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Frequency Spectrum Management Plan

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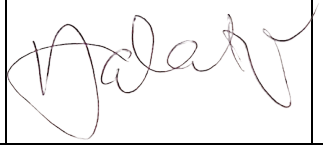
Review and Approval	S Malatji	Head: Learning Hub (MCSA)		20/10/2023

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Notice

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Referenced and Applicable Documents	
[1]	Mine Health and Safety Act No. 29 of 1996
[2]	Government Gazette Vol.690 No. 47790 – 21 December 2022 – *Commencement of the Regulations Relating to Trackless Mobile Machinery.*
[3]	Qualcomm Technologies, Inc., "C-V2X: Cellular Vehicle-to-Everything Technology," Qualcomm Technologies, Inc., 2019. [Online]. Available: https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/c-v2x_technology.pdf.
[4]	Testxchange, "Vehicle-to-Everything (V2X)," Testxchange, [Online]. Available: https://www.testxchange.com/industries/vehicle-to-everything
[5]	ITU. *Radio Regulations - Articles - Edition of 2020*.
[6]	ICASA. *National Radio Frequency Plan 2021.* No.46088
[7]	Government Gazette Vol.597 No. 38641 – 30 March 2015 – *The Radio Frequency Spectrum Regulations 2015*
[8]	Government Gazette vol. 490 Cape Town 18 April 2006 No. 36 of 2005: Electronic Communications act, 2005.
[9]	ME-02-2003 (ANNEX A): *Control over the use of radio transmitter frequencies and radiated power transmitted by equipment used in underground mines.*
[10]	ME-02-2010 DRAFT (ANNEX B) *Control over the use of radio transmitter frequencies and radiated power transmitted by equipment used in underground mines.*

History Sheet			
Version	**Date**	**Effected by**	**Description**
Rev 3.0	18/10/2023	CFH Fouche	Addressed additional feedback and reissued document
Rev 2.0	07/08/2023	CFH Fouché	Approval
Rev 1.0	03/05/2023	H Goosen	Addressed MCSA feedback
Rev 0.7	22/03/2023	H Goosen	Addressing internal feedback (ITC Services)
Rev 0.5	17/03/2023	H Goosen	Compilation of Frequency Spectrum Management Plan

Distribution List	
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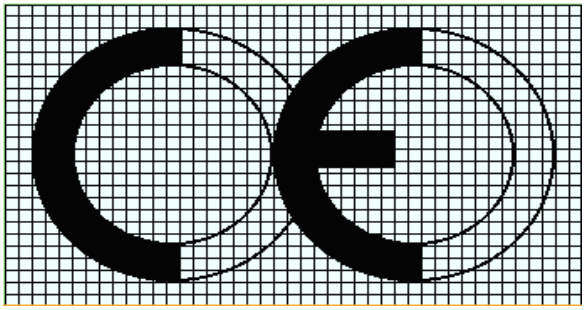
ACRONYMS AND ABBREVIATIONS	
AI	Artificial Intelligence
CAS	Collision Avoidance Systems
CE	Conformité Européene
CISPR	Comité International Spécial des Perturbations Radioélectriques (CISPR; English: International Special Committee on Radio Interference)
CPS	Collision Prevention Systems
DMRE	Department of Mineral Resources and Energy
DSRC	Dedicated Short-Range Communications
EIRP	Effective Isotropic Radiated Power
EMESRT	Earth Moving Equipment Safety Round Table
EMI	Electromagnetic Interference
GPS	Global Positioning System
GSM	Global System for Mobile Communication
ICASA	Independent Communications Authority of South Africa
ICNIRP	International Commission of Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
ISM	Industrial, Scientific, Medical
ITU	International Telecommunications Union
PDS	Proximity Detection Systems
RBE	Rail Bound Equipment
RF	Radio Frequency
RFI	Radio Frequency Interference
RFID	Radio Frequency Identification
SAMI	South African Mining Industry
SANS	South African National Standard
TMM	Trackless Mobile Machines
UHF	Ultra-High Frequency
V2X	Vehicle-to-Anything
VLF	Very Low Frequency

1. DEFINITIONS

CE Mark

The CE mark has a specific layout not to be confused with similar, but incorrect, logos.



A CE Mark (CE) on a product is a manufacturer's declaration that the product complies with the essential requirements*/* performance levels, measured according to Harmonised standards, of the relevant European health, safety and environmental protection legislation and may be legally placed on the market in the European Economic Area.

CE Certificate

A written statement using a “standardized” template declaration drawn up by the manufacturer to demonstrate the fulfilment of the EU requirements relating to a product bearing the CE mark.

