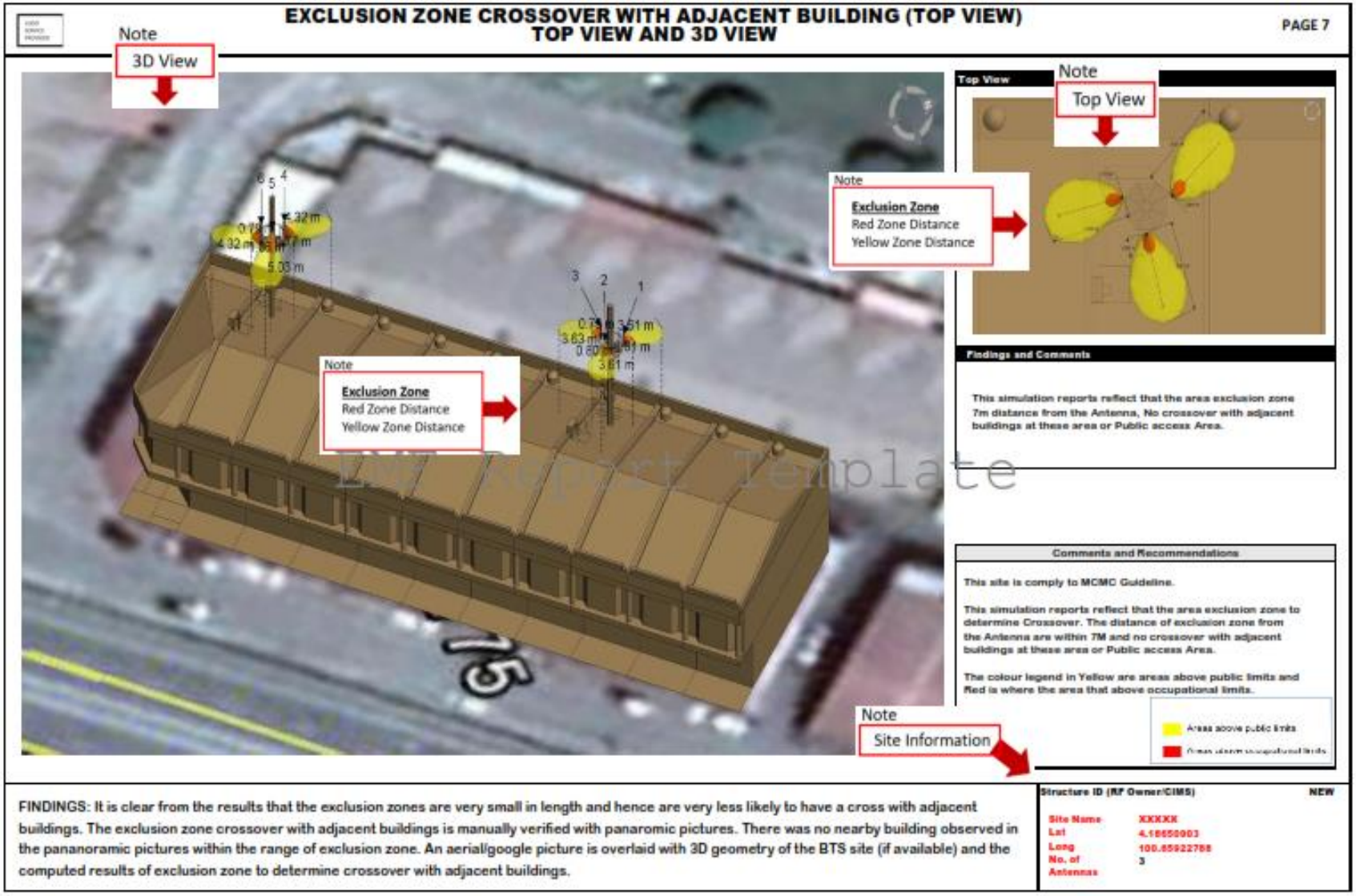
TOWER ID : NEW **STRUCTURE CATEGORY:** Rooftop **PAGE 4**

	ITEM	UNITS	OPERATOR	1	TM WEBE	OPERATOR	2	TM WEBE	OPERATOR	3	TM WEBE
SITE DATA	SITE ID					XXXXXX					
	NAME					XXXXX					
	DATE OF COMMISSIONING										
	SITE ADDRESS					XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXX					
	BUILDING HEIGHT AGL	(m)				10	10	10			
	TOWER HEIGHT (GBT) AGL	(m)				11	11	11			
	LAT					4.18650903	4.18650903	4.18650903			
	LONG					100.65922788	100.65922788	100.65922788			
	RTT/GBT					Unipole	Unipole	Unipole			
	ANTENNA HEIGHT AGL	(m)				15.5	15.5	15.5			
TECHNICAL PARAMETERS	SYSTEM TYPE (2G/3G/LTE/8500/LTE1800/LTE2600)					LTE 2360-2380 MHz	LTE 2360-2380 MHz	LTE 2360-2380 MHz			
	FREQUENCY OF OPERATION	(Mhz)				2360-2380 Mhz	2360-2380 Mhz	2360-2380 Mhz			
	MAKE AND MODEL	Ant-1				Mobi2500-PSA4-16DT2E10-IN-I					
	OF ANTENNA	Ant-2				Mobi2500-PSA4-16DT2E10-IN-I					
		Ant-3				Mobi2500-PSA4-16DT2E10-IN-I					
	ANTENNA GAIN	(dBi)				17.5	17.5	17.5			
	ELECTRICAL TILT	(Deg)				2	2	2			
	MECHANICAL / TOTAL TILT	(Deg)				0	0	0			
	AZIMUTH	(Deg)	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 1	SECTOR 2	SECTOR 3
						0	120	210			
	TX POWER	(Watts)				20	20	20			



FINDINGS: The figure on this page show the calculated exposure levels in the vicinity of the base station site. The colour legend in logarithmic scale ranges from blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline. 100% or more dark red would represent values above the guidelines.

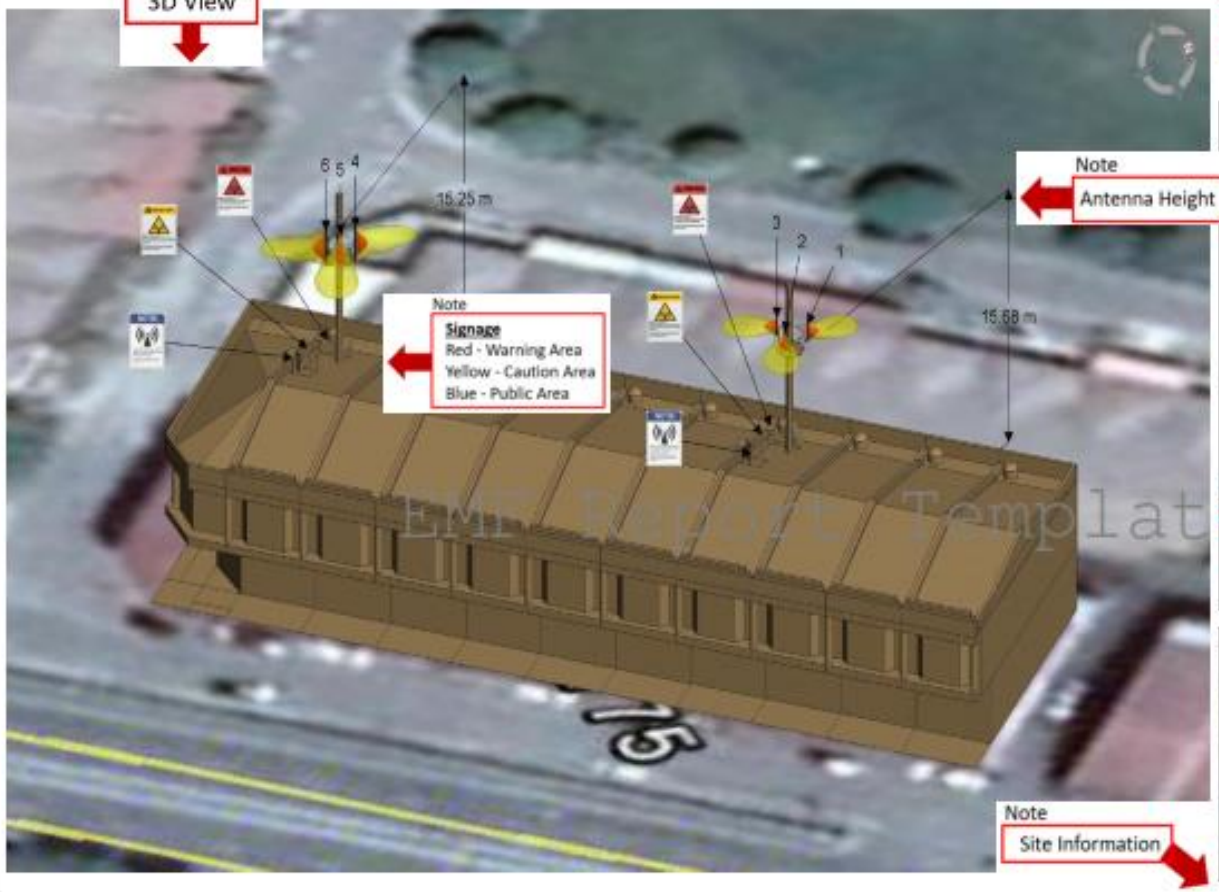

ORTHOSLICE AT BUILDING LEVEL
POWER DENSITY AT 2 M ABOVE THE ROOFTOP LEVEL
PAGE 6
Note
3D View
Environmental slice
% of ICNIRP Public
100%
75%
50%
35%
20%
10%
5%
2.5%
1%
0.1%
0%
Note
Othosliced
2 Meter Above Rooftop
0.8048%
Note
Exposure %
Max Value
EMF Report Template
Note
Top View
Top View
Findings and Comments
The Higher Reading Point of Interest on this Site Electromagnetic Field for Public area are measured by simulations with value of : -
Value
0.804%
v/m
This Site are safe for Public at 2 Meter Above Rooftop. This site is comply to MCMC Guideline
Note
Exposure in % and Value v/m
Conclusions
This simulation reports reflect that the area are safe at Point of interest on Electromagnetic Field for Public are less than 2.5%
The colour legend in logarithmic scale ranges from 2M above ground blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline.
Note
Site Information
FINDINGS: The figure on this page show the calculated exposure levels in the vicinity of the base station site. The colour legend in logarithmic scale ranges from blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline. 100% or more dark red would represent values above the guidelines.
Structure ID (RF Owner/CIMS)
NEW
Site Name
XXXXXX
Lat
4.18650303
Long
100.65922766
No. of Antennas
3

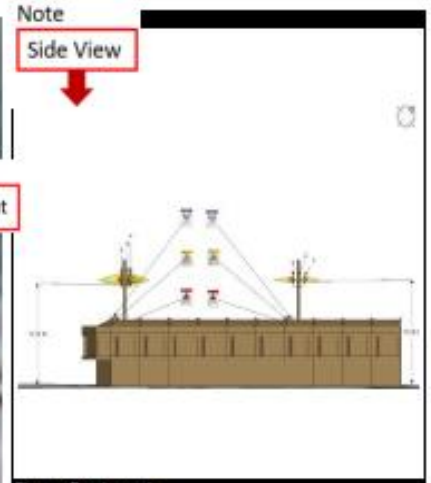


FINDINGS: It is clear from the results that the exclusion zones are very small in length and hence are very less likely to have a cross with adjacent buildings. The exclusion zone crossover with adjacent buildings is manually verified with panaromic pictures. There was no nearby building observed in the pananoramic pictures within the range of exclusion zone. An aerial/google picture is overlaid with 3D geometry of the BTS site (if available) and the computed results of exclusion zone to determine crossover with adjacent buildings.

SIGNAGE IMPLEMENTATIONS
EXCLUSION ZONE HEIGHT AND SIGNAGE IMPLEMENTATION

PAGE 8





Signage Requirements

Signage Type	Qty
AMARAN	2
BERHATI HATI	2
NOTIS	2

Findings and Comments

This simulation reports determining the RF exposure emanating from the site, at positions where the public normally resides and ensuring that this exposure is below the public ICNIRP guidelines, it is also important that adequate control measures be in place to ensure that no person enters into the exclusion zones. Such control measures could include RF hazard signage and/or physical access control at this site.

Signage Danger (BAHAYA) should be place at 1meter near to the Antenna. Whithin 7 Meter is where the Caution signage (BERHATI HATI) need to be place.

Radius of 12 Meter whithin the Antenna is Where the Warning (NOTIS) need to be place

FINDINGS: Apart from determining the RF exposure emanating from the site, at positions where the public normally resides and ensuring that this exposure is below the public ICNIRP guidelines, it is also important that adequate control measures be in place to ensure that no person enters into the exclusion zones. Such control measures could include RF hazard signage and/or physical access control at this site. None of the exclusion zones of antennas on this site is accessible by public. Hence signage of warning at exclusion zone is not required. General signage of Caution at the entry of BTS site and Danger on the lower structure are recommended.

Structure ID (RF Owner/CIMS) NEW

Site Name	HSMJ
Lat	4.18650903
Long	100.65922788
No. of	3

LOGO
SERVICE
PROVIDER

SITE LOCATIONS
(BIRD EYE VIEW)

PAGE 9

Note
BS Location

Note
Site Information

Structure ID (RF Owner/CIMS) **SERVICE PROVIDER** **NEW**

Site Name	XXXXXX
Lat	4.18650903
Long	100.65922788
No. of Antennas	3

Location Address

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX

Annex C
(informative)

EMF simulation report sample for oil and gas

The EMF simulation report sample for oil and gas are as follows.

EMF SIMULATION REPORT

LOGO
SERVICE
PROVIDER

TOWER ID	:	NEW
OPERATOR REF ID	:	XXXXXXXX LTE
SITE NAME	:	XXXXXXXXXXXXXXXXXXXXXXXX
SITE ADDRESS	:	XXXXXXXXXXXXXXXXXXXX
STRUCTURE CATEGORY	:	Rooftop

STRUCTURE TYPE :

SERVICES 1	SERVICES 2	SERVICES 3
Bipod Boom		
LTE		

SIMULATION DATE	:	XXXXXXXXXXXXXXXX
RF OWNER	:	XXXXXXXXXXXXXX
SIMULATIONS RESULT	:	COMPLIANCE
PREPARED BY	:	NAME / COMPANY NAME
SOFTWARE	:	SOFTWARE NAME AND TYPE

LOGO
SERVICE
PROVIDER

TABLE OF CONTENT

Introduction:

In this report maximum cumulative radio-frequency (RF) exposure calculations are presented for the above mentioned cellular base station site. Results are shown 2m above ground level and/or roof top level, unless specified otherwise, and expressed in terms of the ICNIRP guidelines. The actual RF exposure levels will generally be significantly less than the simulated values, due to automatic power control used by cellular base stations as well as reduction in exposure levels due to environmental factors such as the presence of buildings, trees and other objects. The simulated values are aimed towards the analytic worst case scenario for the peak traffic conditions.

Exposure Standards:

Results are expressed in terms of the ICNIRP'98 general public guidelines. These guidelines are reviewed on a regular basis by ICNIRP and specify the limits for continuous exposure of the general public to RF transmissions at frequencies used by cellular phone base stations.

Report Format:

The report in this document is as per MCMC standard "Commission Determination on the mandatory standard for Electromagnetic field emission from telecommunication infrastructure- Determination no. 1 of 2010".
Electromagnetic mapping of BTS site and nearby clutter is done, based on ray tracing computational method as per ITU-T Recommendation K.52 (2004), 'Guidance on complying with limits for human exposure to electromagnetic fields' and K.61 'Guidance to measurement and numerical prediction of Electromagnetic fields for compliance with human exposure limits for telecommunication installations' documents. This report is published in the form prescribed in MCMC Standard document.

Glossary of Terms Used

Exclusion Zone: Area around an antenna or antennas where the RF field values emanating from the antennas exceed the ICNIRP public guidelines (public exclusion zone) or the ICNIRP occupational guidelines (occupational exclusion zone). Red zone indicates no access without following appropriate shut-down, power-down or pass through procedures. Yellow zone indicates access only allowed for RF trained personnel. No access for general staff, maintenance personnel or the public, whereas white zone is free access to everybody.
Orthoslice: Colour representation in form of power density values calculated in a plane of interest, expressed as a percentage of ICNIRP general public reference level with logarithmic legend. The standard dimension/area of Orthoslice of 60mX60m is used in the report as per Malaysian Standard document.

Vendor Logo

Vendor Detail address and tel number

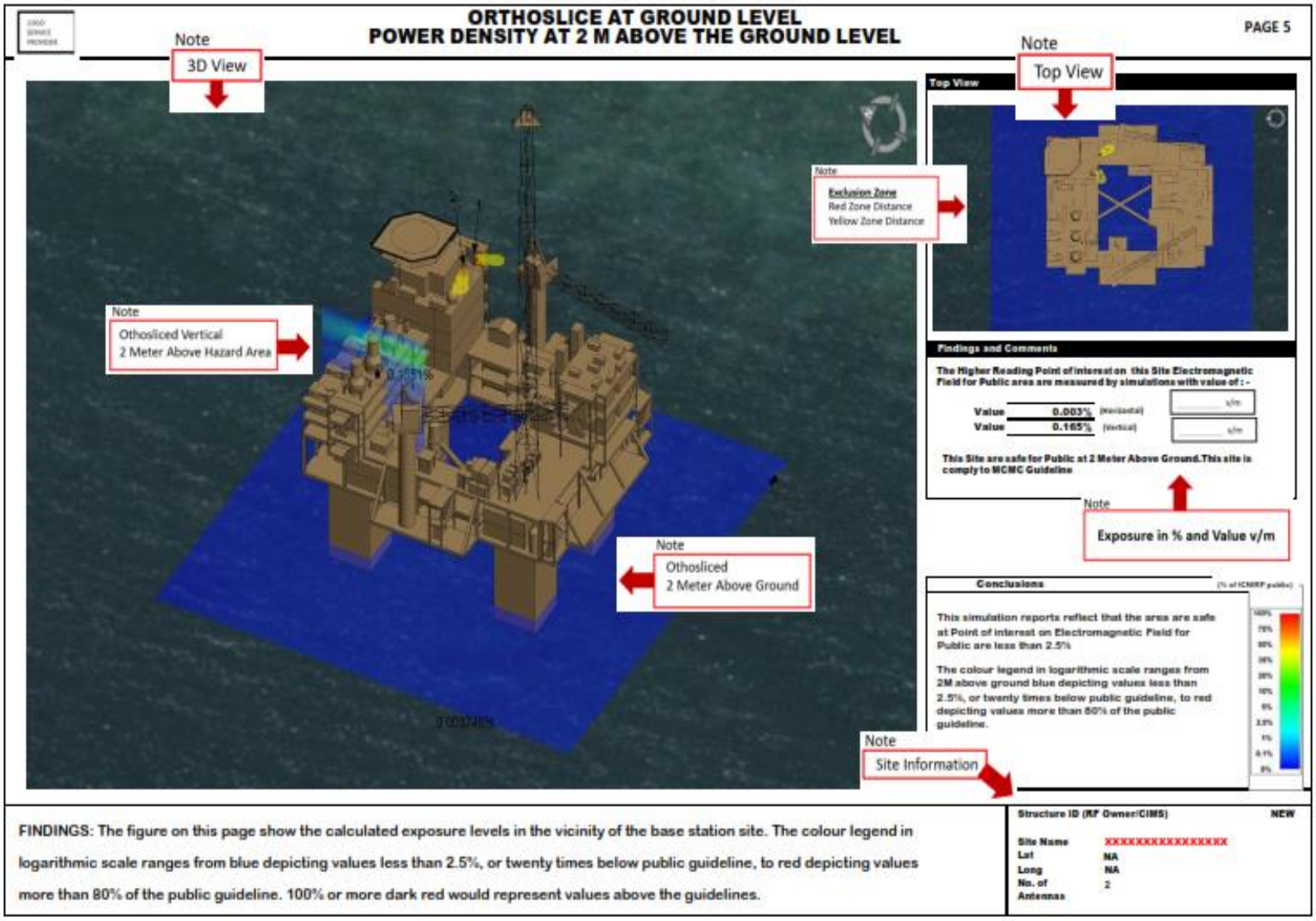
LOGO
SERVICE
PROVIDER

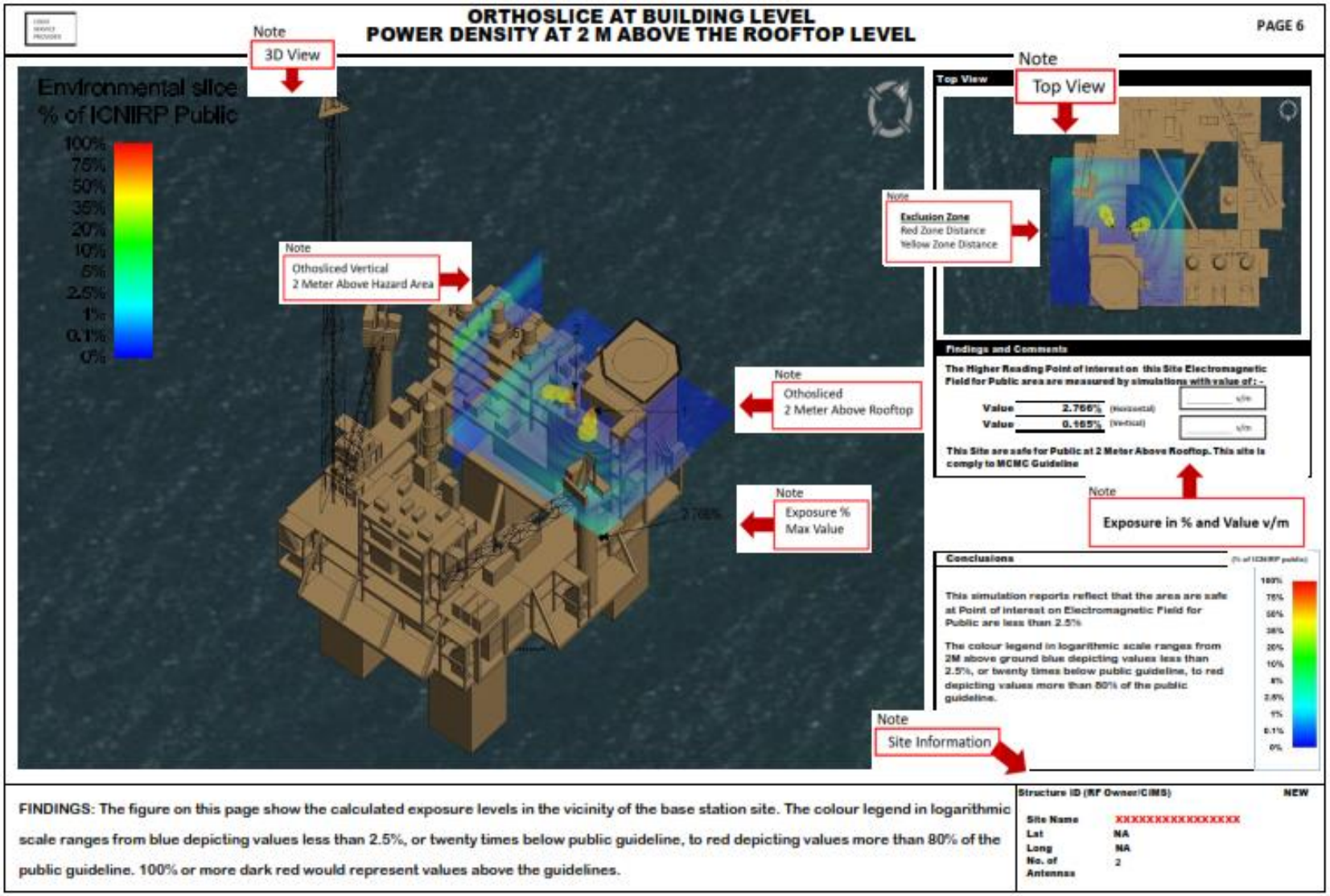
LOGO
SERVICE
PROVIDER

SITE DATA & TECHNICAL PARAMETERS

TOWER ID: NEW STRUCTURE CATEGORY: Rooftop PAGE 4

	ITEM	UNITS	OPERATOR	1	TM WEBE	OPERATOR	2	TM WEBE	OPERATOR	3	TM WEBE
SITE DATA	SITE ID					XXXXXXX					
	NAME					XXXXXXXXXXXXXXXXXX					
	DATE OF COMMISSIONING					TBD					
	SITE ADDRESS					XXXXXXXXXXXXXXXXXX					
	BUILDING HEIGHT AGL	(m)				60	60	60			
	TOWER HEIGHT (GBT) AGL	(m)				3	3	3			
	LAT					NA	NA	NA			
	LONG					NA	NA	NA			
	RTT/GBT					Bipod Boom	Bipod Boom	Bipod Boom			
	ANTENNA HEIGHT AGL	(m)				60	60	0			
TECHNICAL PARAMETERS	SYSTEM TYPE (2G/3G/LTE/850/LTE1800/LTE2600)					LTE 2360-2380	LTE 2360-2380	LTE 2360-2380			
	FREQUENCY OF OPERATION	(Mhz)				2360-2380	2360-2380	2360-2380			
	MAKE AND MODEL	Ant-1				Huawei AQU4518R24					
	OF ANTENNA	Ant-2				Huawei AQU4518R24					
		Ant-3				Huawei AQU4518R24					
	ANTENNA GAIN	(dBi)				16	16	16			
	ELECTRICAL TILT	(Deg)				0	0	0			
	MECHANICAL / TOTAL TILT	(Deg)				2	2	0			
	AZIMUTH	(Deg)	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 1	SECTOR 2	SECTOR 3
						150	250	0			
	TX POWER	(Watts)									

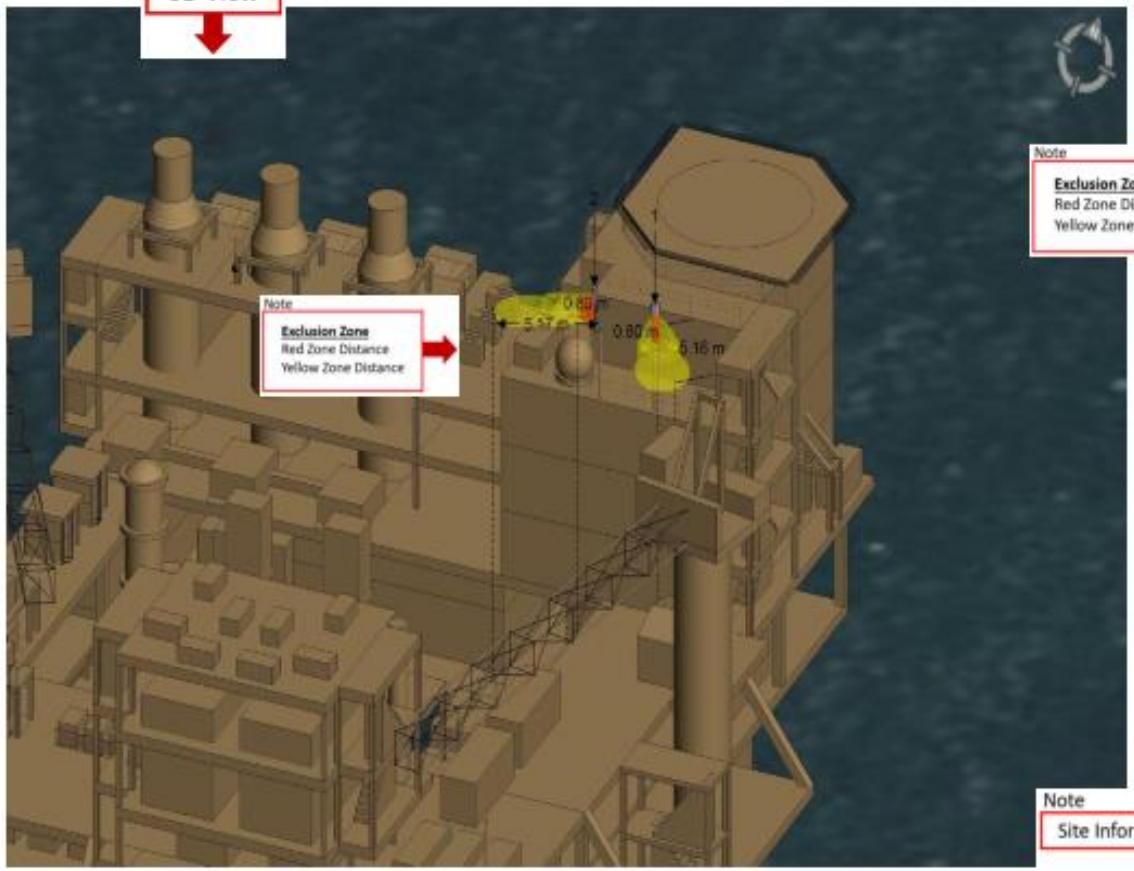

ORTHOSLICE AT GROUND LEVEL
POWER DENSITY AT 2 M ABOVE THE GROUND LEVEL
PAGE 5
Note
3D View
Note
Top View
Top View
Note
Exclusion Zone
Red Zone Distance
Yellow Zone Distance
Note
Othosliced Vertical
2 Meter Above Hazard Area
Findings and Comments
The Higher Reading Point of interest on this Site Electromagnetic Field for Public area are measured by simulations with value of : -
Value 0.003% (horizontal)
Value 0.165% (vertical)
This Site are safe for Public at 2 Meter Above Ground.This site is comply to MCMC Guideline
Note
Exposure in % and Value v/m
Note
Othosliced
2 Meter Above Ground
Conclusions
This simulation reports reflect that the area are safe at Point of interest on Electromagnetic Field for Public are less than 2.5%
The colour legend in logarithmic scale ranges from 2M above ground blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline.
Note
Site Information
FINDINGS: The figure on this page show the calculated exposure levels in the vicinity of the base station site. The colour legend in logarithmic scale ranges from blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline. 100% or more dark red would represent values above the guidelines.
Structure ID (MF Owner/CIMS)
NEW
Site Name XXXXXXXXXXXXXXXX
Lat NA
Long NA
No. of Antennas 2


ORTHOSLICE AT BUILDING LEVEL
POWER DENSITY AT 2 M ABOVE THE ROOFTOP LEVEL
PAGE 6
Note
3D View
Environmental slice
% of ICNIRP Public
100%
75%
50%
35%
20%
10%
5%
2.5%
1%
0.1%
0%
Note
Othosliced Vertical
2 Meter Above Hazard Area
Note
Othosliced
2 Meter Above Rooftop
Note
Exposure %
Max Value
Note
Top View
Top View
Note
Exclusion Zone
Red Zone Distance
Yellow Zone Distance
Findings and Comments
The Higher Reading Point of interest on this Site Electromagnetic Field for Public area are measured by simulations with value of : -
Value 2.766% (Horizontal)
Value 0.165% (Vertical)
This Site are safe for Public at 2 Meter Above Rooftop. This site is comply to MCMC Guideline
Note
Exposure in % and Value v/m
Conclusions
This simulation reports reflect that the area are safe at Point of interest on Electromagnetic Field for Public are less than 2.5%
The colour legend in logarithmic scale ranges from 2M above ground blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline.
Note
Site Information
FINDINGS: The figure on this page show the calculated exposure levels in the vicinity of the base station site. The colour legend in logarithmic scale ranges from blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline. 100% or more dark red would represent values above the guidelines.
Structure ID (RF Owner/CIMS)
NEW
Site Name XXXXXXXXXXXXXXX
Lat NA
Long NA
No. of Antennas 2

EXCLUSION ZONE CROSSOVER WITH ADJACENT BUILDING (TOP VIEW) TOP VIEW AND 3D VIEW

PAGE 7

Note
3D View



Note
Top View

Note
Exclusion Zone
Red Zone Distance
Yellow Zone Distance

Findings and Comments

This simulation reports reflect that the area exclusion zone 7m distance from the Antenna, No crossover with adjacent buildings at these area or Public access Area.

Comments and Recommendations

This site is comply to MCMC Guideline.

This simulation reports reflect that the area exclusion zone to determine Crossover. The distance of exclusion zone from the Antenna are within 7M and no crossover with adjacent buildings at these area or Public access Area.

The colour legend in Yellow are areas above public limits and Red is where the area that above occupational limits.

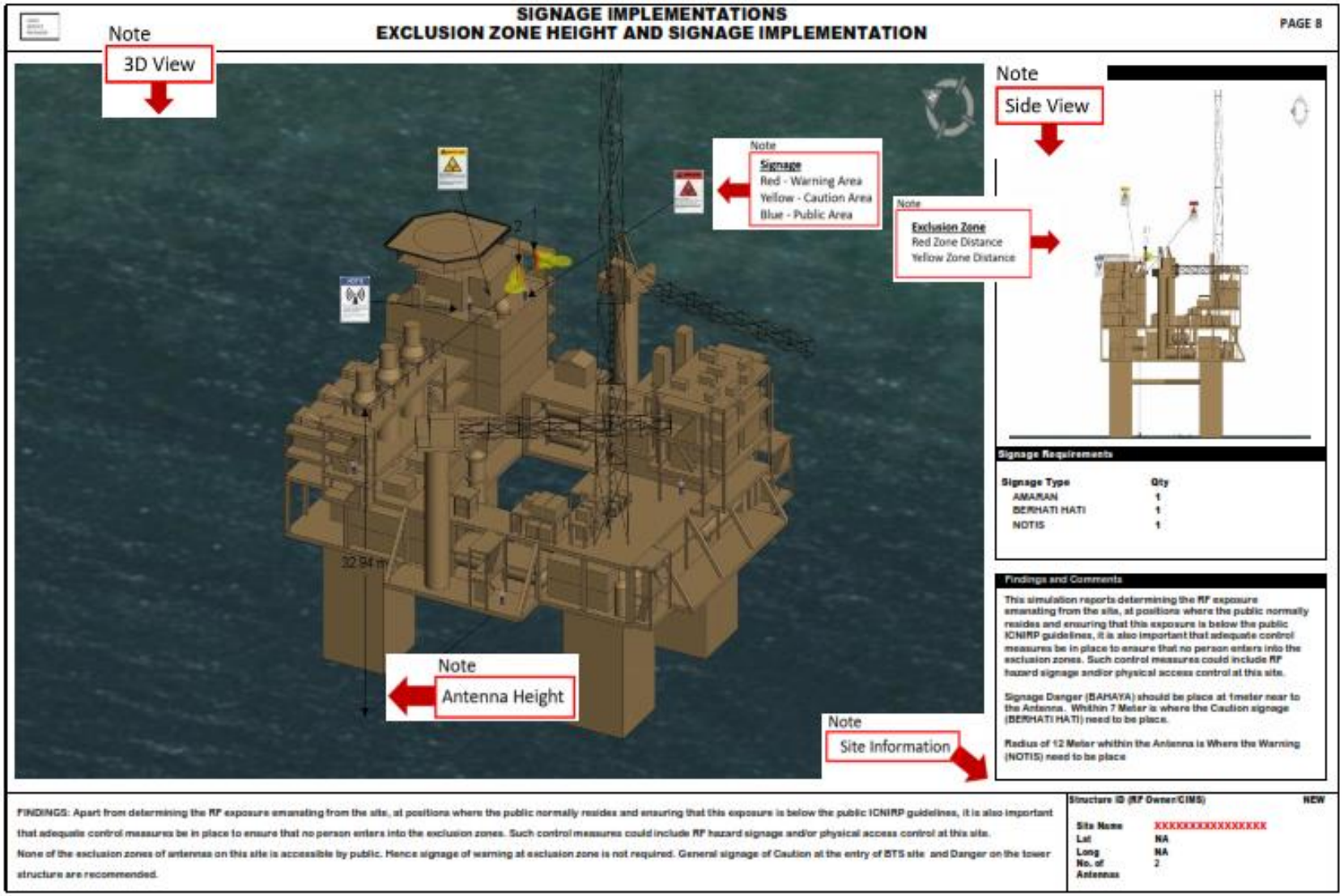
Note
Site Information

Areas above public limits

FINDINGS: It is clear from the results that the exclusion zones are very small in length and hence are very less likely to have a cross with adjacent buildings. The exclusion zone crossover with adjacent buildings is manually verified with panaromic pictures. There was no nearby building observed in the pananoramic pictures within the range of exclusion zone. An aerial/google picture is overlaid with 3D geometry of the BTS site (if available) and the computed results of exclusion zone to determine crossover with adjacent buildings.

Structure ID (RF Owner/CIMS) NEW

Site Name	XXXXXXXXXXXXXXXX
Lat	NA
Long	NA
No. of Antennas	2


SIGNAGE IMPLEMENTATIONS
EXCLUSION ZONE HEIGHT AND SIGNAGE IMPLEMENTATION
PAGE 8
Note
3D View
Note
Signage
Red - Warning Area
Yellow - Caution Area
Blue - Public Area
Note
Exclusion Zone
Red Zone Distance
Yellow Zone Distance
Note
Side View
Signage Requirements
Signage Type
Qty
AMARAN
1
BERHATI HATI
1
NOTIS
1
Findings and Comments
This simulation reports determining the RF exposure emanating from the site, at positions where the public normally resides and ensuring that this exposure is below the public ICNIRP guidelines, it is also important that adequate control measures be in place to ensure that no person enters into the exclusion zones. Such control measures could include RF hazard signage and/or physical access control at this site.
Signage Danger (BAHAYA) should be place at 1meter near to the Antenna. Whithin 7 Meter is where the Caution signage (BERHATI HATI) need to be place.
Radius of 12 Meter whithin the Antenna is Where the Warning (NOTIS) need to be place
32.94 m
Note
Antenna Height
Note
Site Information
FINDINGS: Apart from determining the RF exposure emanating from the site, at positions where the public normally resides and ensuring that this exposure is below the public ICNIRP guidelines, it is also important that adequate control measures be in place to ensure that no person enters into the exclusion zones. Such control measures could include RF hazard signage and/or physical access control at this site.
None of the exclusion zones of antennas on this site is accessible by public. Hence signage of warning at exclusion zone is not required. General signage of Caution at the entry of BTS site and Danger on the tower structure are recommended.
Structure ID (RF Owner/CIMS)
NEW
Site Name
XXXXXXXXXXXXXXX
Lat
NA
Long
NA
No. of Antennas
2

SITE LOCATIONS
(BIRD EYE VIEW)

PAGE 9

Structure ID (RF Owner/CIMS) **SERVICE PROVIDER** **NEW**

Site Name	XXXXXX
Lat	4.18650903
Long	100.65922788
No. of Antennas	3

Location Address

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXX

Annex D
(informative)

EMF summary report template

The EMF summary report template are as follows.

EMF Summary Report Template

BATCH NUMBER

SKMM
Suruhanjaya Komunikasi dan Multimedia Malaysia
Malaysian Communications and Multimedia Commission

Summary of EMF Report

REPORT ON MANDATORY STANDARD ON ELECTROMAGNETIC FIELD (EMF)

This report provides a summary of Calculated RF EMF Levels around the WiMax base station

SUMMARY REPORT (100 SITES)

RF OWNER

LOGO SERVICE PROVIDER

EMF Summary Report Template

Service Provider Name

ADDRESS

MALAYSIAN AUTHORITY

Malaysian Communications and Multimedia Commission
Standards Development Department
(Infrastructure Development & Standards Division)
Suruhanjaya Komunikasi dan Multimedia Malaysia
MCMC Tower 1, Jalan Impact, Cyber 6, 63000 Cyberjaya,
Selangor Darul Ehsan, Malaysia

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Table of Content

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Document Control

Document Approved
The document was reviewed and accepted by the people following:

VENDOR NAME

Name	Position	Date Submission	Signature

Document Storage
This document is provided by Hj Azlan Abass using SAP Crystal Reports applications .

Distributed Document List

Receiver Name	Designation	Company	Signature
	Head of Department	Malaysian Communications and Multimedia Commission	

List of Amendments Documents

Date	Version	Author	Comments

Purpose
REPORT ON MANDATORY STANDARD ON ELECTROMAGNETIC FIELD (EMF) EMISSIONS FROM RADIOCOMMUNICATIONS INFRASTRUCTURE
The purpose of this report is to provide calculations of EME levels from the existing facilities at the site and any proposed additional facilities.

EMF Summary Report Template

Introduction

The purpose of this summary report is to provide calculations of EMF levels from the existing facilities at the sites and any proposed additional facilities.

This report provides a summary of levels of radiofrequency (RF) electromagnetic energy (EME) around the base station These levels have been calculated using EMF Predictions Simulations Software

Levels - Prediction Methodologies"

RF EMF values are calculated at 2m above ground and 2m above rooftop at various distances from the base station, assuming level ground and rooftop. The estimate is based on worst-case scenario, including:

- base station transmitters for mobile and broadband data operating at maximum power
- simultaneous telephonic calls and data transmission
- an unobstructed line of sight view to the antennas.