CISPR

The *Comité International Spécial des Perturbations Radioélectriques* (CISPR; English: International Special Committee on Radio Interference) was founded in 1934 to set standards for controlling electromagnetic interference in electrical and electronic devices and is a part of the International Electrotechnical Commission (IEC).

EMC

Electromagnetic Compatibility (EMC) is the ability of electrical equipment and systems to function acceptably in their electromagnetic environment, by limiting the unintentional generation, propagation and reception of electromagnetic energy which may cause unwanted effects such as electromagnetic interference (EMI) or even physical damage in operational equipment. The goal of EMC is the correct operation of different equipment in a common electromagnetic environment.

EMI

Electromagnetic interference (EMI). The disruption of the normal operation of an electronic device or system caused by electromagnetic radiation or signals from other electronic devices.

EIRP

Effective Isotropic Radiated Power (EIRP) refers to power transmitted by a device, including system gains and losses.

Frequency Register

A document or list that organizes a set of intentional transmitters, with their respective characteristics, in-use at a specific work environment. The register is used to keep track of current and new electrical/electronic equipment and aids in the risk assessment process.

Intentional Transmitter

Any device that is designed to produce radio waves.

SANS

South African National Standards

Spectrum Licensed Equipment

A spectrum license issued by ICASA relates to the right to use a portion of the radio frequency spectrum subject to conditions. 2-way radios are examples.

Transceiver

A device that combines both a transmitter and a receiver into a single unit (such as two-way radios, for example).

Type Approved Equipment

Type approval is granted to a product incorporating a radio frequency transmitter and/or receiver that meets a minimum set of regulatory technical and safety requirements and operates in a frequency band reserved for Industrial, Scientific and Medical (ISM) equipment. Type approval by ICASA is required before a product is allowed to be sold or used in South Africa. No spectrum license is required for WiFi, Bluetooth, Zigbee, Short Range Devices, GSM etc.

Unintentional Radiator/Emitter

A device that creates radio frequencies as a byproduct that is unintentionally radiated from the device.

Permit

A permit is a document that allows a new electric/electronic device to be used on site on a temporary basis. For a device to receive a permit it must comply to all the regulations stipulated by ICASA as well as a site-specific Frequency Register.

CoC – Certificate of Compliance

A CoC permits a new electric/electronic device to be used on site on a permanent basis. A CoC can be issued only after a permit has been issued and the device does not cause unwanted interference to existing systems (confirmed with site acceptance testing).

2. BACKGROUND

Trackless Mobile Machinery (TMM) and rail bound equipment (RBE) used in mining operations, require the implementation of technologies that are used to prevent collisions to increase mine operation safety. When different technologies are installed on a particular site, a method of frequency management is recommended to minimise inter-system interference.

The aim of this document is to provide a framework that can be used by SAMI to draft site-specific Frequency Spectrum Management Plans to manage the use and installation of different technologies (including CPS), as well as different intentional RF transceivers on site.

This document will include the following key points:

- Common CPS sensor operating frequencies of technologies used in South Africa, including devices sourced internationally.
- Consideration of vehicle-to-anything (V2X) standards and the operating frequencies used in other regions for V2X.
- Human risk
- Consideration of how the current regulations contained in the Gap Analysis Document can be amended to enable V2X standards and components to comply with the frequency bands permitted in South Africa and the timelines that would be required for such amendments.
- A framework to develop new technologies at new frequencies.
- ICASA Type Approval or Spectrum License application process.

3. PURPOSE

The main purpose of this document is to:

- Propose a format (that can be used across the mining industry) for the drafting of a register of radio frequencies in use at each mining site (intentional transmitters).
- Provide a risk assessment methodology to identify and limit harmful interference.
- Comment on regulatory compliance for all intentional transmitters.
- Provide a guideline on how to apply for a Spectrum License or Type Approval from ICASA.

4. AN INTRODUCTION TO FREQUENCY REGISTERS

4.1 WHAT IS A FREQUENCY REGISTER AND WHY IS IT IMPORTANT?

A frequency register is a document that contains information regarding all the new and existing equipment, that are intentional transmitters/transceivers (only the transmitter part of the transceiver) and is intended to be used at an active mining site, above or below ground. A frequency register intends to regulate the use of intentional transmitters on site to decrease the amount of possible inter-system Radio Frequency (RF) interference scenarios. The register is also useful for frequency planning before purchasing equipment to be used on site.

The required information to conduct a risk assessment on a specific transmitter will be captured in the register. The frequency register and risk assessment will be used by the radio frequency representative appointed by each mine to issue a permit or CoC.

* Radio Frequency (RF) is a term used to describe a variety of radio waves.

4.2 WHO IS RESPONSIBLE FOR THE CREATION AND UPDATING OF THE FREQUENCY REGISTER?

Each mining organisation needs to appoint a responsible person to create and continuously update the frequency register. It is recommended that such a person be technically knowledgeable and able to understand concepts surrounding radio frequencies produced by electrical and electronic equipment.