In practice, exposures are usually lower because:

- the presence of buildings, trees and other features of the environment reduces signal strength
- the base station automatically adjusts transmit power to the minimum required. Maximum EME levels are estimated in 360° circular bands out to 500m from the base station.

These levels are cumulative and take into account emissions from all ..... base station antennas at this site. The EME levels are presented in Percentage:

- percentage (%) of the MCMC Standard public exposure limit (the public exposure limit = 100%).

Vendor Logo

Vendor Detail address and tel number

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Radio Systems at the Site - Summary Average of all sites Environmental EMF Report

This base station currently has equipment for transmitting the following services:

Carrier	Radio Systems	Radio Frequency	
PROVIDER NAME	XXXXXXX	2360 Mhz	2390 Mhz

EMF Simulations Status

Site Status		
Total Number of Site	100	Sites
Number of Site Comply	100	
Number of Site Need Further Assessment	0	
Number of Site Non Comply	0	

Calculated EMF Levels

This table provides calculations of RF EME at different distances from the base station for emissions from existing equipment alone and for emissions from existing equipment and proposed equipment combined.

The maximum EME level calculated in % for the existing systems at all sites as below table for the public exposure limit.

Distance from the antennas	Maximum Cumulative EME Level at 2m above ground and 2m above rooftop – Single carriers at this site										
0 meter to 60 meter	Existing Equipment Maximum Cumulative EMF Level					Average % Level	Existing and Proposed Equipment Maximum Cumulative EMF Level					Average % Level
Site Number	1-25	25-50	51-75	76-100			1-25	25-50	51-75	76-100		
2 Meter Above Ground	0.44%	0.08%	0.32%	0.83%		0.42%						
2 Meter Above Rooftop	6.54%	2.49%	2.65%	4.29%		3.99%						

Distance from the antennas	Maximum Cumulative EME Level at 2m above ground and 2m above rooftop – Multi carriers at this site (Site Sharing)										
0 meter to 60 meter	Existing Equipment Maximum Cumulative EMF Level					Average % Level	Existing and Proposed Equipment Maximum Cumulative EMF Level					Average % Level
Site Number	1-25	25-50	51-75	76-100			1-25	25-50	51-75	76-100		
2 Meter Above Ground												
2 Meter Above Rooftop												

EMF Summary Report Template

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Appendix I

Detail of EMF Report

EMF Summary Report Template

Site 1 - 25

Detail of Environmental EMF Report

Page 5

This report provides a summary of Calculated RF EMF Levels around the WiMax base station

	Site Informations							Antenna/Frequency		Orthoslice			MCMC AUTHORITY	
	Site Name	Norminal ID	Site Address	Property Type	Lat	long	No	WiMax	LTE	2M Abv Ground	2M Abv Roof	Category	Type	Results Status
1	Confidential			9 storey building	3.15851	101.71449	3	2300		0.007%	2.740%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
2				7 storey building	3.161306	101.697666	3	2300		0.003%	6.518%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
3				3.5 storey shoplot	3.15995	101.711	3	2300		0.002%	0.296%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
4				6 storey building	3.16057	101.719	3	2300		0.034%	1.847%	ROOFTOP	MINI MONOPOLE	COMPLIANCE
5				6 storey building	3.14896	101.70073	3	2300		0.002%	2.415%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
6				3.5 storey shoplot	3.140224	101.73144	3	2300		0.006%	0.077%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
7	Confidential			3 storey building	3.19699	101.76409	3	2300		0.001%	1.329%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
8				3 storey shoplot	3.185067	101.74196	3	2300		0.006%	2.032%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
9				Shoplot	3.205149	101.709417	3	2300		0.004%	2.554%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
10				3.5 storey shoplot	3.18789	101.70301	3	2300		0.004%	3.919%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
11				15 storey building	3.20148	101.73255	4	2300		0.000%	0.589%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
12				6 storey building	3.18935	101.7149	3	2300		0.000%	1.112%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
13				12 storey building	3.18235	101.67636	3	2300		0.000%	0.016%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
14	Confidential			3 storey building	3.18916	101.65263	3	2300		0.005%	1.854%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
15				3 storey shoplot	3.21641	101.65884	3	2300		0.025%	3.374%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
16				12 storey building	3.23026	101.70054	3	2300		0.000%	0.356%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
17				7 storey building	3.24035	101.64828	4	2300		0.000%	0.061%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
18				10 storey building	3.11802	101.65554	3	2300		0.000%	1.620%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
19				5 storey shoplot	3.083126	101.665645	3	2300		0.001%	1.612%	ROOFTOP	MINI MONOPOLE	COMPLIANCE
20	Confidential			4 storey building	3.0611	101.6729	3	2300		0.001%	0.078%	ROOFTOP	UNIPOLE	COMPLIANCE
21				Stadium	3.05453	101.69019	3	2300		0.018%	0.427%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
22				6 storey building	3.15844	101.57174	4	2300		0.008%	0.145%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
23				3 storey building	3.0868	101.647	3	2300		0.053%	0.388%	ROOFTOP	MINIMAST	COMPLIANCE
	Confidential			Building	3.10066	101.6026	3	2300		0.440%	0.672%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
25														

LOGO
SERVICE
PROVIDER

Appendix II

Detail of Antenna Configurations
(For CIMS Upload)

EMF Summary Report Template

Site 1 - 10

Detail of Antenna Configurations

TOWER ID	SITE ID	SITE ADDRESS	OPERATOR	BLD HEIGHT (M)	STRUCTURE HEIGHT (M)	X	Y	LOC OPS	NETWORK TYPE	FREQUENCY BAND	ATN REF ID	ATN MANUFACTURE	ANTENNA MODEL	ANTENNA HIGHT	ANTENNA AZIMUTH	ELECT TILT	MECH TILT	INPUT POWER	NO OF ATN	SIMULATION DATE	SIMULATION RESULT	SUBMISSION
		Confidential		27	4	1.10451	101.71689	Confidential		2300	ANT_1	Argus	LLPX310M	30	50	0	5	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				27	4	1.10451	101.71689			2300	ANT_2	Argus	LLPX310M	30	190	0	8	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				27	4	1.10451	101.71689			2300	ANT_3	Argus	LLPX310M	30	300	0	2	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				27	4	1.10451	101.71689			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.4	3	1.163326	101.697944			2300	ANT_1	Argus	LLPX310M	20	10	0	6	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.4	3	1.163326	101.697944			2300	ANT_2	Argus	LLPX310M	20	230	0	7	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.4	3	1.163326	101.697944			2300	ANT_3	Argus	LLPX310M	20	290	0	7	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.4	3	1.163326	101.697944			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				24	5	1.11995	101.711			2300	ANT_1	Argus	LLPX310M	17	50	0	4	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				24	5	1.11995	101.711			2300	ANT_2	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				24	5	1.11995	101.711			2300	ANT_3	Argus	LLPX310M	17	320	2	5	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				24	5	1.11995	101.711			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
		Confidential		16.3	5	1.16257	101.719	Confidential		2300	ANT_1	Argus	LLPX310M	23.3	70	0	1	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.3	5	1.16257	101.719			2300	ANT_2	Argus	LLPX310M	23.3	190	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.3	5	1.16257	101.719			2300	ANT_3	Argus	LLPX310M	23.3	300	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				16.3	5	1.16257	101.719			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				21	4	1.14896	101.75073			2300	ANT_1	Argus	LLPX310M	25	30	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				21	4	1.14896	101.75073			2300	ANT_2	Argus	LLPX310M	25	170	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				21	4	1.14896	101.75073			2300	ANT_3	Argus	LLPX310M	25	290	2	3	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				21	4	1.14896	101.75073			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				12	6	1.145224	101.75364			2300	ANT_1	Argus	LLPX310M	12.25	50	0	0	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				12	6	1.145224	101.75364			2300	ANT_2	Argus	LLPX310M	12.25	170	0	4	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015
				12	6	1.145224	101.75364			2300	ANT_3	Argus	LLPX310M	12.25	290	0	0	10×10	3	28TH JULY 2015	COMPLIANCE	10TH AUG 2015

Annex E
(informative)

EMF measurement report template

The EMF measurement report template are as follows.

REPORT REFERENCE /SERIAL NO

TITLE OF REPORT AND LOCATION

(RADIOFREQUENCY RADIATION SAFETY ASSESSMENT AT

LOCATION A

A report prepared for

CLIENT'S NAME (ORGANIZATION)

BY

NAME OF COMPANY THAT CONDUCTED THE TEST AND PREPARE THE REPORT (WITH FULL ADDRESS)

MONTH AND YEAR OF MEASUREMENT CONDUCTED AND REPORT PREPARED

NAME OF COMPANY THAT CONDUCTED THE MEASUREMENT

TITLE OF REPORT AND LOCATION

A report prepared by

NAME OF PERSONNEL THAT PREPARE THE REPORT

NAME AND FULL ADDRESS OF COMPANY

MARCH 2020

TABLE OF CONTENT

REPORT TITLE

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

REPORT ON

RADIOFREQUENCY RADIATION SAFETY ASSESSMENT AT

LOCATION A

1. INTRODUCTION

Introduction on the company that requests to perform the measurement, brief information on type of measurement, site location & date of the measurement.

2. OBJECTIVE

Description of the objective of the measurement

3. SCOPE OF THE MEASUREMENT

Brief description on the scope of measurement, measurement component and unit and the standards referred to when evaluating the data and the results

4. DESCRIPTION OF SURVEY SITE AND RADIATION SOURCE

Detail description on the measurement site and the RF source involved. This is including the transmitting frequency emitted by the antenna, owner of the site, service provider information and photo of the site (Figure 1)

5. SAFETY GUIDELINES AND EXPOSURE LIMITS

Description on the permissible exposure limit standard that we are referring to and the table of permissible exposure limit (PEL) for public or workers. As the PEL is depending to the transmitting frequency of the site, PEL of the site shall be calculated and mention in this section. For sharing site, PEL is selected by calculation using the lowest transmitted frequency by the service provider

Figure 1: Photo of an overview at the measurement site

6. STANDARD MEASUREMENT EQUIPMENT

Description on the RF equipment used for the measurement. Information on probe and frequency should be included with the date of the calibration. Photo of the equipment set up at the measurement site should be included as well (Figure 2)

Figure 2: Set-up of measurement equipment

7. METHOD OF MEASUREMENTS

Briefly explain the measurement method and standards referred to and the layout of the location of measurement captured with GPS Coordinate (longitude and latitude) to ensure the . Each measurement point and the location of the site and telecommunication structure should be plotted on the map

Figure 3: Layout of the measurement locations

8. RESULTS AND DISCUSSION

Discussion on the data of electric field, magnetic field (whichever related) and power density. The highest electromagnetic field at specific location should be stated and the data obtained from the measurement should be simplified in a table and compared to the related permissible exposure limits. Data should be plot in properly for Electric field strength (V/m) or Magnetic field (A/m) and power density (μW/cm^2) in order to show the variation of the strength of electromagnetic fields towards measurement points and comparison towards the permissible exposure limit (Figure 4 and Figure 5) by Malaysian Communication and Multimedia Commission (MCMC) and International Commission on Non-ionising Radiation Protection (ICNIRP).

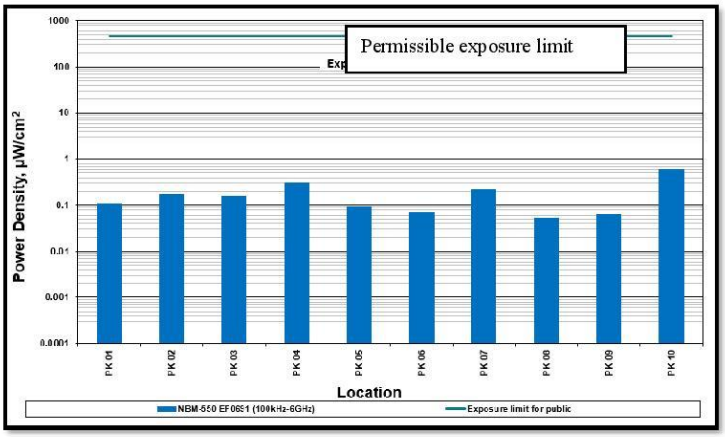


Figure 4 : A plot of radiation levels in microwatts per unit area (µW/cm^2) against location of measurement (and their comparison with MCMC exposure limit for public/workers).

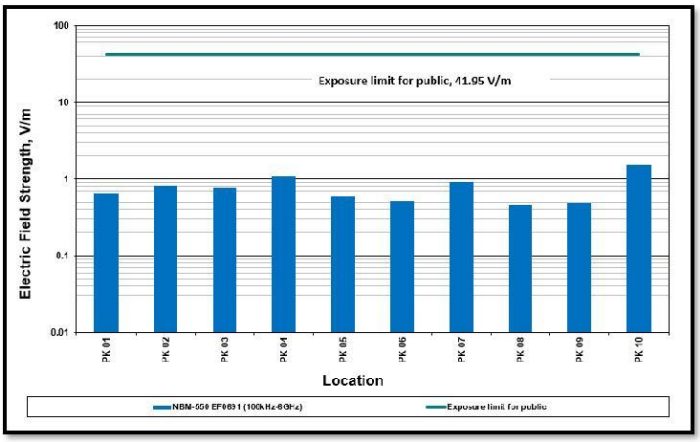


Figure 5: A plot of radiation levels in V/m against location of measurement (and their comparison with MCMC exposure limit for public/workers)

9. **CONCLUSIONS**

Statement of conformity and findings of the measurement.

10. REFERENCES

List of reference document

11. REPORT VERIFICATION

Name of Site:

Assessment Conducted by:

Report Prepared by:

Date of Assessment:

Report Approved by:

_____

(Approved signatory)

Bibliography

[1] MCMC SRSP 504, 21 June 2017; *Requirements for mobile cellular systems and International Mobile Telecommunications (IMT) systems operating in the frequency bands 824 MHz to 834 MHz paired with 869 MHz to 879 MHz and 880 MHz to 915 MHz paired with 925 MHz to 960 MHz*

[2] MCMC SRSP MS 2100, 3 May 2018; *Requirements for international mobile telecommunications systems operating in the frequency bands of 1 915 MHz to 1 980 MHz, 2 010 MHz to 2 025 MHz, and 2 110 MHz to 2 170 MHz*

[3] MCMC SRSP 508, 21 June 2017; *Requirements for mobile cellular systems and International Mobile Telecommunications (IMT) systems operating in the frequency band 1 710 MHz to 1 785 MHz paired with 1 805 MHz to 1 880 MHz*

[4] SKMM SRSP-523 IMT, 28 November 2012; *Requirements for International Mobile Telecommunications (IMT) systems operating in the frequency band 2 500 MHz to 2 690 MHz*

[5] MTSFB 004: 2005; *Technical standard on RF emission control of cellular radio sites*

[6] MS 739:1981: *Specification for Hot–Dip Galvanized Coatings on Iron Threaded Fasteners*

[7] MS 740:1981: *Specification for Hot– Dip Galvanized Coatings on Iron and Steel Articles*

[8] ITU-T K.91(11,2019); *Protection against interference, guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields*

[9] ITU-T K. Sup 9 (05/2019), *5G technology and human exposure to radiofrequency electromagnetic fields*

[10] ICNIRP Statement, Health Phys. 118(5):477–482; 2020; *Principles for non-ionizing radiation protection*

[11] IEEE Std. C95.1-2019/Cor 1-2019; *IEEE standard for safety levels with respect to human exposure to electric, magnetic, and electromagnetic fields, 0 Hz to 300 GHz*

[12] The electromagnetic spectrum of non-Ionizing radiation
https://www.cdc.gov/nceh/radiation/nonionizing_radiation.html

[13] Electromagnetic fields and public health
https://www.who.int/peh-emf/publications/facts/fs304/en/

Acknowledgements

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Ts Ir Jason Lee Lian Hong	Multimedia University
Ms Kong Mun Yeen	Orbitage Sdn Bhd
Mr Anwar Faizd Osman	Rohde & Schwarz Malaysia Sdn Bhd
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Ms Roha Tukimin	Malaysian Nuclear Agency
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Dr Bidi Ab Hamid	Ministry of Health Malaysia
Ts Dr Kesavan Ulaganathen	Politeknik Sandakan Sabah

ANNEX 2

MCMC MTSFB TC GXXX:XXXX
(MTSFB 088:2021)

TECHNICAL CODE

PREDICTION AND MEASUREMENTS OF RF EMF EXPOSURE FROM TERRESTRIAL RADIO AND TELEVISION BROADCASTING TRANSMITTER STATIONS

Developed by

Malaysian Technical Standards Forum Bhd

Registered by

MCMC

Registered date:

MCMC MTSFB TC GXXX:XXXX
(MTSFB 088:2021)

Development of technical codes

The Communications and Multimedia Act 1998 ('the Act') provides for 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 requirement 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 the Commission pursuant to section 95 of the Act registers it.

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 Centre of Excellence (CoE)
Off Persiaran Multimedia
Jalan Impact
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MALAYSIA

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Contents

Page

Committee representation

This Technical code was developed by Broadcast Technology Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB) consists of representatives from the following organisations:

Fraunhofer IIS

Maxis Broadband Sdn Bhd

Measat Broadcast Network System Sdn Bhd

Media Prima Berhad

MYTV Broadcasting Sdn Bhd

Panasonic AVC Networks Kuala Lumpur Malaysia Sdn Bhd

Sharp Electronics (M) Sdn Bhd

SIRIM Berhad

Sony EMCS Malaysia Sdn Bhd

Telekom Malaysia Bhd

Universiti Teknikal Malaysia Melaka

Universiti Teknologi Malaysia

Universiti Teknologi Mara

Wideminds Pte Ltd

MCMC MTSFB TC GXXX:XXXX
(MTSFB 088:2021)

Foreword

This technical code for Prediction and Measurements of RF EMF Exposure from Terrestrial Radio and Television Broadcasting Transmitter Stations ('this Technical Code') was developed pursuant to section 95 and section 185 of the Act 588 by the Malaysian Technical Standards Forum Bhd (MTSFB) via its Broadcast Technology Working Group.

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

MCMC MTSFB TC GXXX:XXXX
(MTSFB 088:2021)

PREDICTION AND MEASUREMENTS OF RF EMF EXPOSURE FROM TERRESTRIAL RADIO AND TELEVISION BROADCASTING TRANSMITTER STATIONS

1. Scope

This Technical Code provides prediction and measurement methods for the determination of Radio Frequency (RF) field strength and power density in the vicinity of terrestrial radio and television broadcasting transmitter stations for the purpose of evaluating Electromagnetic Field (EMF) exposure to humans.

2. Normative reference

The following normative reference is indispensable for the application of this document. For dated reference, only the edition cited applies. For undated reference, the latest edition of the normative reference (including any amendment) applies.

MCMC Determination No. 1 of 2010 December 2010, *Commission determination on the mandatory standard for electromagnetic field emission from radiocommunications infrastructure.*

MCMC Spectrum Plan Issued 2017

ITU-R-REC-BS.1698-0 (02/2005), *Evaluating Fields from Terrestrial Broadcasting Transmitting Systems For Assessing Exposure To Non-Ionizing Radiation*

ITU-T K.100 (07/2019), *Measurement of radio frequency electromagnetic fields to determine compliance with human exposure limits when a base station is put into service*

ITU-T K.70 (01/2018), Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations

ITU-T K.61 (01/2018), *Guidance on measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations*

ITU-T K.52 (01/2018), *Guidance on complying with limits for human exposure to electromagnetic fields*

IEC 62232:2019, Determination *of RF field strength, power density and Specific Energy Absorption Rate (SAR) in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure*

ICNIRP Guidelines, Health Phys. 118(5):483–524; 2020; *Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz)*

3. Abbreviations

For the purposes of this Technical Code, the following abbreviations apply.

AF	Antenna Factor
AM	Amplitude Modulation
CASP	Content Applications Services Provider
CIIP	Common Integrated Infrastructure Provider
CF	Calibration Factor
D	Dimension
DTT	Digital Terrestrial Television
E-field	Electric field
EIRP	Equivalent Isotropic Radiated Power
EMF	Electromagnetic Fields
ERP	Effective Radiated Power
FDTD	Finite-Difference Time-Domain
FF	Far-field
FM	Frequency Modulation
HF	High Frequency
H-field	Magnetic field
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electrotechnical Commission
ITU	International Telecommunication Union
MOM	Method of Moments
MR	Multiple-Region
MR-FDTD	Multiple-Region Finite-Difference Time
MW	Medium Wave
NEC	Numeric Electromagnetic Code
NF	Near-field
PEL	Permissible Exposure Limit
RF	Radio Frequency
SW	Short Wave
UHF	Ultra High Frequency
VHF	Very High Frequency
WHO	World Health Organisation

4. Terms and definitions

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

4.1 Antenna Factor (AF)

Ratio of the electromagnetic field strength incident upon an antenna to the voltage that is produced across a specified impedance (e.g., 50 Ω) terminating the line connection of the antenna.

4.2 Averaging time

Appropriate time over which exposure is averaged for purposes of determining compliance.

4.3 Compliance zone

In the compliance zone, potential exposure to EMF is below the applicable limits for both controlled/occupational exposure and uncontrolled/general public exposure.

4.4 Directivity

Ratio of the radiation intensity produced by an antenna in a given direction to the value of the radiation intensities averaged across all directions in space.

4.5 Effective Radiated Power (ERP)

Product of the power supplied to the antenna and the maximum antenna gain relative to a half-wave dipole.

4.6 Electric field (E-field) strength

Vector field quantity, E which exerts on any charged particle at rest a force, F equal to the product of E and the electric charge, Q of the particle.

4.7 Effective Isotropic Radiated Power (EIRP)

Product of the power supplied to the antenna and the maximum antenna gain relative to an isotropic antenna.

4.8 Exceedance zone

In the exceedance zone, potential exposure to EMF exceeds the applicable limits for both controlled/occupational exposure and uncontrolled/general public exposure.

4.9 Exclusion zone

Areas around an antenna or antennas where the RF field values emanating from the antennas exceed the International Commission on Non-Ionizing Radiation Protection (ICNIRP) public guidelines (public exclusion zone) or the ICNIRP occupational guidelines (occupational exclusion zone).

4.10 Exposure

Exposure occurs wherever a person is subjected to electric, magnetic or electromagnetic fields or to contact currents other than those originating from physiological processes in the body or other natural phenomena.

4.11 Exposure level

Value given in the appropriate quantity used when to express the degree of exposure of a person to electromagnetic fields or contact currents.

4.12 Exposure limits

Values of the basic restrictions or reference levels acknowledged, according to obligatory regulations, as the limits for the permissible maximum level of the human exposure to the electromagnetic fields.

4.13 Far-field (FF) region

Region of the field of an antenna where the radial field distribution is essentially dependent inversely on the distance from the antenna. In this region, the field has a predominantly plane-wave character, i.e., locally uniform distribution of electric field and magnetic field in planes transverse to the direction of propagation.

4.14 Magnetic field (H-field) strength

Vector quantity obtained at a given point by subtracting the magnetisation, M from the magnetic flux density, B divided by the magnetic constant, μ_0.

4.15 Near-field (NF) region

Region generally in proximity to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The Near-field (NF) region is further subdivided into the reactive NF region, which is closest to the radiating structure and that contains most or nearly all of the stored energy, and the radiating NF region where the radiation field predominates over the reactive field, but lacks substantial plane-wave character and is complex in structure.

4.16 Occupational zone

In the occupational zone, potential exposure to EMF is below the applicable limits for controlled/occupational exposure but exceeds the applicable limits for uncontrolled/general public exposure.

4.17 Shared sites

Multiple services or systems on the same or different radiocommunications infrastructure within a particular location.

4.18 Transmitter station

Fixed equipment including the radio frequency transmitter and associated antenna(s) as used in terrestrial radio and television broadcasting.

5. Exposure limits

All service providers have to individually and jointly comply with the EMF exposure limits, determined according to the ICNIRP Guidelines for general public and occupational workers. Basic restriction and reference level units are shown in Table 1.

Table 1. Quantities and corresponding SI units used

Quantity	Symbol	Unit
Incident power density	S_{inc}	Watt per square meter, W m^{-2}
Incident electric field strength	E_{inc}	Volt per meter, V m^{-1}
Induced magnetic field strength	H_{ind}	Ampere per meter, A m^{-1}
Incident magnetic field strength	H_{inc}	Ampere per meter, A m^{-1}
Specific energy absorption rate	*SAR*	Watt per kilogram, W kg^{-1}
Electric current	*I*	Ampere, A
Frequency	*f*	Hertz, Hz
Time	*t*	Second, s

For convenience, the limit of EMF exposure from a transmitter station for public and occupational workers shall not exceed the specified values as shown in Table 2. In the event of any inconsistency with the Mandatory Standard issued by MCMC, the limits specified by the Mandatory Standard shall prevail. The averaging and integrating time of the relevant exposure quantities are specified to determine whether personal exposure level is compliant with the guidelines. The averaging time is not necessarily the same as the measurement time needed to estimate field strengths or other exposure quantities.

Table 2. Reference levels for exposure from 100 kHz to 300 GHz (unperturbed root mean square (rms) values)

Exposure scenario	Frequency range	Incident E-field strength, E_{inc} (V m^{-1})	Incident H-field strength, H_{inc} (A m^{-1})	Incident power density, S_{inc} (W m^{-2})
Occupational workers	0.1 MHz - 30 MHz	$660/f_M^{0.7}$	$4.9/f_M$	N/A
	> 30 MHz - 400 MHz	61	0.16	10
	> 400 MHz – 2 000 MHz	$3f_M^{0.5}$	$0.008f_M^{0.5}$	$f_M/40$
	> 2 GHz - 300 GHz	N/A	N/A	50
Public	0.1 MHz - 30 MHz	$300/f_M^{0.7}$	$2.2/f_M$	N/A
	> 30 MHz - 400 MHz	27.7	0.073	2
	> 400 MHz - 2 000 MHz	$1.375f_M^{0.5}$	$0.0037f_M^{0.5}$	$f_M/200$
	> 2 GHz - 300 GHz	N/A	N/A	10

NOTES:

1. N/A signifies not applicable and does not need to be taken into account when determining compliance.
2. f_M is frequency in MHz.

Table 2. Reference levels for exposure from 100 kHz to 300 GHz (unperturbed root mean square (rms) values) *(continued)*

Exposure scenario	Frequency range	Incident E-field strength, E_{inc} (V m^{-1})	Incident H-field strength, H_{inc} (A m^{-1})	Incident power density, S_{inc} (W m^{-2})
3. S_{inc}, E_{inc}, and H_{inc} are to be averaged over 30 min, over the whole-body space. Temporal and spatial averaging of each of E_{inc} and H_{inc} must be conducted by averaging over the relevant square values. For frequencies of 100 kHz to 30 MHz, regardless of the Far-Field (FF)/NF zone distinctions, compliance is demonstrated if neither E_{inc} or H_{inc} exceeds the above reference level values. 4. For frequencies of > 30 MHz to 2 GHz: a. within the FF zone: compliance is demonstrated if either S_{inc}, E_{inc} or H_{inc}, does not exceed the above reference level values (only one is required); S_{eq} may be substituted for S_{inc}; b. within the radiative NF zone, compliance is demonstrated if either S_{inc}, or both E_{inc} and H_{inc}, does not exceed the above reference level values; and c. within the reactive NF zone: compliance is demonstrated if both E_{inc} and H_{inc} do not exceed the above reference level values; S_{inc} cannot be used to demonstrate compliance, and so basic restrictions must be assessed. 5. For frequencies of > 2 GHz to 300 GHz: a. within the FF zone: compliance is demonstrated if S_{inc} does not exceed the above reference level values; S_{eq} may be substituted for S_{inc}; b. within the radiative NF zone, compliance is demonstrated if S_{inc} does not exceed the above reference level values; and c. within the reactive NF zone, reference levels cannot be used to determine compliance, and so basic restrictions must be assessed.				

Exposure limits for EMF workers are higher than for the general public because workers are adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions. Anyone who is not at work would be regarded as a member of the public and the public exposure limits apply.

6. Shared site

Shared site is referred to as a multiple broadcast transmitter or terrestrial systems which are installed within the same tower or structure. For the purpose to determine the RF owner for a shared site, the following details methods shall be applied. Figure 1 shows an example of shared site for broadcast transmitter.

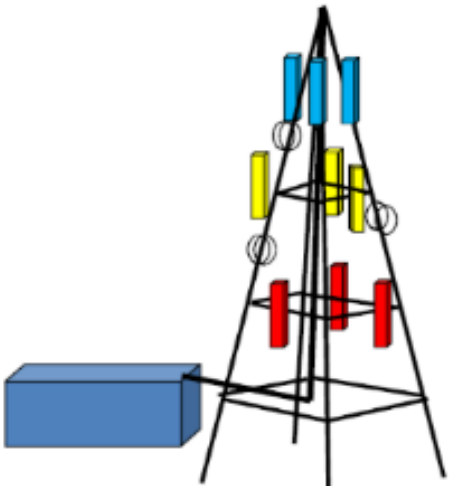


Figure 1. 4-legged tower

6.1 Determination of Radio Frequency (RF) owner at shared site

In view of the existence of multiple service providers at one site, there is a need to appoint a RF owner to ease EMF compliance related works such as to generate and submit the latest simulation report. Nevertheless, the compliance with EMF exposure limit is the responsibility of all sharing parties whereby any non-compliance should be resolved amicably.

6.2 Principles of determining RF owner for a shared site

The RF owner for each shared site should be decided by the relevant service providers that share the same tower. The list below stipulates the principles of determining a RF owner for a shared site depending on the ownership of the site:

6.2.1 Site owned by Content Applications Services Provider (CASP) or Common Integrated Infrastructure Provider (CIIP)

Site structure owner is designated as the RF owner. The role will be relinquished to the subsequent service operator that comes onboard. Ownership will also change to the service operator who performs an upgrade with additional antennas or transmitters. However, the site structure owner has the responsibility to inform all existing service operators that are currently operated at the site if any new tenant came in or change in transmitter or antenna. This is to allow the current RF owner to handover the responsibility to the new RF owner.

6.2.2 Site not owned by the CASP or CIIP

The first comer is designated as the RF owner. The role will be relinquished to the subsequent service operator that comes onboard. Ownership will also change to the service operator who performs an upgrade with additional antennas or transmitters. However, the site structure owner has the responsibility to inform all existing service operators that are currently operating at the site if any new tenant came in or change in transmitter or antenna. This is to allow the current RF owner to handover the responsibility to the new RF owner.

NOTE: While the principles highlighted above are more applicable to new sites that are on-air subsequent to the issuance date of this document, it is encouraged for relevant service providers to deliberate on the RF ownership amicably for existing sites that are on-air prior to this.

6.3 EMF measurement responsibility for a shared site

In the case of any EMF measurement works that do not involve with the current RF owner but for other RF licensees, the respective licensee will be responsible for the said works. For any EMF measurement works that involve the current RF owner and other RF licensee/licensees, the current RF owner will be the coordinator for the said works with the collaboration from the respective licensee/licensees.

7. Exclusion zones

The methods for determining the limit of EMF levels and exclusion zones shall be in accordance with the calculations as described in the ITU-T K.100, ITU-R BS.1698 and IEC 62232.

7.1 Theoretical calculation for single station

The theoretical calculation for determining the exclusion zone is derived from NF zone formula and FF zone formula.

7.1.1 NF zone

The NF zone formula is used to estimate the power density for distances less than the FF zone distance.

The formula is shown as below:

$$S_m = \frac{4PE}{A}$$

where,

S_m	the maximum power density, in watts per square metre, *W/m²*;
E	antenna efficiency (in number 0 to 1);
P	the power output of the system; and
A	the physical aperture area, in square metres, *m²*.

7.1.2 FF zone

The FF zone formula is used to estimate the incident power density for FF zone distance.

The formula is shown as below:

$$S_{inc} = \frac{PG_{\theta,\varphi}}{(4\pi d^2)}$$

where,

S_{inc}	the incident power density;
P	transmitted power;
$G_{\theta,\varphi}$	gain of the antenna in the direction (θ,$\boldsymbol{\varphi}$); and
d	distance from the antenna to the evaluation point.

The associated incident electric field strength, E_{inc}, and incident magnetic field strength, H_{inc}, can be evaluated as follows:

$$E_{inc} = \sqrt{\frac{30PG_{\theta,\varphi}}{d}}$$

$$H_{inc} = \frac{E}{\eta_0}$$

where, $\eta_0 \approx 377\ \Omega$.

If the power density is evaluated in the direction of maximum antenna gain:

$$S_{inc} = \frac{EIRP}{(4\pi d^2)}$$

where, Equivalent Isotropic Radiated Power (EIRP) is $PG_{\theta,\varphi}$.

The equation is re-arranged to calculate the minimum safe distance from the antenna, d_{min} or also known as exclusion zone distance as follows:

$$d_{min} = \sqrt{\frac{EIRP}{4\pi S_{inc}}} \qquad \approx \qquad d_{min} = \sqrt{\frac{1.64ERP}{4\pi S_{inc}}}$$

If the electric field strength is evaluated in the direction of maximum antenna gain, the equation for the minimum safe distance from the antenna, d_{min} or also known as exclusion zone distance as follows:

$$d_{min} = \frac{5.5\sqrt{\mathrm{EIRP}}}{\mathrm{E}} \qquad \approx \qquad d_{min} = \frac{5.5\sqrt{1.64\mathrm{ERP}}}{\mathrm{E}}$$

7.2 Exclusion zone distances for terrestrial radio and television broadcasting transmitters

Based on the method described in section 7.1.2, the exclusion zone distances at antenna main lobe for terrestrial radio and television transmitter stations are calculated as in Tables 3 and 4. The list of spectrum frequency bands in these tables are in accordance with the MCMC Spectrum Plan Issued 2017 which specify for frequency bands for terrestrial radio and television broadcasting service in Malaysia.

Table 3. Exclusion zone distances for terrestrial radio broadcasting transmissions

Band	Frequency (MHz)	Transmit power at antenna / Highest ERP (dBW)	ICNIRP limit for public	ICNIRP limit for occupational exposure	Exclusion zone distance for public (m)	Exclusion zone distance for workers (m)
Medium Wave (MW)	0.525 - 1.605	N/A*	470.99 V/m	1036.17 V/m	N/A*	N/A*
Short Wave (SW)	5.9 - 6.2	59	86.60 V/m	190.52 V/m	72.50	32.95
	7.2 - 7.45	59	75.33 V/m	165.73 V/m	83.34	37.88
	9.4 - 9.9	59	62.51 V/m	137.52 V/m	100.45	45.66
	11.6 - 12.1	59	53.95 V/m	118.69 V/m	116.38	52.90

Table 3. Exclusion zone distances for terrestrial radio broadcasting transmissions *(continued)*

Band	Frequency (MHz)	Transmit power at antenna / Highest ERP (dBW)	ICNIRP limit for public	ICNIRP limit for occupational exposure	Exclusion zone distance for public (m)	Exclusion zone distance for workers (m)
Short Wave (SW)	13.57 - 13.87	59	48.34 V/m	106.35 V/m	129.88	59.04
	15.1 - 15.8	59	44.86 V/m	98.69 V/m	139.97	63.62
	17.48 - 17.9	59	40.49 V/m	89.08 V/m	155.07	70.49
	18.9 - 19.02	59	38.34 V/m	84.34 V/m	163.78	74.45
	21.45 - 21.85	59	35.09 V/m	77.19 V/m	178.95	81.34
	25.67 - 26.1	59	30.94 V/m	68.07 V/m	178.95	92.24
Frequency Modulation (FM)	87.5 - 108	43.39	2 W/m^2	10 W/m^2	37.74	16.88
Very High Frequency (VHF)	174 - 230	N/A*	2 W/m^2	10 W/m^2	N/A*	N/A*

NOTES:

1. No MW and VHF radio or television broadcasting service available as of November 2020.
2. The highest ERP value stated in Table 3 has made reference to the common operation of radio broadcasting in Malaysia.
3. The calculation for exclusion zones of MW and SW band are based on lowest frequency band and ICNIRP limit level refers to electric field strength (V m-1). However, for FM and VHF bands, the calculation of exclusion zone is based on lowest frequency band and ICNIRP limit level refers to power density (W m-2).
4. The exclusion zone for other than the main lobe direction will be smaller than the value determined in Table 3.

Table 4. Exclusion zone distances for terrestrial television broadcasting transmissions

UHF channel	Frequency (MHz)	Transmit power at antenna / Highest ERP (dBW)	ICNIRP limit for public, S_{inc} (W m^{-2})	ICNIRP limit for occupational exposure, S_{inc} (W m^{-2})	Exclusion zone distance for public (m)	Exclusion zone distance for workers (m)
21	470 – 478	51	2.35	11.75	83.61	37.39
22	478 – 486	51	2.39	11.95	82.91	37.08
23	486 – 494	51	2.43	12.15	82.23	36.77
24	494 – 502	51	2.47	12.35	81.56	36.47
25	502 – 510	51	2.51	12.55	80.90	36.18
26	510 – 518	51	2.55	12.75	80.27	35.90
27	518 – 526	51	2.59	12.95	79.64	35.62
28	526 – 534	51	2.63	13.15	79.04	35.35

Table 4. Exclusion zone distances for terrestrial television broadcasting transmissions
(continued)

UHF channel	Frequency (MHz)	Transmit power at antenna / Highest ERP (dBW)	ICNIRP limit for public, S_{inc} (W m^{-2})	ICNIRP limit for occupational exposure, S_{inc} (W m^{-2})	Exclusion zone distance for public (m)	Exclusion zone distance for workers (m)
29	534 – 542	51	2.67	13.35	78.44	35.08
30	542 – 550	51	2,71	13.55	77.86	34.82
31	550 – 558	51	2.75	13.75	77.29	34.57
32	558 – 566	51	2.79	13.95	76.74	34.32
33	566 – 574	51	2.83	14.15	76.19	34.07
34	574 – 582	51	2.87	14.35	75.66	33.84
35	582 – 590	51	2.91	14.55	75.14	33.60
36	590 – 598	51	2.95	14.75	74.63	33.37
37	598 – 606	51	2.99	14.95	74.13	33.15
38	606 – 614	51	3.03	15.15	73.64	32.93
39	614 – 622	51	3.07	15.35	73.15	32.72
40	622 – 630	51	3.11	15.55	72.68	32.50
41	630 – 638	51	3.15	15.75	72.22	32.30
42	638 – 646	51	3.19	15.95	71.76	32.09
43	646 – 654	51	3.23	16.15	71.32	31.89
44	654 – 662	51	3.27	16.35	70.88	31.70
45	662 – 670	51	3.31	16.55	70.45	31.51
46	670 – 678	51	3.35	16.75	70.03	31.32
47	678 – 686	51	3.39	16.95	69.62	31.13
48	686 – 694	51	3.43	17.15	69.21	30.95

NOTES:

1. The highest ERP value stated in Table 4 has made reference to the common operation of Digital Terrestrial Television (DTT) broadcasting in Malaysia.

2. The calculation for the exclusion zone of the UHF band is based on lowest frequency band and ICNIRP limit level refers to power density (W m-2).

3. The exclusion zone for other than the main lobe direction will be smaller than the value determined in Table 4.

It shall be noted that the exclusion zone distances in Table 3 and 4 are only examples based on practical ERP and antenna data which are determined by common operation values used by local broadcaster.

The calculation for exclusion zone distances of other broadcasting frequency spectrum bands as specified in Annex A shall be based on actual transmitter station specifications. It shall also be based on the proper usage of the formulas and the ERP values.

However, in real condition, the guidelines in Figure 2 and examples of simple EMF exposure evaluation for various situations shown in ITU-T K.52 shall be referred.