4.3 UNINTENTIONAL EMITTERS

Unintentional emitters (electrical/electronic equipment that does not intentionally transmit a signal) are regulated by SABS using CISPR Standards. These standards are used for electrical/electronic equipment that is not classified as intentional transmitters. The CISPR standards specify certain levels of emissions as well as immunity that electrical/electronic equipment must adhere to or be able to withstand.

To mitigate the risk of unintentional RF emitters within a mining environment, all electrical/electronic equipment not classified as intentional transmitters used on site, must comply to the relevant CISPR standards.

4.4 DRAFTING A FREQUENCY REGISTER

To generate and update a list of current intentional transmitters that is used on site, the following information must be included in the list, as a minimum:

- System Name
- System Function
- Operating Frequency (Band) – ICASA Certificate
- Maximum EIRP – ICASA Certificate
- Location of use
- Interval of intended use i.e., Daily, Weekly, Monthly, Once-off.
- Risk Assessed

A proposed template for the creation of a frequency register will be made available in a separate Microsoft Excel worksheet (Proposed Template of a Frequency Register).

The information in the register can then be compared to the following documents:

- Table 1 of this document
- The National Radio Frequency Plan (available at: https://www.icasa.org.za/legislation-and-regulations/radio-frequency-spectrum-plans)
- The National Radio Frequency Spectrum Regulation (available at: https://www.icasa.org.za/uploads/files/Radio-Frequency-Spectrum-Regulations-2015.pdf)

The following flow charts indicate the process of populating and updating the frequency register, as well as the steps to follow to ensure that equipment that is to be used on site is approved to be added to the register.