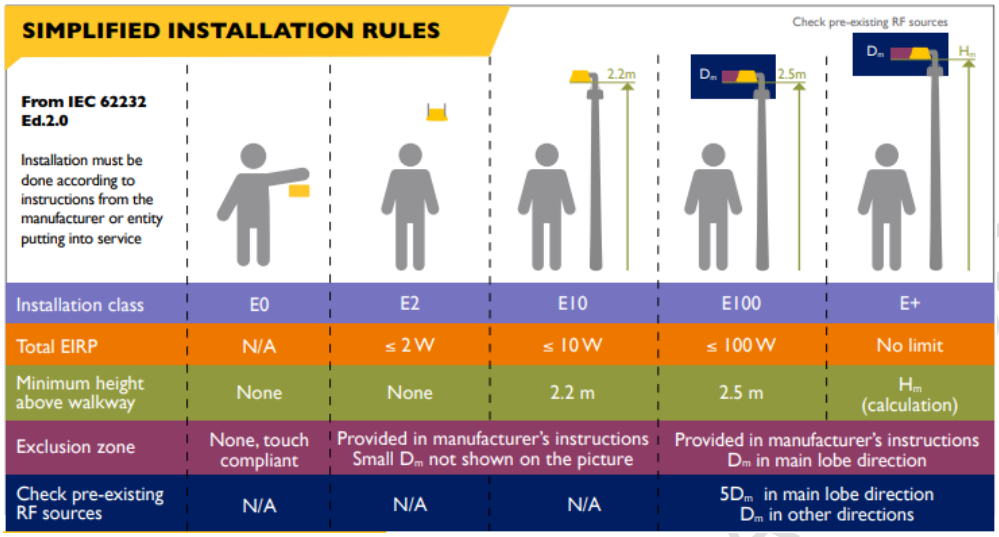


Figure 2. Simplified installation rules and total EIRP determination

8. Prediction methods for EMF compliance assessment

This section describes the calculation and computation methods to assess compliance with MCMC Determination No. 1 of 2010 for EMF exposure limit. The selection of numerical methods suitable for EMF exposure prediction in various situations are provided in ITU-T K.61 and IEC 62232.

Compliance procedure is divided into:

a) compliance by calculation for single transmitter station; and

b) compliance by advanced computation using a simulation software, for complex station (where there are 2 or more antennas/transmitters).

Compliance status shall be revoked for any configuration changes on the station and requirement for new compliance shall be asserted. Service provider shall submit a revised compliance report with updated configuration parameters.

8.1 Compliance by calculation

In the case of compliance for a single transmitter station (including directional or omni-directional for coverage in all directions), the basic calculation of EMF exposure as stipulated in Clause 7 in accordance with ITU-T K.52. The assessment of the EMF exposure is to be made at various publicly accessible points in the environment surrounding the station. The EMF exposure calculation report, which contains the data and technical parameters as shown in Table 5 shall be submitted.

Table 5. EMF exposure calculation information

Type	Descriptions
Station information	a) station ID; b) station address; c) Global Positioning System (GPS) coordinate; and d) date of commission.
Technical parameters	a) station location b) station height in meter c) tower height d) antenna height e) electrical tilt and mechanical tilt in degree; f) antenna gain in dB; g) antenna vertical bandwidth beam in degree; h) antenna side lobe attenuation in dB; i) antenna type, model and manufacturer; and j) transmitter power output in Watt.
Other technical parameters	Uncertainty estimation analysis, consist of: a) cable, connector and combiner loss in dB; b) scattering from nearby object and ground in dB; c) mismatch between antenna and its feed in dB; and d) antenna radiation pattern data.
Calculation tool`s information	a) version, model and manufacturer (if any); b) operator name and designation; and c) date and time of calculation report.

8.2 Compliance by advanced computation

Advanced computational electromagnetic mapping using a simulation software is required for complex sites where there are 2 or more transmitters or antennas. The simulation results are to be presented in the form of field strength or power densities that are calculated according to the plane of interest, and expressed in terms of numerical values and percentage of the exposure limit. Based on the simulated results, it is required for the EMF measurements to be performed if the power density values are found to exceed the stipulated exposure limit.

8.2.1 Advanced computation methods

For complex scattering environment, exclusion zones for multiple antennas in close proximity are drawn by software simulation based on methodologies as proposed in IEC 62232, ITU-T K.52 and ITU-T K.61.

There are several methods useful for determining compliance with exposure limits:

a) Finite-Difference Time-Domain (FDTD);

b) Multiple-Region Finite-Difference Time-Domain (MR/FDTD);

c) ray tracing model;

d) hybrid ray tracing/FDTD methods; and

e) NF antenna models such as Method of Moments (MOM) and the Numeric Electromagnetic Code (NEC).

The guidance in selecting appropriate computation methods to assess compliance with EMF levels is shown in Table 6 which shall depend on the following factors:

a) the field zone where the exposure evaluation is required;

b) the quantities being evaluated; and

c) the topology of the environment where the exposure occurs.

Table 6. Selection of numerical techniques

Field zone	Topology	Evaluated quantity	Suitable numerical technique
NF	Open	Field	FDTD, MOM
NF	Open	SAR	FDTD
NF	Closed, multiple scatterers	Field	FDTD, MOM
NF	Closed, multiple scatterers	SAR	FDTD, MR/MOM
FF	Open	Field	Ray tracing, MOM
FF	Multiple scatterers (complex urban environment)	Field	Ray tracing
NOTE: More detailed information on numerical techniques can be found in IEC 62232.			

8.2.2 Software estimation of uncertainty

Every method requires an uncertainty analysis report to be submitted together with the simulation report. The software estimation of uncertainty involves 4 tasks:

a) identification of all sources of uncertainty that may reasonably be expected to cause significant variation or uncertainty in the evaluation;

b) for each source of uncertainty, an estimation of the probability distribution type and parameter;

c) specification of how the sources of uncertainty are combined to provide a total uncertainty value (a mathematical model which defines how the influence quantities are combined or added); and

d) determine the best estimate of the evaluation and expanded uncertainty for a 95 % confidence interval.

8.2.3 Validation of EMF simulation report

The simulation software shall be validated with a reference example stated in IEC 62232 depending on the choice of computational method used. If the maximum deviation from the reference results is within ± 3 dB, the simulation package has passed the validation. The validation report of the software algorithm for each version and model shall be registered to MCMC. The latest simulation software validation registration is required for the updated version or/and model.

Simulation software operator shall be trained and a training certificate shall be provided for verification purpose. Software operator name and designation shall be available in the simulation report. A simulation software (EMF estimator) as described in ITU-T K.70 should be used.

8.2.4 Exclusion zone indicators

The simulation report shall provide clear information on zoning as defined in ITU K.52 that classifies potential exposure to EMF as belonging to one of the three following zones; compliance zone, occupational zone and exceedance zone.

In the examples shown in Figure 3, the red zone indicates the exceedance zone, where no person is allowed into this area without following the appropriate shut-down, power-down or safe pass-through procedures. The yellow zone indicates the occupational zone, where only the RF trained personnel are allowed, on the condition that they follow the relevant site access procedures. The area outside the yellow zone (white zone) is open for public access.

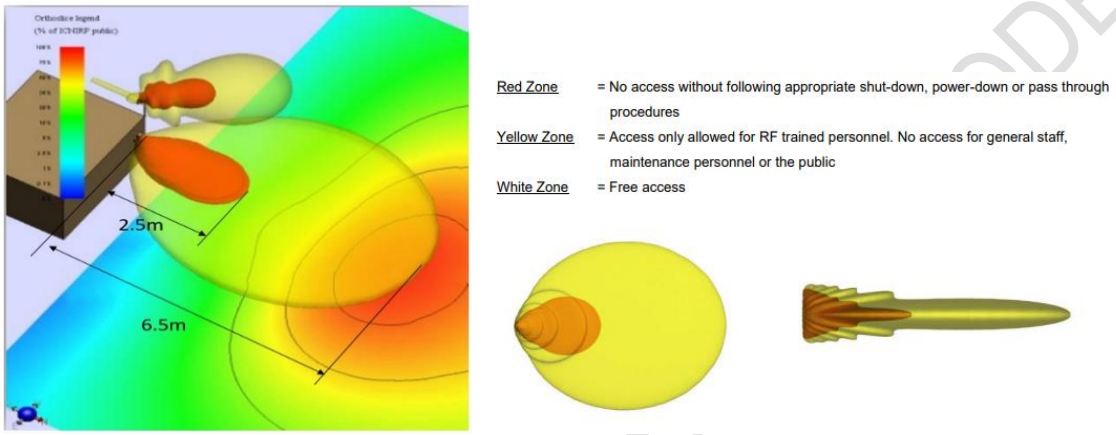


Figure 3. An example of simulated exclusion zone

The examples of simulation models illustrating the exclusion zones for various antenna structures are shown in Figure 4.

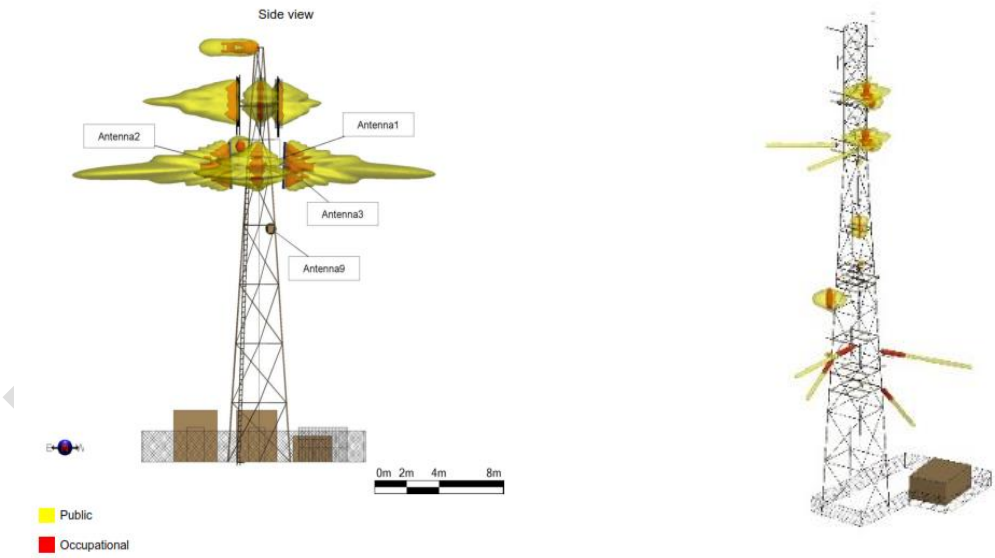


Figure 4. Examples of computed exclusion zone

8.2.5 EMF simulation report

The simulation report which contains the following data and technical parameters for technical and public viewers as elaborated and explained in Annex B shall be submitted:

a) broadcast transmitter information;

b) technical parameters;

c) cut-plane figures;

d) simulation software information; and

e) blueprint to scale.

The computations and assessments of the exposure level shall consider the following condition:

a) the maximum emission conditions (e.g., maximum EIRP, gain and beamwidth of the antenna system;

b) the simultaneous presence of several EMF sources, even at different frequencies; and

c) various characteristics of the installation, such as the antenna location, antenna height, beam direction, beam tilt.

Templates of the simulation report are shown in Annex C and D. If there are more than 30 sites of simulation reports, the summary report shall be prepared as in Annex E.

9. On-site measurement

On-site measurement can be performed to analyse and confirm the actual EMF exposure at site and its surrounding areas. The measurement shall comply with the Permissible Exposure Limit (PEL) as stated in the relevant Mandatory Standard issued by MCMC. This clause specifies the techniques and instrumentation for the on-site EMF measurement.

9.1 In-situ EMF measurement

In-situ measurement is a measurement of the RF exposure level in the vicinity of the station. Measurement or evaluation shall be made in the areas, which are known to be accessible by public and workers, and shall be performed at one location or area, known as the measurement area. The in-situ measurement method shall be in accordance to the IEC 62332.

9.1.1 NF measurement

NF measurement is conducted to determine the EMF exposure level for workers. For NF measurement, both E-field and H-field intensities shall be measured and compared to the PEL as specified in the ITU-T K.61.

9.1.2 FF measurement

FF measurement is conducted to determine the EMF exposure for the public. For FF measurement, only electric field strength (E-field) or power density shall be measured and compared to the permissible exposure limit to humans, and shall be in accordance with the ITU-T K.61.

FF region can be determined by the following formula:

If the dimension D, of the antenna is much longer as compared to the wavelength, it can be determined by the following formula:

$$FF = \frac{2D^2}{\lambda}$$

where,

FF	the distance which indicates the beginning of the FF region;
D	the biggest dimension of the antenna in metre, m; and
λ	wavelength of the transmitted radiation in metre, m.

a) However, for the onset of the FF zone, the maximum phase difference of the electromagnetic waves coming from different points on the antenna is 22.5º. For estimating the field strength (worst case scenario), a realistic practical distance from a large antenna (parabolic) at the FF zone begins at:

$$FF = \frac{0.5D^2}{\lambda}$$

b) For small antenna size (e.g., rod/dipole), the FF can be determined using the following formula.

$$FF = \frac{\lambda}{2\pi}$$

The NF and FF region are illustrated in Figure 5.

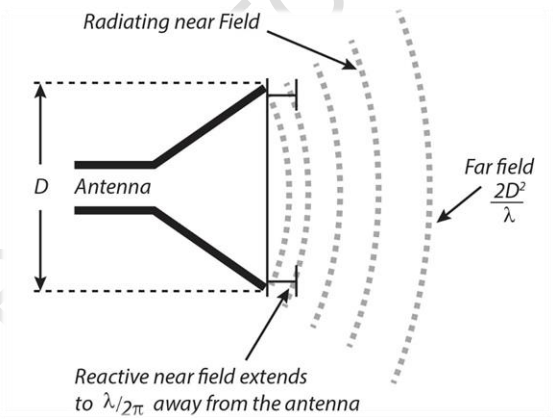


Figure 5. NF and FF region

9.1.3 Measurement instrumentations

Measurement shall be performed using the most appropriate measuring equipment to obtain the information of transmit electromagnetic fields emitted on-site. According to the ITU-T K.61, there are several considerations in selecting the measurement devices as follows:

a) frequency range

There are two frequency ranges, which are the broadband and narrowband frequency range. Broadband devices will measure the overall frequency available around the site. This measurement will not indicate the individual frequency spectrum, but this is very appropriate for measurement at the public area, to show the overall EMF emission as indication of the public exposure. Measurement devices are generally antennas with a big frequency range. Narrowband measurement devices are generally

antennas with flat antenna factors over limited spectrum ranges and can be used for selective frequency measurement.

b) antenna directivity

The antenna response may be isotropic or directional. For the isotropic devices, the response is expected to be dependent on the direction of the incident EMF. Directional devices are generally polarised and have an axial symmetry in the radiation pattern.

c) quantity measured

The majority of the devices measure either the electric field or the magnetic field. In the FF region, measurement devices for the electric field component are preferred. The equivalent power density within the FF region is obtained from the measured field by calculation shown in Table 1 of the ITU-T K.61, which is based on the following equation.

$$Power\ density, S = \frac{E^2}{Z_0} = Z_0 \cdot H^2$$

where,

E	Electric field
Z_0	Intrinsic impedance
H	Magnetic field

d) device selection

The selection for EMF measurement devices is determined by some factors, for instance:

i) The equipment and device shall comply the following recommendation:

1) The device shall measure electric field (V/m), magnetic field (A/m) and power density (µWatts/cm^2) and comply to the existing standard by ICNIRP; and

2) The equipment should be suitable for the frequency range; i.e., narrowband or broadband measurement to comply with the characteristics of the EMF source.

ii) For NF measurement, the EMF personal monitor is required.

iii) The number and the characteristics of EMF sources (which meet the measurement objective).

iv) Equipment or device shall be calibrated and has a valid calibration certificate.

v) The field region (i.e., reactive NF, radiating NF or FF) in which the measurement is made.

The accuracy of measurement results depends on the measurement procedures as well on the characteristics of the measurement instrument used. An expanded measurement uncertainty with a 95 % confidence interval less than or equal to 4 dB is deemed sufficient to show compliance.

9.1.4 Calibration requirements

Calibration is very important to ensure the reliability of the equipment used. The objective of the calibration is to minimise any measurement uncertainty by ensuring the accuracy of the test equipment by quantifying and controlling errors within measurement processes to an acceptable level. The calibration requirements shall comply with the ITU-T K.61 and IEC 62232.

a) Calibration Factor (CF)

For the broadband probes, the CF is defined by the following formula:

$$CF = \frac{E_{ref}}{E_{meas}}$$

It is the ratio between the expected electric field reference field strength, E_{ref} and the measured value, E_{meas} displayed on the dedicated receiver unit. This factor is mainly a function of frequency and in the presence of non-linearity error or field strength. The CF is determined as a frequency function. For each frequency, the CF value shall be known with uncertainty less than 1 dB. Errors due to frequency interpolation are included in the tolerable uncertainty on CF.

b) Antenna Factor (AF)

The AF is defined for antennas and frequency selective probe as the ratio of the following formula:

$$AF = \frac{E_{ref}}{V}\,[m^{-1}]$$

where,

E_{ref} the E-field strength on the probe; and
V the voltage measured on the spectrum analyser.

This factor is primarily a function of frequency but, in presence of non-linearity errors, it may depend on field strength too. The AF is determined as a frequency function. For each frequency, the AF value shall be known with an expanded uncertainty (i.e., 95 % statistical confidence) of less than 2 dB. The maximum tolerable uncertainty includes the error due to the frequency interpolation.

c) isotropy

An isotropic probe is needed for compliance measurement of EMF emission. The isotropic response is usually achieved by a three-axial antenna system, where the three axes are arranged to be orthogonal. The deviation from an ideal isotropic response is called isotropic error and in general it is a function of the incident wave direction. It can be evaluated by measuring the difference from a cosine response of each axis if they are spatially identified and a signal from each axis is available or by checking the whole probe response (if it is not possible to clearly define the position of each axis or a single axis signal is not available). The mean deviation from the isotropic response should be less than 1 dB.

d) linearity

A linear response versus the field amplitude is required; a linearity error would mean that the antenna and the calibration factors are functions of the test field strength. Thus, the linearity test should be the starting point of the whole characterisation process of the probe.

9.1.5 Probe selection

General consideration in probe selection is the frequency range. It can be a broadband probe or a narrowband probe. This depends on the EMF sources intended to be measured (single source and multiple EMF sources). Broadband measurement will provide one set of field strength measurement for all frequency range and sources at the measurement area while narrowband measurement requires separate sets of field strength values of each source and frequencies at the measurement area. The choice of the measurement type depends on the objective of the in-situ evaluation as stated in the IEC 62232.

The dimension of the probe sensor should be less than a wavelength at the highest operating frequency. According to ITU-T K.61, a non-directional probe is preferred in conducting EMF measurement.

9.1.6 Measurement method

The details of the measurement method which comply in accordance with IEC 62232, ITU-T K.61 and ITU-T K.100 are as follows:

a) measurements shall be conducted by qualified personnel with specific training on EMF instrumentations and techniques;

b) visual inspection shall be conducted before the measurement starts;

c) physical condition of the EMF source at the site must be recorded (number of antenna, height of the structure, type of the antenna) and a photo of the site must be taken for record on the day of the measurement;

d) the parameters that shall be considered during the assessment are as follows:

   i) frequency range;

   ii) type of antenna;

   iii) transmitting power;

   iv) dimension of the antenna; and

   v) distance.

e) identification of RF source and measurement points;

f) the locations of measurement selected shall be based on the worst-case situation (nearest accessible location facing the antenna beam) and popular public places (residential area, playground, bus stops).

   Distance from the EMF source to the measurement point must be recorded as reference. The NF or FF region shall be determined before selecting the measurement point. EMF measurement shall be conducted at various location points and should be mapped with the exact location (with longitude and latitude coordinate). This process is called EMF mapping and through this, we can see the EMF exposure level variations over the distance and at the selected measurement points. The layout plan must be sketched for any measurement conducted in the building;

g) EMF measurement instruments shall match with the EMF sources frequency range and suit the FF or NF region in which appropriate equipment and probes shall be selected based on the intended frequency range;

h) the measurement shall be carried out at 1.5 m to 2 m from the ground/floor which the measurement probe should be mounted on a wooden tripod;

i) inspection or measurement point shall be selected at least 3 probe lengths or 0.2 m away from any conducting or reflecting objects;

j) for each point, measurement shall be taken for 6 min by using broadband and selective spectrum analyser with appropriate probe (according to the frequency used by each telco service); and

k) results shall be recorded in power density (µWatts/cm^2) to represent the PEL.

Measurement for the shared site shall consider the number of RF sources available at the site. Information on the individual frequency of the RF source used by each service provider shall be obtained before the measurement. The broadband measurement is required to determine the total

electromagnetic field around the site. Individual frequency measurement using the selective spectrum analyser can be conducted if needed. The PEL calculation for the shared sites shall be determined by using the lowest frequency used by the shared service provider as a consideration of the worst-case scenario.

9.1.7 Measurement report

A template of the measurement report is as per Annex D. A measurement report shall consist of the following information:

a) introduction;

b) objective;

c) scope of the measurement;

d) description of survey site and radiation source;

e) safety guideline and exposure limit;

f) standard measurement equipment;

g) method of measurement;

h) results and discussion;

i) conclusion;

j) attachment; and

k) report verification.