4.5 METHODOLOGY FLOW OF RECORDING ENTRIES IN THE FREQUENCY REGISTER

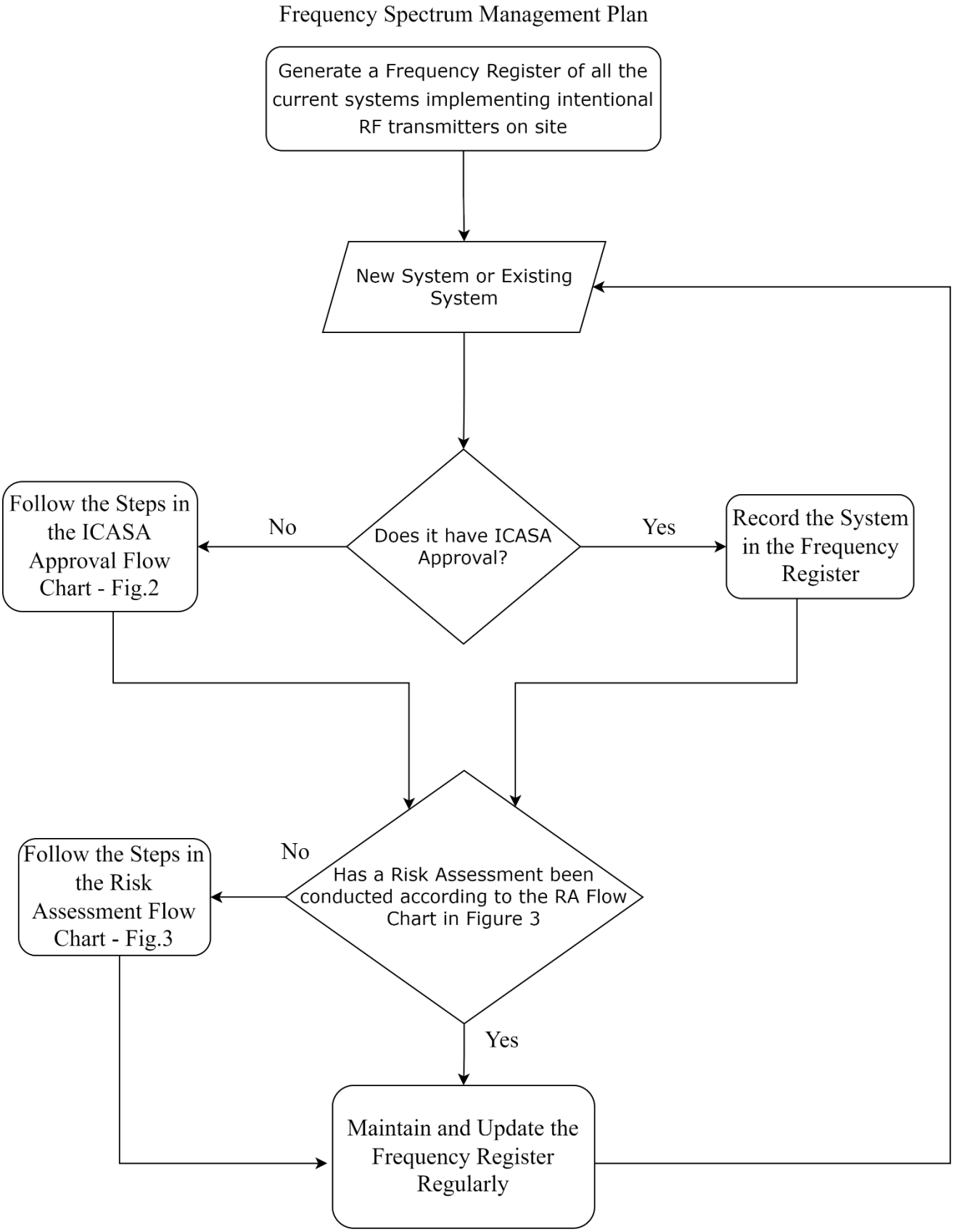


Figure 1 - System Overview Flow Chart

4.6 METHODOLOGY TO ACQUIRE APPROVAL OF A NEW SYSTEM/TECHNOLOGY

For a new system/technology to be used at a mine, there are three main compliance scenarios to investigate. Follow the instructions in Figure 2.

- Does the new system have a CE mark only?
- Does the new system have a CE mark as well as ICASA approval?
- Is the system a new development? (Neither CE mark nor ICASA Approval)

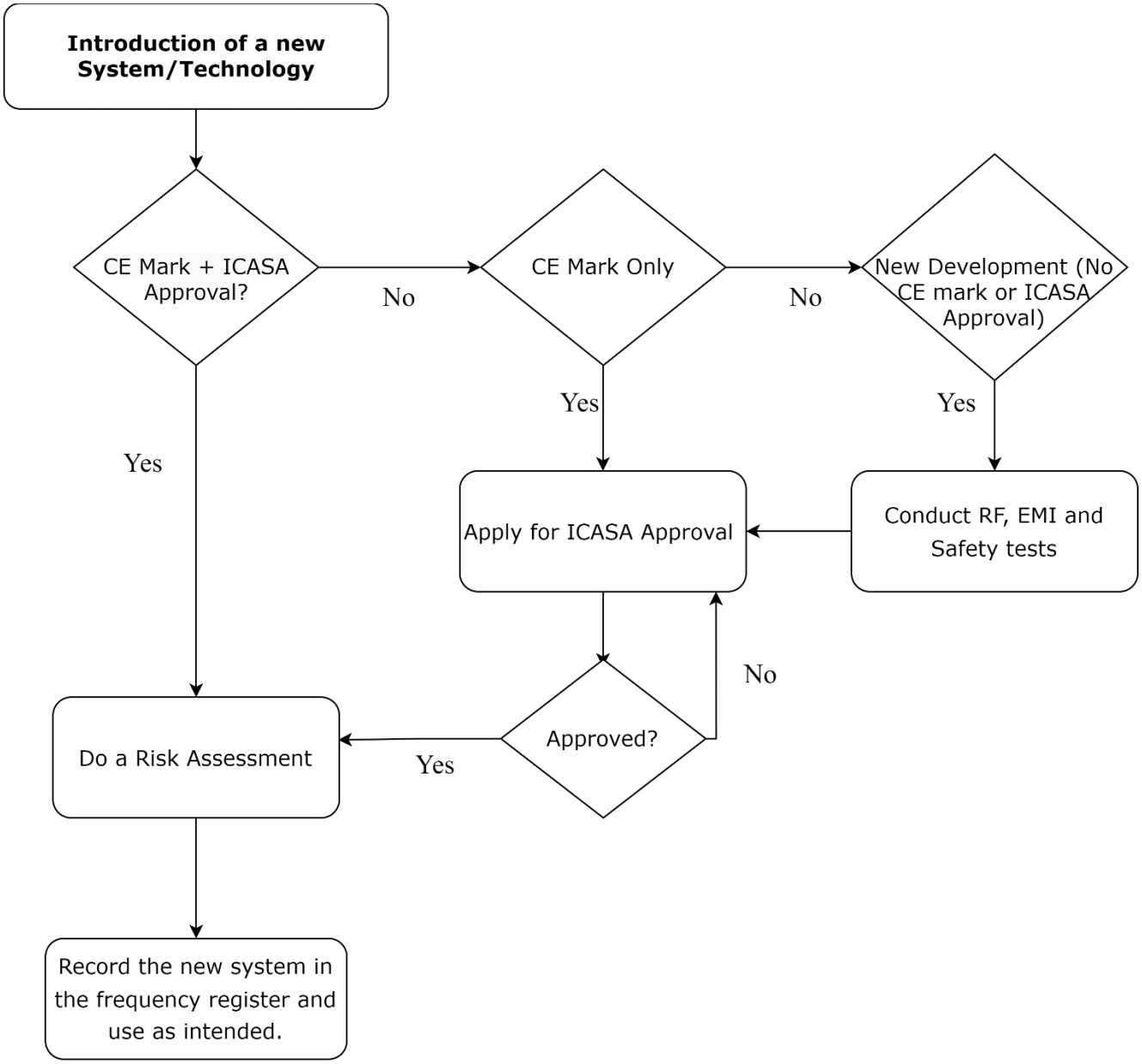


Figure 2 – ICASA Approval Flow Chart

5. ICASA – REGISTRATION COSTS AND TIMELINES

5.1 ICASA APPROVAL FOR ABOVE AND BELOW GROUND MINING EQUIPMENT

It is stated in the Electronic Communications Act (ECA) 36 of 2005 [8] (available at: https://www.gov.za/sites/default/files/gcis_document/201409/a36-050.pdf) that no product used or manufactured in South Africa may cause intentional or unintentional RFI or EMI to existing electrical/electronic equipment. Thus, all intentional transmitters used at a mining site (above or below ground) must have either an ICASA Type-Approval or an ICASA Spectrum License. This will ensure that an accurate and reliable frequency register is maintained.

The ECA of 2005 states the following:

CHAPTER 6

TECHNICAL EQUIPMENT AND STANDARDS

Approval of type

35. (1) No person may use, supply, sell, offer for sale or lease or hire any type of electronic communications equipment or electronic communications facility, including radio apparatus, used or to be used in connection with the provision of electronic communications, unless such equipment, electronic communications facility or radio apparatus has, subject to subsection (2), been approved by the Authority.

(2)The Authority may prescribe—

(a) the types of equipment, electronic communications facilities and radio apparatus, the use of which does not require approval where such equipment, electronic communications facilities and radio apparatus has been approved for use by the European Telecommunications Standards Associations or other competent standards body where the equipment complies with type approval standards prescribed by the Authority; and

(b) circumstances under which the use of equipment, electronic communications facilities, radio apparatus and subscriber equipment does not require approval, including uses for research and development, demonstrations of prototypes and testing.

The act was then amended in 2014 to read as follows (the document can be sourced from: https://www.icasa.org.za/legislation-and-regulations/electronic-communications-act-2014):

Amendment of section 35 of Act 36 of 2005

17. Section 35 of the principal Act is hereby amended by the substitution for subsection (1) of the following subsection:

"(1) No person may possess, use, supply, sell, offer for sale or lease or hire any type of electronic communications equipment or electronic communications facility, including radio apparatus, used or to be used in connection with the provision of electronic communications, unless such equipment, electronic communications facility or radio apparatus has, subject to subsection (2), been approved by the Authority.".

Thus, all electrical/electronic equipment that include wireless transceivers and is intended to be used in South Africa (above or below ground) requires approval from ICASA.

5.2 THE ONUS OF APPROVAL

When a mining organisation sources the electrical/electronic equipment locally, the onus to have the product ICASA approved is on the supplier of the product.

If the product is sourced internationally, the onus may be on the mine (as buyer or importer of the technology) or the supplier to ensure that the equipment is approved by ICASA for use in South Africa. This includes any equipment that is to be used above or below ground. ICASA states the following on its website as guidance on responsibilities:

Any Equipment used or to be used in connection with the provision of electronic communications, unless explicitly exempted by the Authority, is subject to Type Approval by the Authority.

Applications for Type Approval can be submitted by any of the following parties:

1. Manufacturers;
2. Importers;
3. Distributors; and
4. Any South African registered company

The Type Approval Certificate will only be issued to South African registered companies. Therefore, details such as company registration number, physical and postal addresses, contact persons and telephone numbers are required in terms of the applicable application form.

The following information pertaining to exemptions from type approval is also available on the website:

EXEMPTIONS

Local and foreign entities that are involved in the provisioning of electronic communications services may apply for exemption from Equipment Type Approval during the hosting of special events. ICASA will accept test reports of the relevant European standards, provided the testing has been performed at an accredited test facility. An accredited test facility is a laboratory or a test house that is continuously being checked by the national accreditation bodies in their countries for, among other things, compliance with ISO 17025 requirements and the qualifications of personnel conducting such tests. Normally such a routine check is done once a year. Updated information is normally obtained from national bodies.

- All applicants must show that the equipment conforms to the relevant technical standards as specified in the Official List Standard regulations, No. 32885, published by ICASA.
- All exempted equipment will be granted with a special permit and all such equipment must be clearly marked with an ICASA sticker in order to differentiate them from illegal users. ICASA will issue the relevant sticker.
- Type approval does not expire and the equipment can be used again in future without the need for another application for type approval.