Annex A
(informative)

Frequency spectrum allocation for broadcasting services

The list of frequency spectrum allocation for broadcasting services as specified in ITU Region 3 and MCMC Spectrum Plan 2017 are tabulated in Table A.1

Table A.1. Frequency spectrum allocation for broadcasting services

ITU Region 3 frequency band (MHz)	Allocation service	Malaysia footnotes
0.5265 – 0.535	Broadcasting Mobile	MLA3 MLA11 MLA93
0.535 – 1.606.5	Broadcasting	MLA3 MLA11 MLA93
2.30 – 2.495	Fixed Mobile Broadcasting	MLA13
3.20– 3.23	Fixed Mobile (except aeronautical mobile) Broadcasting	MLA3 MLA13 MLA93
3.23 – 3.40	Fixed Mobile (except aeronautical mobile) Broadcasting	MLA3 MLA13 MLA93
3.90 – 3.95	Aeronautical mobile Broadcasting	MLA3 MLA13 MLA83 MLA93
3.95 – 4.00	Broadcasting	MLA3 MLA13 MLA83 MLA93
4.75 – 4.85	Fixed Broadcasting Land mobile	MLA3 MLA13 MLA93
4.85 – 4.995	Fixed Broadcasting Land mobile	MLA3 MLA13 MLA93
5.005 – 5.06	Fixed Broadcasting	MLA3 MLA13 MLA93
5.90 – 5.95	Broadcasting	MLA13 MLA93
5.95 – 6.20	Broadcasting	MLA3 MLA93
7.20 – 7.30	Broadcasting	MLA3 MLA93
7.30 – 7.40	Broadcasting	MLA3 MLA93
7.40 – 7.45	Broadcasting	MLA3 MLA93
9.40 – 9.50	Broadcasting	MLA3 MLA93
9.50 – 9.90	Broadcasting	MLA3 MLA93
11.60 – 11.65	Broadcasting	MLA3 MLA93
11.65 – 12.05	Broadcasting	MLA3 MLA93

Table A.1. Frequency spectrum allocation for broadcasting services *(continued)*

ITU Region 3 frequency band (MHz)	Allocation service	Malaysia footnotes
12.05 – 12.10	Broadcasting	MLA3 MLA93
13.57 – 13.60	Broadcasting	MLA3 MLA93
13.60 – 13.80	Broadcasting	MLA3 MLA93
13.80 – 13.87	Broadcasting	MLA3 MLA93
15.10 – 15.60	Broadcasting	MLA3 MLA93
15.60 – 15.80	Broadcasting	MLA3 MLA93
17.48 – 17.55	Broadcasting	MLA3 MLA93
17.55 – 17.90	Broadcasting	MLA3 MLA93
18.90 – 19.02	Broadcasting	MLA3 MLA93
21.45 – 21.85	Broadcasting	MLA3 MLA93
2.567 – 2.61	Broadcasting	MLA3 MLA93
47 – 50	Fixed Mobile Broadcasting	MLA3 MLA14 MLA90 MLA94 MLA102
54 – 68	Fixed Mobile Broadcasting	MLA3 MLA102
87 – 100	Fixed Mobile Broadcasting	MLA3 MLA94 MLA102
100 – 108	Broadcasting	MLA3 MLA94 MLA102
174 – 223	Fixed Mobile Broadcasting	MLA3 MLA29 MLA31 MLA86 MLA94 MLA95 MLA102
223 – 230	Fixed Mobile Broadcasting Aeronautical radionavigation Radiolocation	MLA29 MLA31 MLA32 MLA86 MLA87 MLA94 MLA95 MLA102
470 – 585	Fixed Mobile Broadcasting	MLA3 MLA29 MLA 85 MLA86 MLA93 MLA94 MLA95 MLA102
585 – 610	Fixed Mobile Broadcasting Radionavigation	MLA3 MLA29 MLA86 MLA94 MLA95 MLA102
610 – 698	Fixed Mobile Broadcasting	MLA3 MLA29 MLA86 MLA94 MLA95 MLA102
698 – 790	Fixed Mobile Broadcasting	MLA3 MLA29 MLA86 MLA94 MLA95 MLA102

Table A.1. Frequency spectrum allocation for broadcasting services *(continued)*

ITU Region 3 frequency band (MHz)	Allocation service	Malaysia footnotes
1,452 – 1,492	Fixed Mobile Broadcasting Broadcasting-satellite	MLA48 MLA106
2,520 – 2,535	Fixed Fixed-satellite Mobile (except aeronautical mobile) Broadcasting-satellite	MLA3 MLA89 MLA102
2,535 – 2,655	Fixed Mobile (except aeronautical mobile) Broadcasting-satellite	MLA3 MLA89 MLA102
2,655 – 2,670	Fixed Fixed-satellite Mobile (except aeronautical mobile) Broadcasting-satellite Earth exploration-satellite (passive) Radio astronomy Space research (passive)	MLA3 MLA89 MLA102
11,700 – 12,200	Fixed Mobile (except aeronautical mobile) Broadcasting Broadcasting-satellite	MLA96 MLA97
12,200 – 12,500	Fixed Fixed-satellite Mobile (except aeronautical mobile) Broadcasting	MLA58 MLA96 MLA97
12,500 – 12,750	Fixed Fixed-satellite Mobile (except aeronautical mobile) Broadcasting-satellite	MLA3 MLA58 MLA96 MLA97
21,400 – 22,000	Fixed Mobile Broadcasting-satellite	MLA3 MLA74 MLA102
40,500 – 41,000	Fixed Fixed-satellite Broadcasting Broadcasting-satellite Mobile	
41,000 – 42,500	Fixed Fixed-satellite Broadcasting Broadcasting-satellite Mobile	

Table A.1. Frequency spectrum allocation for broadcasting services *(concluded)*

ITU Region 3 frequency band (MHz)	Allocation service	Malaysia footnotes
74,000 – 76,000	Fixed Fixed-satellite Mobile Broadcasting Broadcasting-satellite Space research	

NOTES:

1. MLA3 - Class assignment.
2. MLA11 - The band from 526.5 kHz to 1606.5 kHz is being used by stations for transmitting analogue broadcasting service and may be reserved for digital broadcasting service.
3. MLA13 - Part of the bands may be used for Digital Broadcasting Service.
4. MLA14 - Specific frequency bands exclusively for the Government of Malaysia.
5. MLA29 - Standard Radio System Plan 536: Requirements for Digital Terrestrial Television (including digital terrestrial sound) (DTT) Service Operating in the Frequency Bands from 174 MHz to 230 MHz and 470 MHz to 742 MHz.
6. MLA31 - The use of the band from 174 MHz to 230 MHz by the Fixed and Mobile Services shall not cause harmful interference to the Broadcasting Service.
7. MLA32 - The stations in the Aeronautical Radionavigation Service in the band from 225 MHz to 235 MHz shall not cause harmful interference to and shall not claim protection from broadcasting stations.
8. MLA48 - Standard Radio System Plan 520: Requirements for Digital Multimedia Service (DMS) Operating in the Frequency Band from 1452 MHz to 1492 MHz.
9. MLA83 - Some frequencies in HF band have been identified as common Public Protection and Disaster Relief (PPDR) use in Brunei Darussalam, Malaysia and Singapore.
10. MLA86 - Analogue TV broadcasting stations are allowed to operate in the bands from 174 MHz to 230 MHz and from 470 MHz to 790 MHz until Analogue Switch-Off (ASO) targeted in June 2018. Analogue TV broadcasting stations shall cease operation after ASO.
11. MLA87 - Use of frequency band from 223 MHz to 230 MHz for Airport Tower operation in the Aeronautical Radionavigation Service is allowed until 31st December 2020.
12. MLA90 - Technical Specification for Cordless Telephone System (SKMM WTS CTS).
13. MLA93 - Specification for Land Mobile Radio Equipment (MCMC MTSFB TC T012).
14. MLA94 - Specification for Short Range Devices (MCMC MTSFB TC T007).
15. MLA95 - Specification for Digital Terrestrial Television Broadcast Receiver (SKMM MTSFB TC T004).
16. MLA102 - Standard Radio System Plan 549: Requirements for Fixed Service Line-Of-Sight Radio-Relay Systems Operating in the Frequency Bands from 71 GHz to 76 GHz and 81 GHz to 86 GHz.
17. MLA106 - No new assignment in the frequency band 1,452 MHz to 1,492 MHz shall be considered. Existing stations are allowed to operate until 31 December 2020.

Annex B
(normative)

Technical requirements in EMF simulation report

The following data and technical details are required in the EMF simulation report:

a) station information consists of the following data;

   i) Radiocommunication Infrastructure (RCI) ID;

   ii) RCI address;

   iii) GPS coordinate; and

   iv) date of commission.

b) technical parameters consist of the following data;

   i) RCI type - Tower/pole,

   ii) RCI height in meter;

   iii) electrical tilt and mechanical tilt in degree;

   iv) antenna transmit gain in dBi;

   v) antenna vertical bandwidth beam in degree;

   vi) antenna side lobe attenuation in dB;

   vii) antenna type, model and make;

   viii) antenna GPS position; and

   ix) transmitter power output in Watt.

c) other technical parameters;

Uncertainty estimation analysis consists of:

   i) cable, connector and combiner loss in dB;

   ii) scattering from nearby objects and ground in dB;

   iii) mismatch between antenna and its feed in dB; and

   iv) antenna radiation pattern data.

d) cut-plane figures for the following items below, as described in Table B.1 in reference to;

   i) orthoslice at ground level as Figure B.1;

   ii) exclusion zone crossover with adjacent building as Figure B.2.

Table B.1. The description of the required cut-plane figures

Cut-plane type	Description
Orthoslice at ground level	Horizontal plane 2 m above ground level in terms of power density or emission percentage against exposure limits. Legend with logarithmic rainbow colour scale shall be marked clearly.
Exclusion zone crossover with adjacent building:	At antenna height level to analyse the crossover within adjacent nearby buildings in close vicinity, in terms of power density or emission percentage against exposure limits. Legend with logarithmic rainbow colour scale shall be marked clearly.
NOTE: Public, occupational, and exceedance exposure limits shall be marked clearly.	

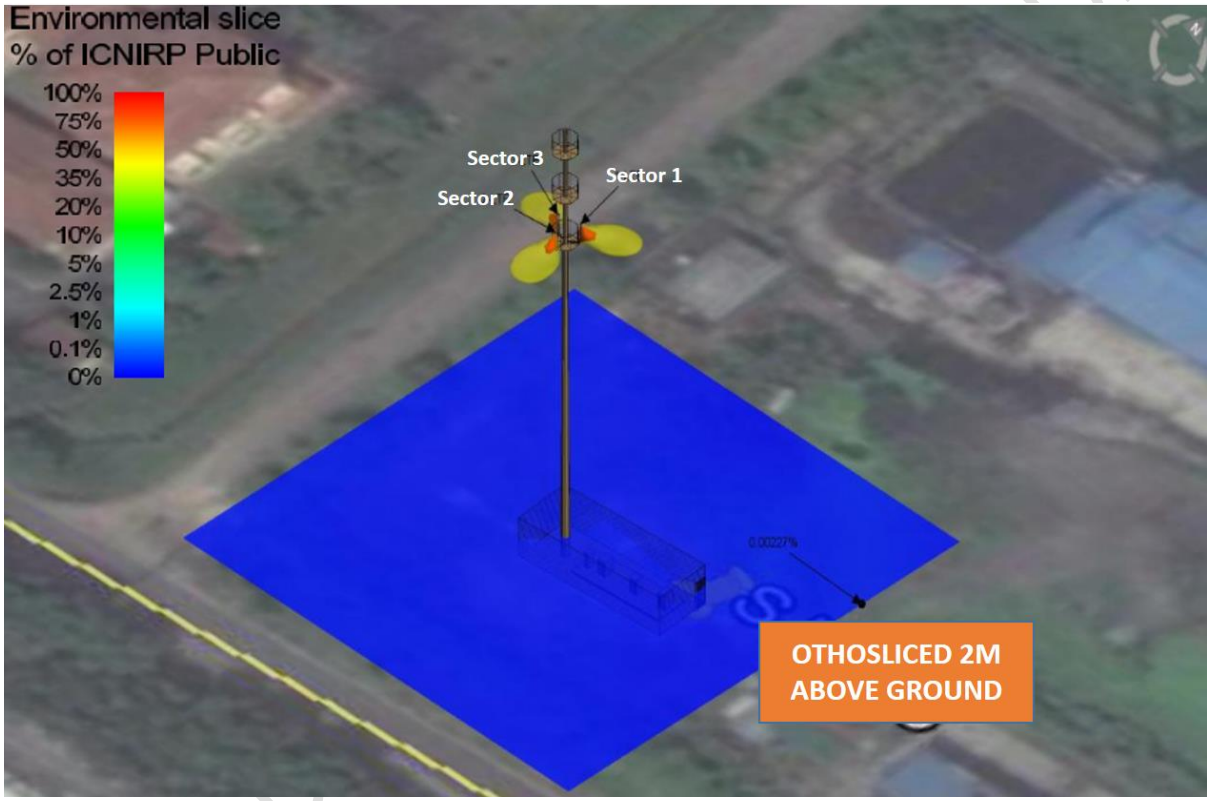


Figure B.1. Orthoslice method (2 meter above ground level)

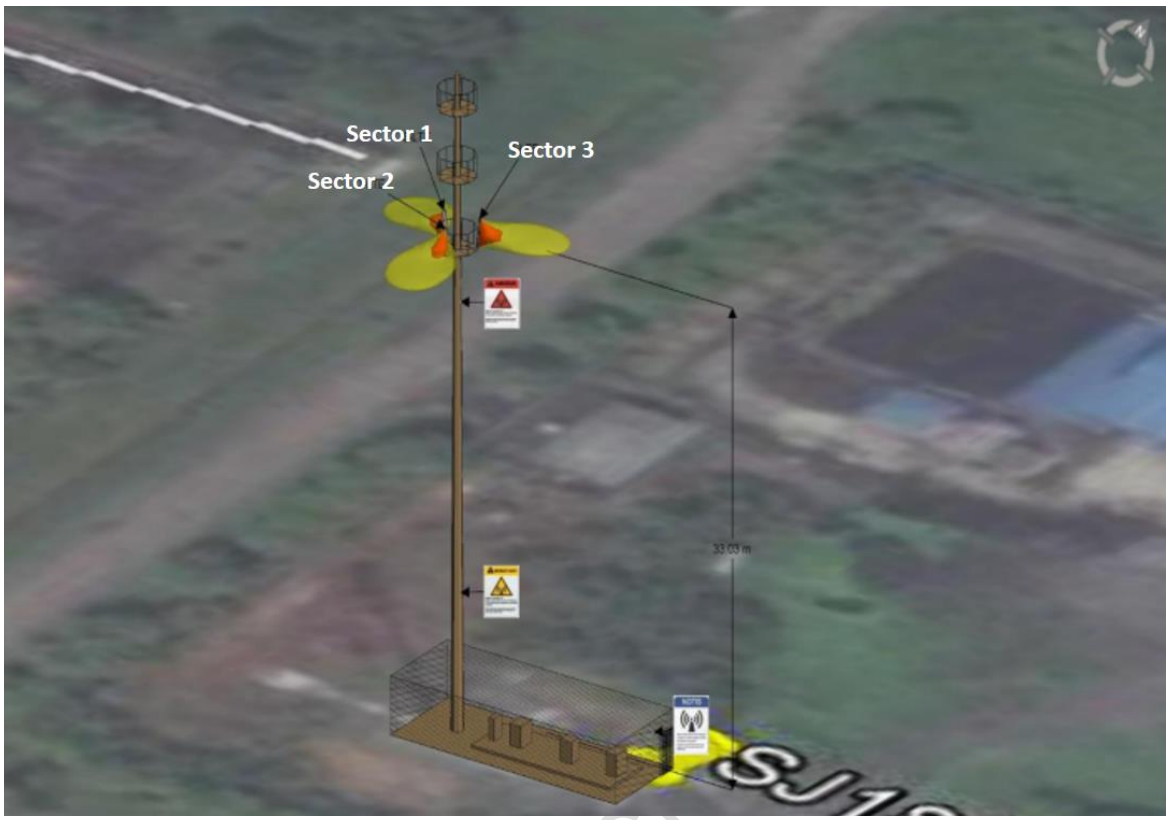


Figure B.2. Orthoslice method (exclusion zone with adjacent)

e) simulation software information consists of the following information;

   i) simulation software's version, model and manufacturer;

   ii) simulation software operator's name and designation; and

   iii) date and time of the simulation report.

f) following requirements for blueprint to scale as the sample of blueprint to be imported as shown in Figure B.2:

   i) simulation must be based on the actual size of the building and area;

   ii) the actual size of blueprints and aerial pictures either in any format (JPEG, PDF, PNG and BMP) must be imported

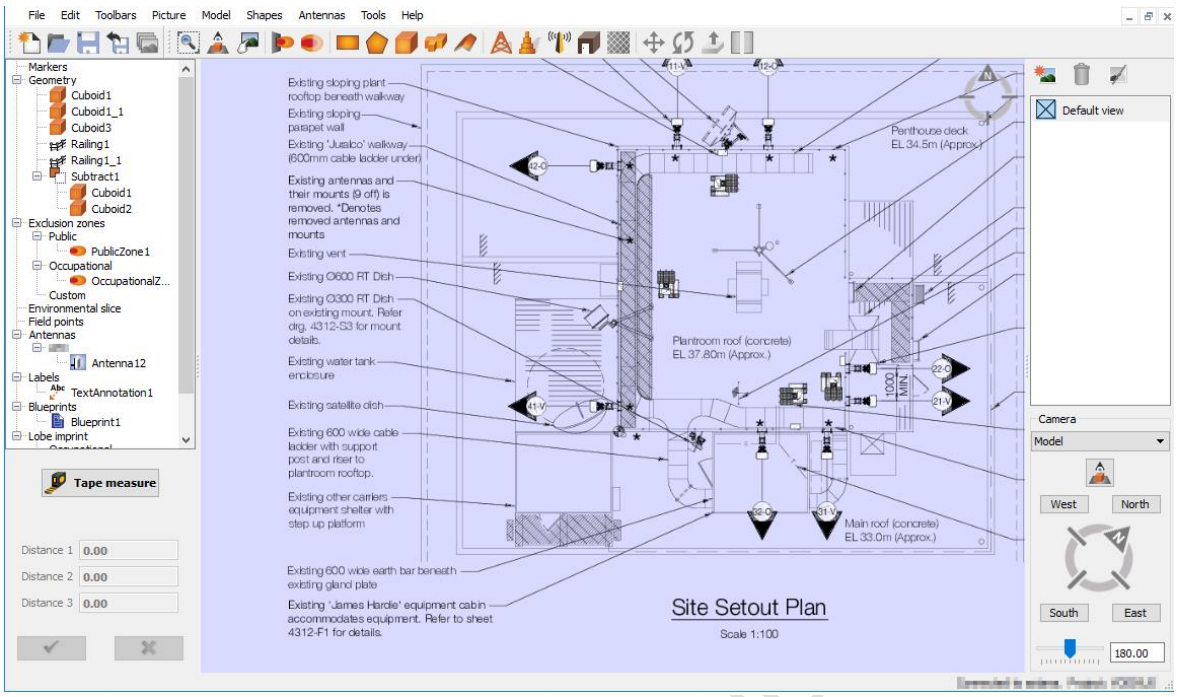
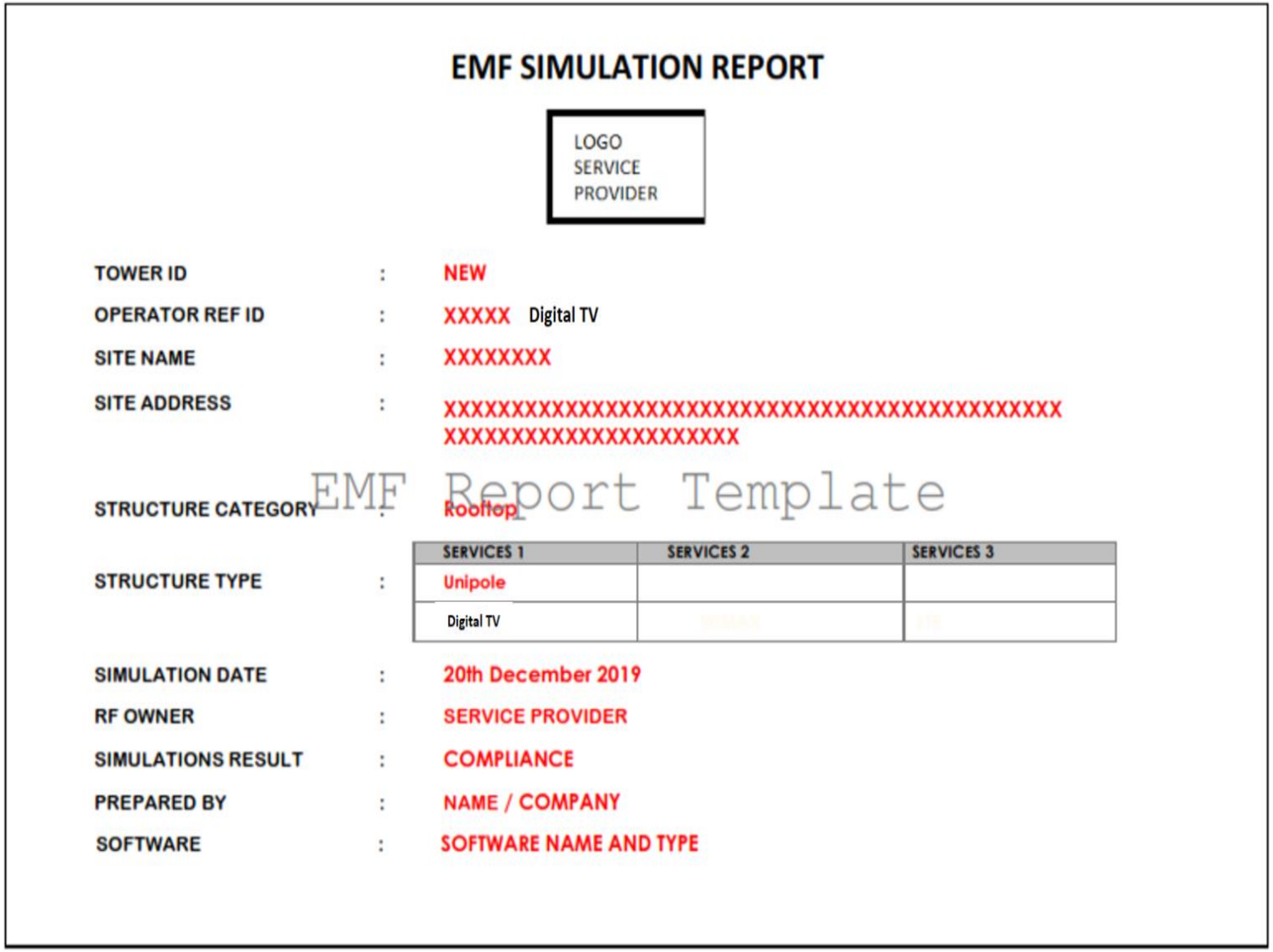


Figure B.3. Blueprint sample

Annex C
(informative)

EMF simulation report sample for ground level

The EMF simulation report sample for ground level is as follows.