5.3 HOW TO APPLY FOR ICASA APPROVAL

To register a new product at a new frequency with ICASA, first determine if the system requires a Spectrum License or a Type Approval. If the frequency band of operation of the new system does not form part of the ISM (Industrial, Scientific, Medical) frequency bands, which are listed in the Radio Frequency Spectrum Regulations document (available at: https://www.icasa.org.za/uploads/files/Radio-Frequency-Spectrum-Regulations-2015.pdf), then a Spectrum License will be required from ICASA. If the frequency band of operation of the new system is listed in the Radio Frequency Spectrum Regulations document (ISM Frequency Bands), then a Type Approval from ICASA is in order.

Follow the steps on ICASA's website apply for the specific license that is required for the new system. Appendix C lists the technical information required by the website to apply for Type Approval. To ensure a successful application, gather the needed information (as in the appendix) before attempting to start the process on the website.

5.4 FEES

The following is an indication of the fees that is associated with ICASA applications per piece of equipment at the time of the compilation of this document. As such, it should be noted that the fees are subject to change.

- Type Approval for RF equipment – R5516 per application
- Spectrum License – R2758 Unit Price per MHz Paired.

The turnaround time per application is 30 days per revision. Thus, the total application approval time is dependent on the number of queries returned on your application by ICASA.

6. FREQUENCY RISK ASSESSMENTS

A risk assessment must be conducted on all frequencies that is intended to be used on the mine site (all systems recorded in the Frequency Spectrum Plan or Frequency Register). The mine needs to appoint an individual that will be responsible for conducting the risk assessments. This person should either be the same one as would be responsible for the frequency register, or should work closely with such individual(s) to ensure that the register is adapted as needed together with the performance of risk assessments.

Note that no frequency recorded in the Frequency Register may have a maximum EIRP (Effective Isotropic Radiated Power – Transmit Power) of above 500mW for underground mines based on the ME-02-2003 Document [9], regardless of the allocation in the National Frequency Spectrum Regulation.

Use the following steps (as shown in Figure 3 - Risk Assessment Flow Chart) as a guide to conduct a Risk Assessment on a new or existing system:

- Determine if the frequency band of operation and EIRP of the system is within specified regulations stipulated by ICASA.
- Use the operating frequency and EIRP of the system in the FRIIS formula to calculate the field strength in the direct vicinity of the system (note that an Excel document with the formula pre-entered to conduct these calculations will be provided).
- The transmitted field strength of the system can be used to determine the separation distance between systems to avoid unwanted interference.
- Evaluate the installation/location where the system will be used and determine the likelihood that the system will cause interference with existing systems in the area.
- Issue a Permit for the system to be temporarily installed or used on site.
- Conduct an on-site evaluation of the system to determine if a CoC can be issued.

*Permits authorise the use of electrical/electronic equipment on site for a limited amount of time.
*CoC authorises the use of electrical/electronic equipment on site permanently.

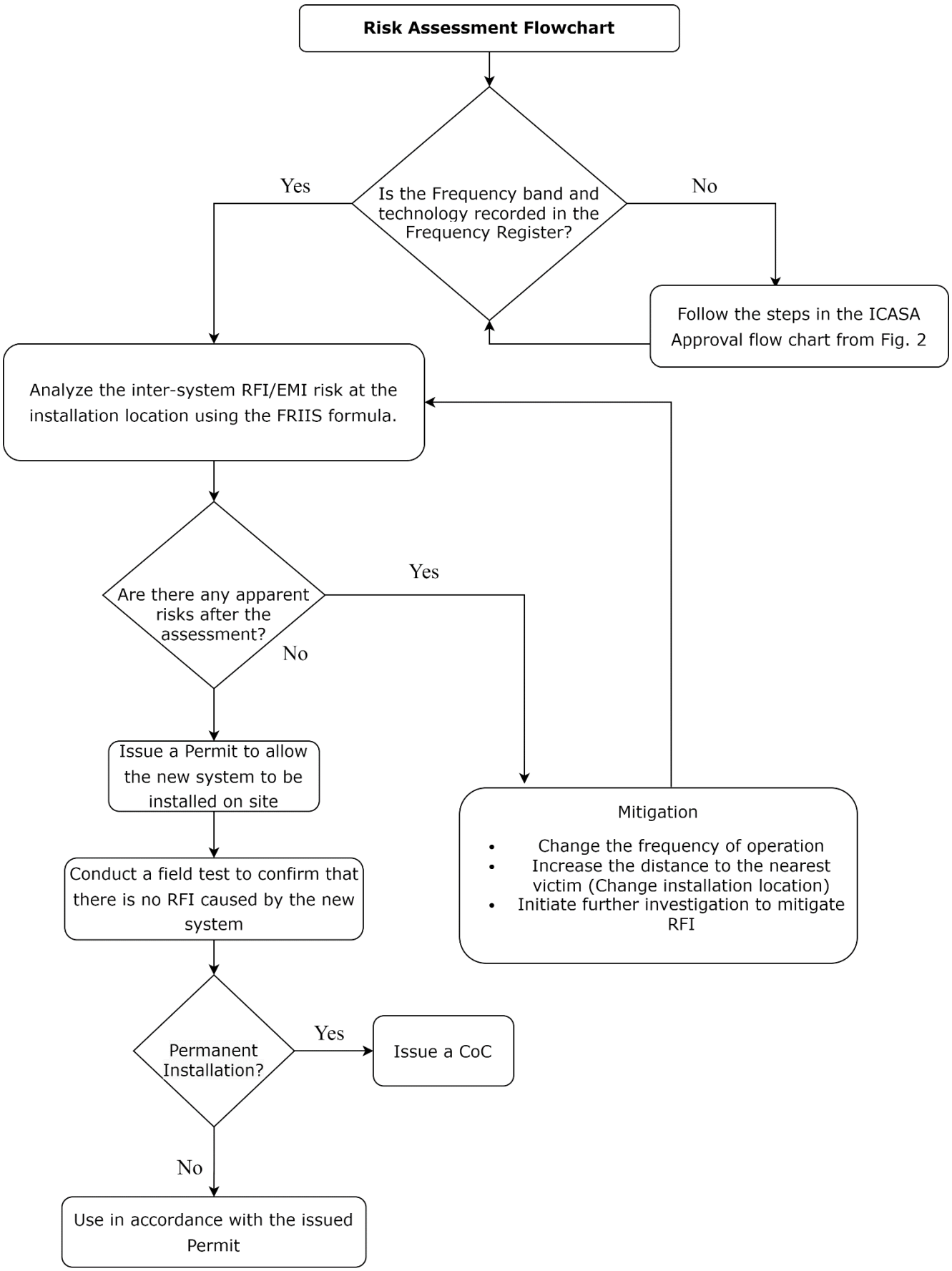


Figure 3 - Risk Assessment Flow Chart

6.1 HUMAN RISK – ICNIRP LEVELS

The International Commission of Non-Ionizing Radiation Protection (ICNIRP) is a scientific organisation that researches and determines limits for human exposure to electric, magnetic and electromagnetic fields.

The ICNIRP safety levels are illustrated below. If any electrical/electronic equipment emits/transmits below these levels at that specific frequency, it poses a negligible risk to human safety. Note that, if an electrical/electronic device has been tested and type approved by ICASA before its sale or use, then its emissions would be below the ICNIRP limits of electric and magnetic field exposure.