EMF SIMULATION REPORT

LOGO
SERVICE
PROVIDER

TOWER ID : NEW
OPERATOR REF ID : XXXXX Digital TV
SITE NAME : XXXXXXXX
SITE ADDRESS : XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXX
STRUCTURE CATEGORY : Rooftop
STRUCTURE TYPE :

SERVICES 1	SERVICES 2	SERVICES 3
Unipole		
Digital TV	WiMAX	LTE

SIMULATION DATE : 20th December 2019
RF OWNER : SERVICE PROVIDER
SIMULATIONS RESULT : COMPLIANCE
PREPARED BY : NAME / COMPANY
SOFTWARE : SOFTWARE NAME AND TYPE

LOGO
SERVICE
PROVIDER

TABLE OF CONTENT

Introduction:

In this report maximum cumulative radio-frequency (RF) exposure calculations are presented for the above mentioned cellular base station site. Results are shown 2m above ground level and/or roof top level, unless specified otherwise, and expressed in terms of the ICNIRP guidelines. The actual RF exposure levels will generally be significantly less than the simulated values, due to automatic power control used by cellular base stations as well as reduction in exposure levels due to environmental factors such as the presence of buildings, trees and other objects. The simulated values are aimed towards the analytic worst case scenario for the peak traffic conditions.

Exposure Standards:

Results are expressed in terms of the ICNIRP'98 general public guidelines. These guidelines are reviewed on a regular basis by ICNIRP and specify the limits for continuous exposure of the general public to RF transmissions at frequencies used by cellular phone base stations.

Report Format:

The report in this document is as per MCMC standard "Commission Determination on the mandatory standard for Electromagnetic field emission from telecommunication infrastructure- Determination no. 1 of 2010".
Electromagnetic mapping of BTS site and nearby clutter is done, based on ray tracing computational method as per ITU-T Recommendation K.52 (2004), 'Guidance on complying with limits for human exposure to electromagnetic fields' and K.61 'Guidance to measurement and numerical prediction of Electromagnetic fields for compliance with human exposure limits for telecommunication installations' documents. This report is published in the form prescribed in MCMC Standard document.

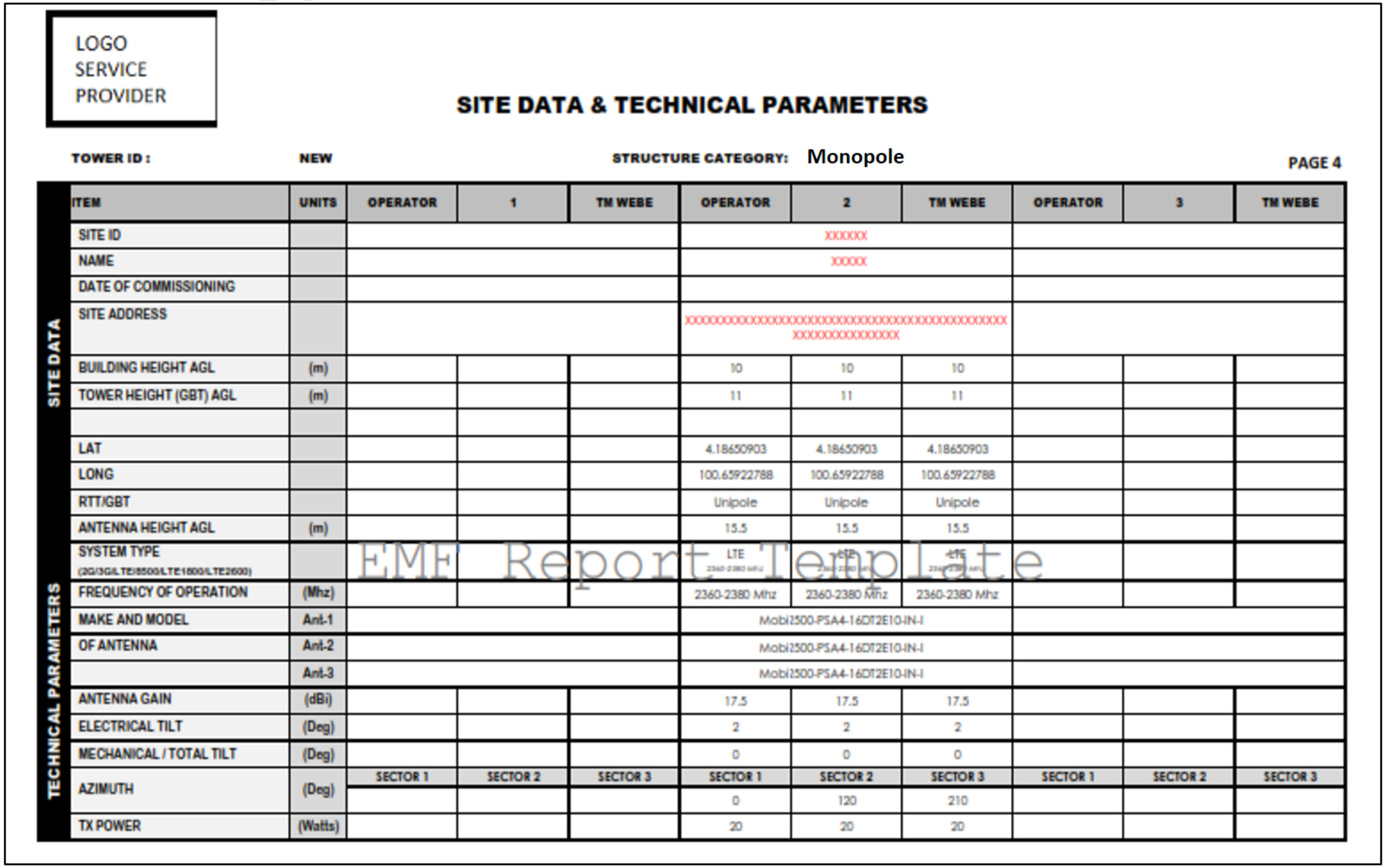
Glossary of Terms Used

Exclusion Zone: Area around an antenna or antennas where the RF field values emanating from the antennas exceed the ICNIRP public guidelines (public exclusion zone) or the ICNIRP occupational guidelines (occupational exclusion zone). Red zone indicates no access without following appropriate shut-down, power-down or pass through procedures. Yellow zone indicates access only allowed for RF trained personnel. No access for general staff, maintenance personnel or the public, whereas white zone is free access to everybody.
Orthoslice: Colour representation in form of power density values calculated in a plane of interest, expressed as a percentage of ICNIRP general public reference level with logarithmic legend. The standard dimension/area of Orthoslice of 60mX60m is used in the report as per Malaysian Standard document.

Vendor Logo

Vendor Detail address and tel number

LOGO
SERVICE
PROVIDER

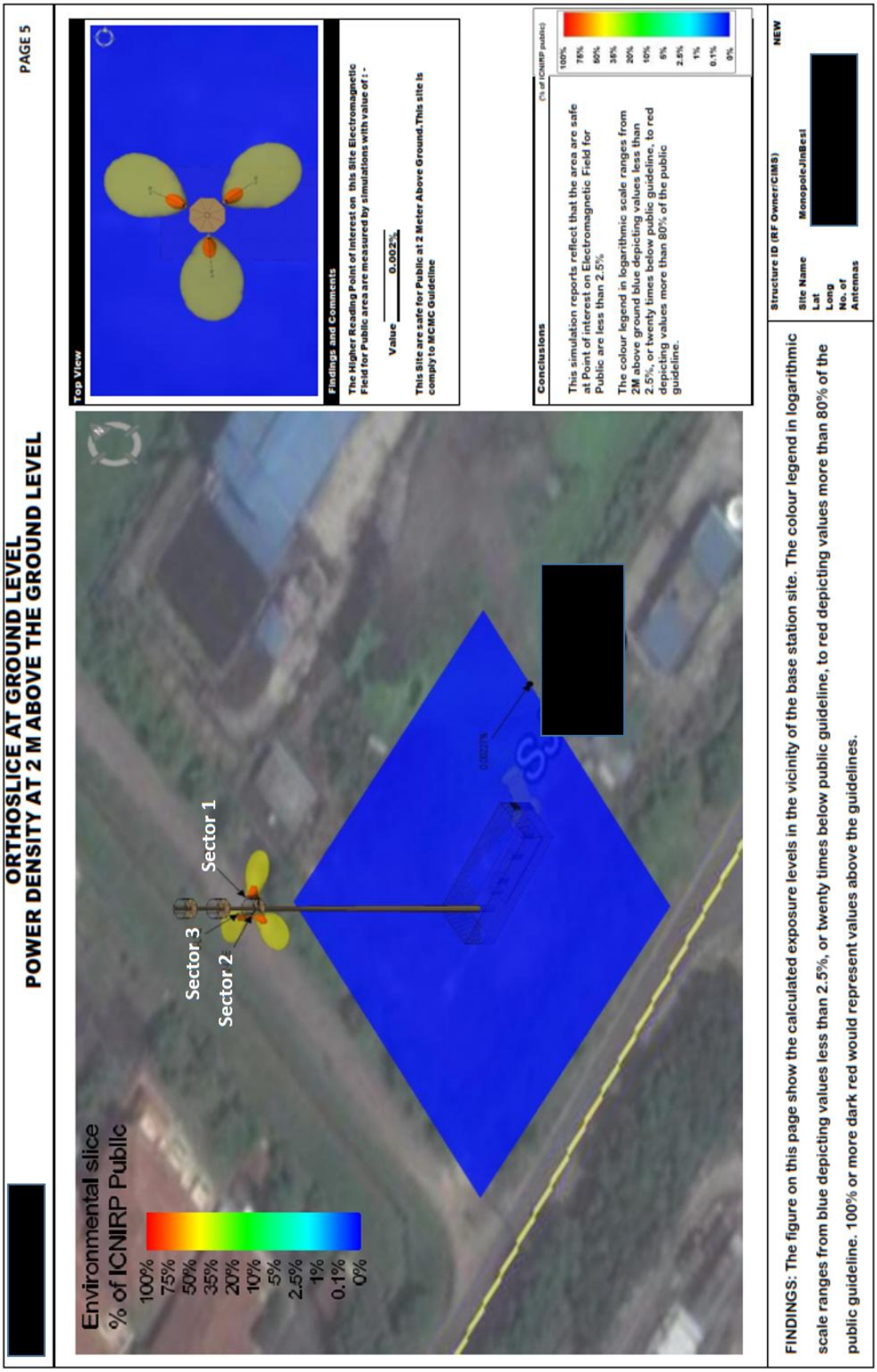


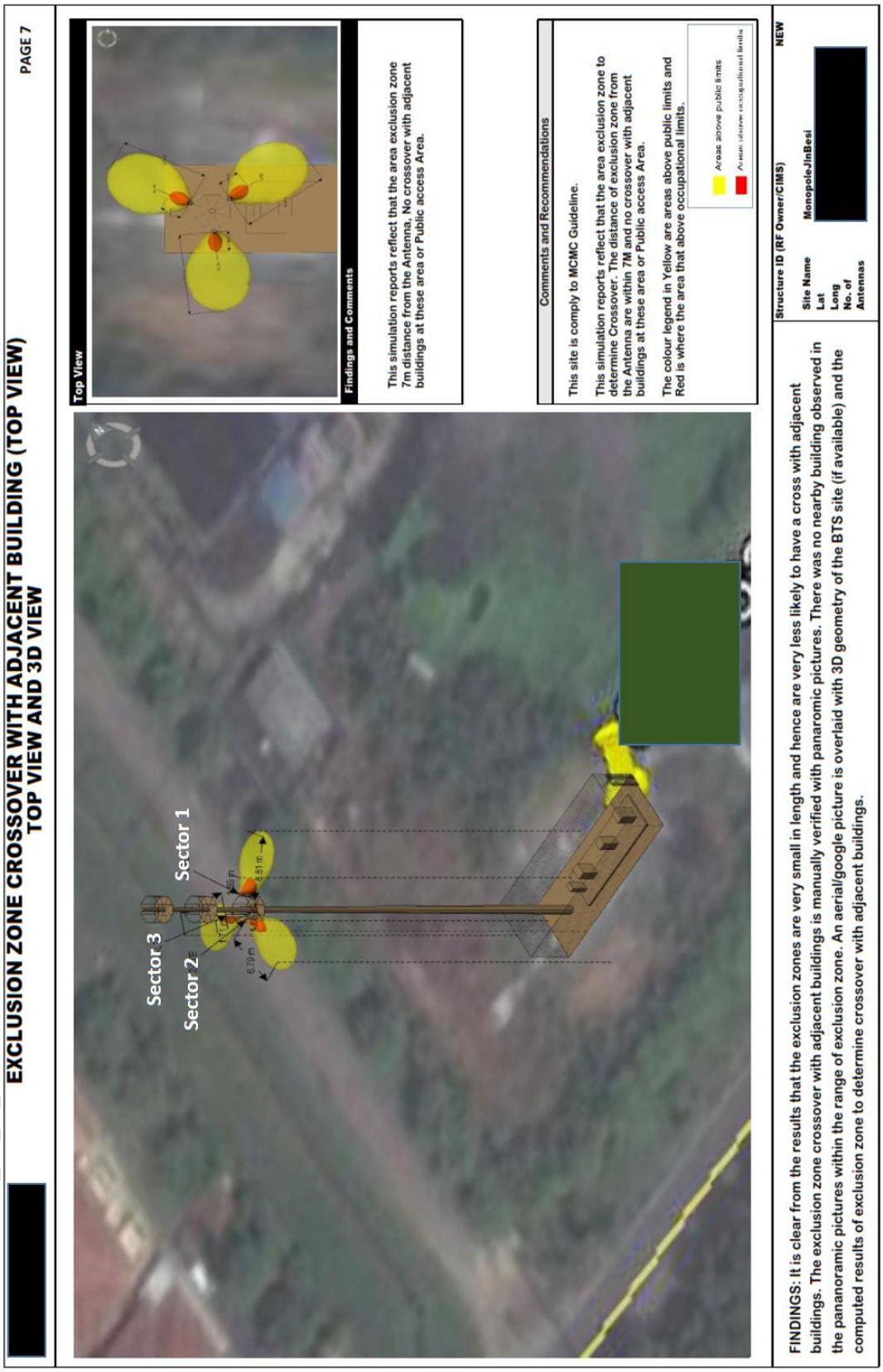
LOGO
SERVICE
PROVIDER

SITE DATA & TECHNICAL PARAMETERS

TOWER ID : **NEW** **STRUCTURE CATEGORY:** Monopole **PAGE 4**

	ITEM	UNITS	OPERATOR	1	TM WEBE	OPERATOR	2	TM WEBE	OPERATOR	3	TM WEBE
SITE DATA	SITE ID					XXXXXX					
	NAME					XXXXX					
	DATE OF COMMISSIONING										
	SITE ADDRESS					XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX					
	BUILDING HEIGHT AGL	(m)				10	10	10			
	TOWER HEIGHT (GBT) AGL	(m)				11	11	11			
	LAT					4.18650903	4.18650903	4.18650903			
	LONG					100.65922788	100.65922788	100.65922788			
	RTT/GBT					Unipole	Unipole	Unipole			
	ANTENNA HEIGHT AGL	(m)				15.5	15.5	15.5			
TECHNICAL PARAMETERS	SYSTEM TYPE (2G/3G/LTE/8500/LTE1800/LTE2600)					LTE 2360-2380 MHz	LTE 2360-2380 MHz	LTE 2360-2380 MHz			
	FREQUENCY OF OPERATION	(Mhz)				2360-2380 Mhz	2360-2380 Mhz	2360-2380 Mhz			
	MAKE AND MODEL	Ant-1				Mobi2500-PSA4-16DT2E10-IN-I					
	OF ANTENNA	Ant-2				Mobi2500-PSA4-16DT2E10-IN-I					
		Ant-3				Mobi2500-PSA4-16DT2E10-IN-I					
	ANTENNA GAIN	(dBi)				17.5	17.5	17.5			
	ELECTRICAL TILT	(Deg)				2	2	2			
	MECHANICAL / TOTAL TILT	(Deg)				0	0	0			
	AZIMUTH	(Deg)	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 1	SECTOR 2	SECTOR 3	SECTOR 1	SECTOR 2	SECTOR 3
						0	120	210			
	TX POWER	(Watts)				20	20	20			


[redacted]
ORTHOSLICE AT GROUND LEVEL
POWER DENSITY AT 2 M ABOVE THE GROUND LEVEL
PAGE 5
Environmental slice
% of ICNIRP Public
100%
75%
50%
35%
20%
10%
5%
2.5%
1%
0.1%
0%
Sector 1
Sector 2
Sector 3
[redacted]
Top View
Findings and Comments
The Higher Reading Point of Interest on this Site Electromagnetic Field for Public area are measured by simulations with value of : -
Value 0.002%
This Site are safe for Public at 2 Meter Above Ground.This site is compy to MCMC Guideline
Conclusions
(% of ICNIRP public)
This simulation reports reflect that the area are safe at Point of interest on Electromagnetic Field for Public are less than 2.5%
The colour legend in logarithmic scale ranges from 2M above ground blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline.
Structure ID (RF Owner/CIMS)
NEW
Site Name
Lat
Long
No. of Antennas
MonopoleJinBest
[redacted]
FINDINGS: The figure on this page show the calculated exposure levels in the vicinity of the base station site. The colour legend in logarithmic scale ranges from blue depicting values less than 2.5%, or twenty times below public guideline, to red depicting values more than 80% of the public guideline. 100% or more dark red would represent values above the guidelines.


EXCLUSION ZONE CROSSOVER WITH ADJACENT BUILDING (TOP VIEW)
TOP VIEW AND 3D VIEW
PAGE 7
Sector 1
Sector 2
Sector 3
Top View
Findings and Comments
This simulation reports reflect that the area exclusion zone 7m distance from the Antenna, No crossover with adjacent buildings at these area or Public access Area.
Comments and Recommendations
This site is comply to MCMC Guideline.
This simulation reports reflect that the area exclusion zone to determine Crossover. The distance of exclusion zone from the Antenna are within 7M and no crossover with adjacent buildings at these area or Public access Area.
The colour legend in Yellow are areas above public limits and Red is where the area that above occupational limits.
Areas above public limits
Areas above occupational limits
Structure ID (RF Owner/CIMS)
NEW
Site Name
Lat
Long
No. of Antennas
MonopoleJlnBesi
FINDINGS: It is clear from the results that the exclusion zones are very small in length and hence are very less likely to have a cross with adjacent buildings. The exclusion zone crossover with adjacent buildings is manually verified with panaromic pictures. There was no nearby building observed in the pananoramic pictures within the range of exclusion zone. An aerial/google picture is overlaid with 3D geometry of the BTS site (if available) and the computed results of exclusion zone to determine crossover with adjacent buildings.

Annex D
(informative)

EMF summary report template

The EMF summary report template is as follows.

EMF Summary Report Template

BATCH NUMBER

SKMM

Suruhanjaya Komunikasi dan Multimedia Malaysia
Malaysian Communications and Multimedia Commission

Summary of EMF Report

REPORT ON MANDATORY STANDARD ON ELECTROMAGNETIC FIELD (EMF)

This report provides a summary of Calculated RF EMF Levels around the WiMax base station

SUMMARY REPORT (100 SITES)

RF OWNER

LOGO SERVICE PROVIDER

EMF Summary Report Template

Service Provider Name

ADDRESS

MALAYSIAN AUTHORITY

Malaysian Communications and Multimedia Commission
Standards Development Department
(Infrastructure Development & Standards Division)
Suruhanjaya Komunikasi dan Multimedia Malaysia
MCMC Tower 1, Jalan Impact, Cyber 6, 63000 Cyberjaya,
Selangor Darul Ehsan, Malaysia

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Table of Content

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

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	Head of Department	Malaysian Communications and Multimedia Commission	

List of Amendments Documents

Date	Version	Author	Comments

Purpose
REPORT ON MANDATORY STANDARD ON ELECTROMAGNETIC FIELD (EMF) EMISSIONS FROM RADIOCOMMUNICATIONS INFRASTRUCTURE
The purpose of this report is to provide calculations of EME levels from the existing facilities at the site and any proposed additional facilities.

EMF Summary Report Template

Introduction

The purpose of this summary report is to provide calculations of EMF levels from the existing facilities at the sites and any proposed additional facilities.

This report provides a summary of levels of radiofrequency (RF) electromagnetic energy (EME) around the base station These levels have been calculated using EMF Predictions Simulations Software

Levels - Prediction Methodologies"

RF EMF values are calculated at 2m above ground and 2m above rooftop at various distances from the base station, assuming level ground and rooftop. The estimate is based on worst-case scenario, including:

- base station transmitters for mobile and broadband data operating at maximum power
- simultaneous telephonic calls and data transmission
- an unobstructed line of sight view to the antennas.

In practice, exposures are usually lower because:

- the presence of buildings, trees and other features of the environment reduces signal strength
- the base station automatically adjusts transmit power to the minimum required. Maximum EME levels are estimated in 360° circular bands out to 500m from the base station.

These levels are cumulative and take into account emissions from all ..... base station antennas at this site. The EME levels are presented in Percentage:

- percentage (%) of the MCMC Standard public exposure limit (the public exposure limit = 100%).

Vendor Logo

Vendor Detail address and tel number

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Radio Systems at the Site - Summary Average of all sites Environmental EMF Report

This base station currently has equipment for transmitting the following services:

Carrier	Radio Systems	Radio Frequency	
PROVIDER NAME	XXXXXXX	2360 Mhz	2390 Mhz

EMF Simulations Status

Site Status		
Total Number of Site	100	Sites
Number of Site Comply	100	
Number of Site Need Further Assessment	0	
Number of Site Non Comply	0	

Calculated EMF Levels

This table provides calculations of RF EME at different distances from the base station for emissions from existing equipment alone and for emissions from existing equipment and proposed equipment combined.

The maximum EME level calculated in % for the existing systems at all sites as below table for the public exposure limit.

Distance from the antennas	Maximum Cumulative EME Level at 2m above ground and 2m above rooftop – Single carriers at this site										
0 meter to 60 meter	Existing Equipment Maximum Cumulative EMF Level					Average % Level	Existing and Proposed Equipment Maximum Cumulative EMF Level					Average % Level
Site Number	1-25	25-50	51-75	76-100			1-25	25-50	51-75	76-100		
2 Meter Above Ground	0.44%	0.08%	0.32%	0.83%		0.42%						
2 Meter Above Rooftop	6.54%	2.49%	2.65%	4.29%		3.99%						

Distance from the antennas	Maximum Cumulative EME Level at 2m above ground and 2m above rooftop – Multi carriers at this site (Site Sharing)										
0 meter to 60 meter	Existing Equipment Maximum Cumulative EMF Level					Average % Level	Existing and Proposed Equipment Maximum Cumulative EMF Level					Average % Level
Site Number	1-25	25-50	51-75	76-100			1-25	25-50	51-75	76-100		
2 Meter Above Ground												
2 Meter Above Rooftop												

EMF Summary Report Template

LOGO
SERVICE
PROVIDER

Appendix I

Detail of EMF Report

EMF Summary Report Template

Site 1 - 25

Detail of Environmental EMF Report

Page 5

This report provides a summary of Calculated RF EMF Levels around the WiMax base station

	Site Informations							AntennaFrequency		Orthoslice			MCMC AUTHORITY		
	Site Name	Norminal ID	Site Address	Property Type	Lat	long	No	WiMax	LTE	2M Abv Ground	2M Abv Roof	Category	Type	Results Status
1	Confidential			9 storey building	3.15851	101.71449	3	2300		0.007%	2.740%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
2				7 storey building	3.163306	101.697666	3	2300		0.003%	6.518%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
3				3.5 storey shoplot	3.15995	101.711	3	2300		0.002%	0.296%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
4				6 storey building	3.16057	101.719	3	2300		0.034%	1.847%	ROOFTOP	MINI MONOPOLE	COMPLIANCE
5				6 storey building	3.14896	101.70073	3	2300		0.002%	2.415%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
6				3.5 storey shoplot	3.140224	101.73344	3	2300		0.006%	0.077%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
7	Confidential			3 storey building	3.10699	101.76409	3	2300		0.001%	1.329%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
8				3 storey shoplot	3.185067	101.74196	3	2300		0.006%	2.033%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
9				Shoplot	3.205149	101.709417	3	2300		0.004%	2.554%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
10				3.5 storey shoplot	3.18789	101.70301	3	2300		0.004%	3.919%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
11				15 storey building	3.20188	101.73255	4	2300		0.000%	0.589%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
12				[illegible]	[illegible]	[illegible]	3	2300		0.001%	1.127%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
13	Confidential			12 storey building	3.18235	101.67636	3	2300		0.000%	0.016%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
14				3 storey building	3.18916	101.65263	3	2300		0.005%	1.854%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
15				3 storey shoplot	3.21641	101.65884	3	2300		0.025%	3.374%	ROOFTOP	BOOM-TRIPOD	COMPLIANCE
16				12 storey building	3.23026	101.70054	3	2300		0.000%	0.356%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
17				7 storey building	3.24035	101.64828	4	2300		0.000%	0.061%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
18				10 storey building	3.11802	101.65554	3	2300		0.000%	1.620%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
19	Confidential			5 storey shoplot	3.083126	101.665645	3	2300		0.001%	1.612%	ROOFTOP	MINI MONOPOLE	COMPLIANCE
20				4 storey building	3.0611	101.6729	3	2300		0.001%	0.078%	ROOFTOP	UNIPOLE	COMPLIANCE
21				Stadium	3.05453	101.69019	3	2300		0.018%	0.427%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
22				6 storey building	3.15844	101.57174	4	2300		0.008%	0.145%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
23	Confidential			3 storey building	3.0868	101.647	3	2300		0.053%	0.388%	ROOFTOP	MINIMAST	COMPLIANCE
				Building	3.10066	101.6026	3	2300		0.440%	0.673%	ROOFTOP	BOOM-BYPOD	COMPLIANCE
25														

LOGO
SERVICE
PROVIDER

Appendix II

Detail of Antenna Configurations

(For CIMS Upload)

Site 1 - 10

Detail of Antenna Configurations

TOWER ID	SITE ID	SITE ADDRESS	OPERATOR	BLD GHEIGHT (M)	STRUCTURE HEIGHT (M)	X	Y	LOCOPS	NETWORK TYPE	FREQUENCY BAND	ATN REF ID	ATN MANUFACTURE	ANTENNA MODEL	ANTENNA HGHT	ANTENNA AZIMUTH	ELECT TILT	MECH TILT	INPUT POWER	NO OF ATN	SIMULATION DATE	SIMULATION RESULT	SUBMISSION
		Confidential		27	4	3.16811	101.71689	Confidential		2300	ANT_1	Argus	LLPX310M	30	50	0	5	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				27	4	3.16811	101.71689			2300	ANT_2	Argus	LLPX310M	30	190	0	8	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				27	4	3.16811	101.71689			2300	ANT_3	Argus	LLPX310M	30	300	0	2	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				27	4	3.16811	101.71689			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.4	3	3.163306	101.697944			2300	ANT_1	Argus	LLPX310M	20	10	0	6	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.4	3	3.163306	101.697944			2300	ANT_2	Argus	LLPX310M	20	230	0	7	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.4	3	3.163306	101.697944			2300	ANT_3	Argus	LLPX310M	20	290	0	7	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.4	3	3.163306	101.697944			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	5	3.15996	101.711			2300	ANT_1	Argus	LLPX310M	17	50	0	4	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	5	3.15996	101.711			2300	ANT_2	Argus	LLPX310M	17	120	2	5	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	5	3.15996	101.711			2300	ANT_3	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	5	3.15996	101.711			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
		Confidential		18.3	5	3.16267	101.719	Confidential		2300	ANT_1	Argus	LLPX310M	23.3	70	0	1	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.3	5	3.16267	101.719			2300	ANT_2	Argus	LLPX310M	23.3	190	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.3	5	3.16267	101.719			2300	ANT_3	Argus	LLPX310M	23.3	300	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				18.3	5	3.16267	101.719			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	6	3.16896	101.70073			2300	ANT_1	Argus	LLPX310M	21	30	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	6	3.16896	101.70073			2300	ANT_2	Argus	LLPX310M	21	170	0	3	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	6	3.16896	101.70073			2300	ANT_3	Argus	LLPX310M	21	290	2	3	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				21	6	3.16896	101.70073			2300	ANT_4	Argus	LLPX310M					10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
		Confidential		12	6	3.165224	101.73364	Confidential		2300	ANT_1	Argus	LLPX310M	12.26	50	0	0	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				12	6	3.165224	101.73364			2300	ANT_2	Argus	LLPX310M	12.26	170	0	4	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015
				12	6	3.165224	101.73364			2300	ANT_3	Argus	LLPX310M	12.26	290	0	0	10×10	3	28TH JULY 2015	COMPLIANCE	10T AUG 2015

Annex E
(informative)

EMF measurement report template

The EMF measurement report template is as follows.

REPORT REFERENCE /SERIAL NO

TITLE OF REPORT AND LOCATION

RADIOFREQUENCY RADIATION SAFETY ASSESSMENT AT

LOCATION A

A report prepared for

CLIENT'S NAME (ORGANIZATION)

BY

NAME OF COMPANY THAT CONDUCTED THE TEST AND PREPARED THE REPORT (WITH FULL ADDRESS)

MONTH AND YEAR OF MEASUREMENT REPORT

TITLE OF REPORT AND LOCATION

A report prepared by

NAME OF PERSONNEL THAT PREPARE THE REPORT

NAME AND FULL ADDRESS OF COMPANY

JANUARY 2021

TABLE OF CONTENT

REPORT TITLE

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

REPORT ON

RADIOFREQUENCY RADIATION SAFETY ASSESSMENT AT

LOCATION A

1. INTRODUCTION

Requisition to the company to perform the measurement, brief information on type of measurement, site location & date of the measurement.

2. OBJECTIVE

Objective of the measurement

3. SCOPE OF THE MEASUREMENT

Brief description on the scope of measurement, measurement components, units and the standards reference for the evaluation of the data and results.

4. DESCRIPTION OF SURVEY SITE AND RADIATION SOURCE

Detail description on the measurement site and the RF source involved. This is including the transmitting frequency emitted by the antenna, owner of the site, service provider information and photo of the site (Figure 1)

5. SAFETY GUIDELINES AND EXPOSURE LIMITS

Description on the permissible exposure limit standard that we are referring to and the table of permissible exposure limit (PEL) for public or workers. PEL is depended on the transmitting frequency of the site.It shall be calculated and mentioned in this section. For shared site, PEL is determined by the calculation of the lowest transmitted frequency by the service provider.

Figure 1: Sample Photo of the site

6. STANDARD MEASUREMENT EQUIPMENT

Description on the RF equipment used for the measurement .Detailed Information of the probe and frequency with the calibration information shall be provided in table form. Photos of the equipment set up at the measurement site should be included as well. (Figure 2)

Figure 2: Set-up of measurement equipment

7. METHOD OF MEASUREMENTS

Brief explanation on the methodology and standards of measurement. Each measurement point at the indoor broadcasting facility should be plotted in accordance to the floor plan. For outdoor areas, the measuring points will be captured or referred by the GPS Coordinates (Longitude & Latitude). Refer (Figure 3 &4)

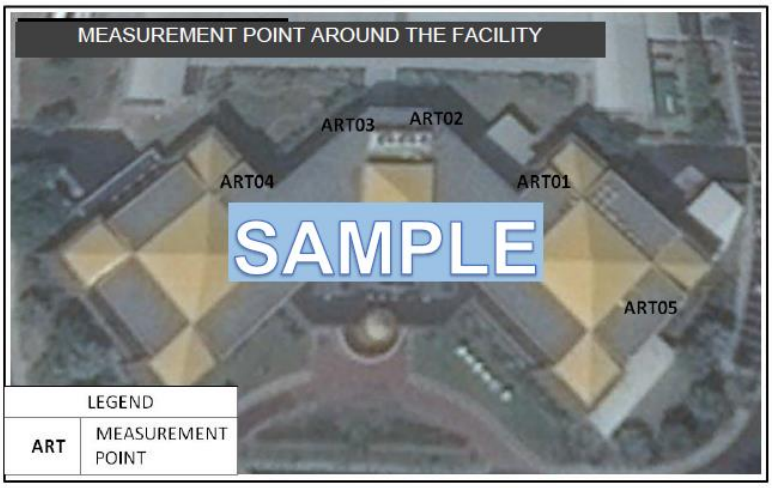

Figure 3: Measurement locations around the broadcasting facility

Figure 3: Layout of the measurement locations

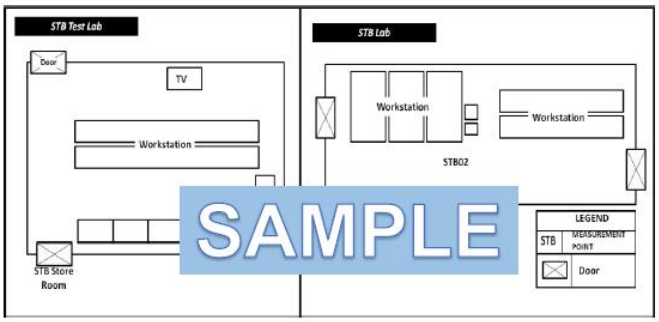

Figure 4: Llayout plan to indicate the measurement point

8. RESULTS AND DISCUSSION

Discussion of the data on electric field, magnetic field (whichever related) and power density. The highest electromagnetic field at specific locations should be stated. Data obtained from the measurement should be simplified in a table form with the comparison of the related permissible exposure limits. Data should be plotted in properly for Electric field strength (V/m) or Magnetic field (A/m) and power density (μW/cm^2) in order to show the variation of the strength of electromagnetic fields towards measurement points and comparison towards the permissible exposure limit (Figure 5 and Figure 6) by Malaysian Communication and Multimedia Commission (MCMC) and International Commission on Non-ionising Radiation Protection (ICNIRP).

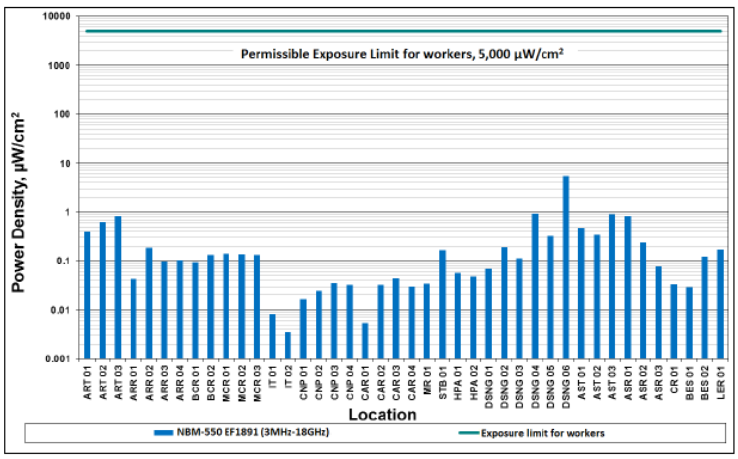

Figure 5 : A plot of radiation levels in microwatts per unit area (μW/cm^2) against location of measurement (and their comparison with MCMC exposure limit for public/workers).

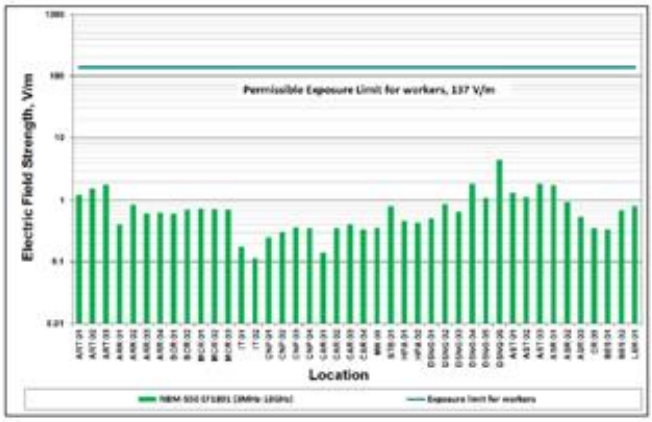

Figure 6: A plot of radiation levels in V/m against location of measurement (and their comparison with MCMC exposure limit for public/workers)

9. CONCLUSIONS

Statement of conformity and findings of the measurement.

10. REFERENCE

List of reference documents used.

11. REPORT VERIFICATION

Name of Site:

Assessment Conducted by: (personnel that performed the measurement)

Report Prepared by: (Personnel that prepared the report)

Date of Assessment:

Report Approved by:

_____

(Approved signatory)

Bibliography

[1] MCMC(T)13-TDD/170/001 Jld.1 (02), Guideline on the mandatory standard for electromagnetic field emission from radio communications infrastructure

[2] MS 739:1981: *Specification for Hot–Dip Galvanized Coatings on Iron Threaded Fasteners*

[3] MS 740:1981: *Specification for Hot– Dip Galvanized Coatings on Iron and Steel Articles*

[4] ITU-T K.91(11,2019); *Protection against interference, guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields*

[5] ITU-R BS.1195-1 (01/2013), Transmitting antenna characteristic at VHF and UHF

[6] ICNIRP Statement, Health Phys. 118(5):477–482; 2020; *Principles for non-ionizing radiation protection*

[7] IEEE Std. C95.1-2019/Cor 1-2019; *IEEE standard for safety levels with respect to human exposure to electric, magnetic, and electromagnetic fields, 0 Hz to 300 GHz*

[8] The electromagnetic spectrum of non-Ionizing radiation
https://www.cdc.gov/nceh/radiation/nonionizing_radiation.html

[9] Electromagnetic fields and public health
https://www.who.int/peh-emf/publications/facts/fs304/en/

Acknowledgements

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