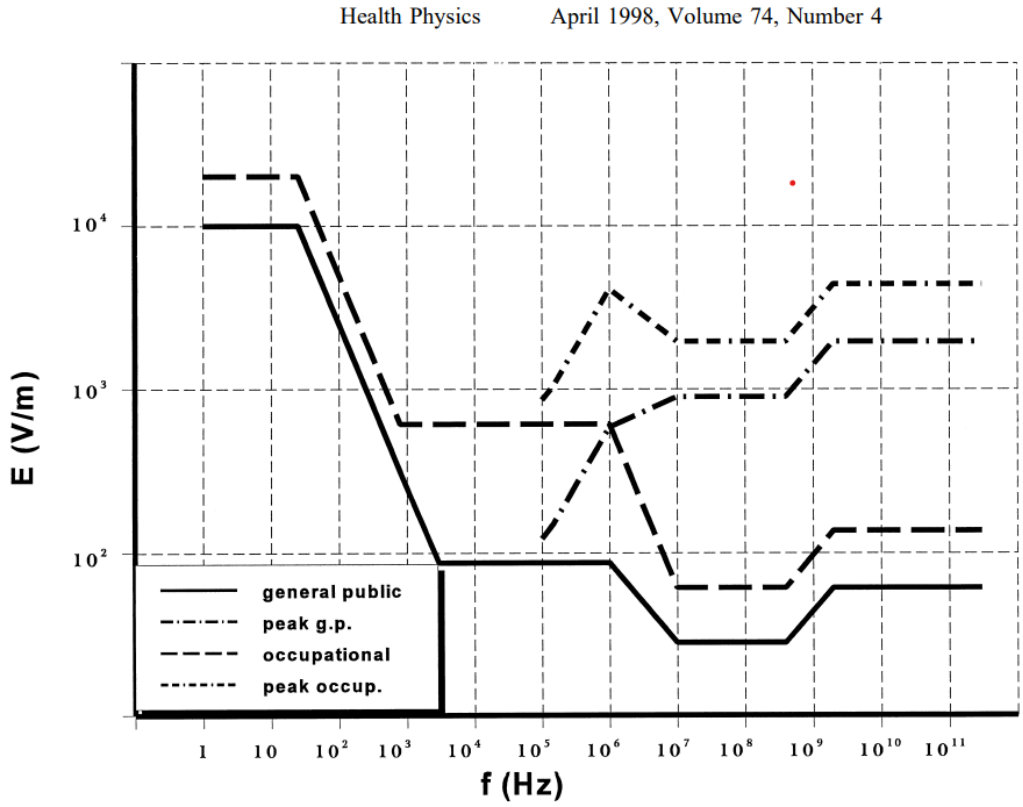


Figure 4 - Reference Levels for Exposure to Time Varying Electric Fields

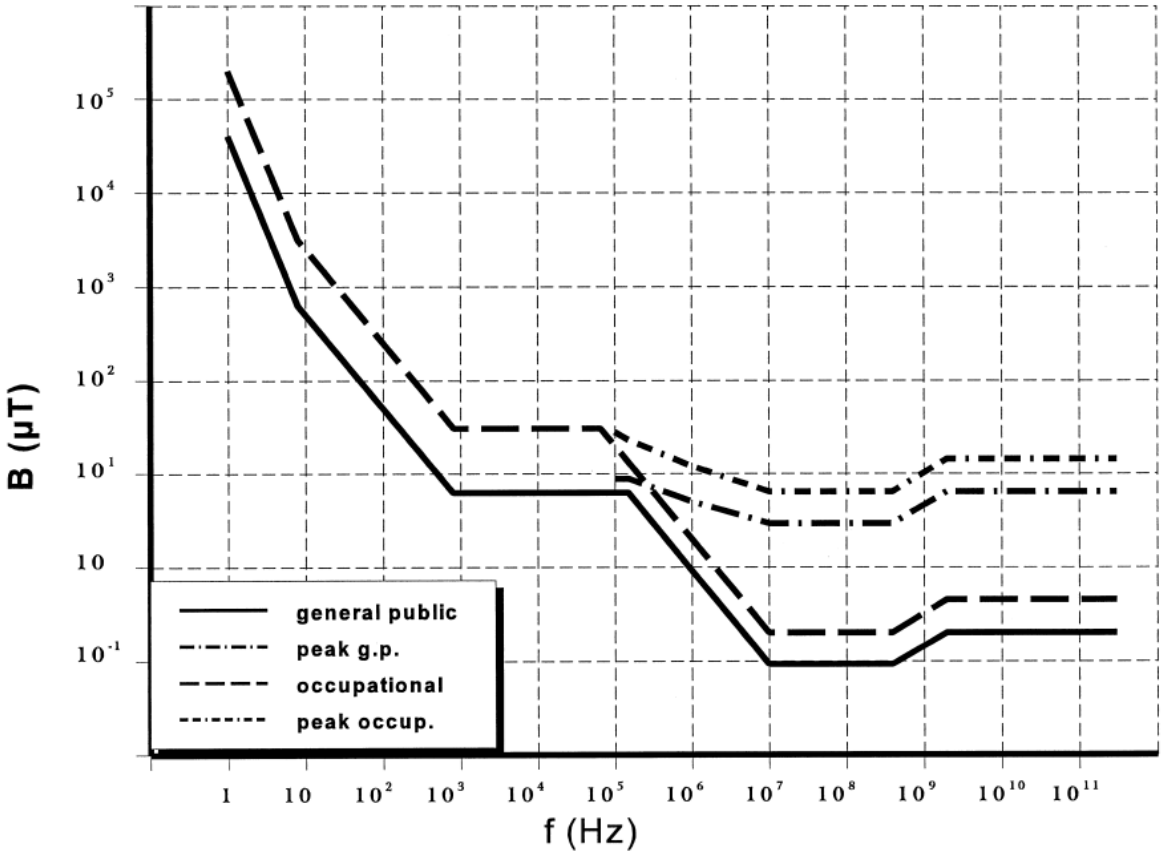


Figure 5 - Reference Levels for Exposure to Time Varying Magnetic Fields

7. CPS SYSTEMS USED FOR TMM'S IN THE MINING INDUSTRY

7.1 LIST OF TECHNOLOGIES TYPICALLY USED IN SOUTH AFRICA WITH THEIR RESPECTIVE OPERATING FREQUENCIES

Table 1 - CPS Technologies with Operating Frequencies

Area of Operation	Technology	Frequency	EIRP
Above Ground	GPS	1215-1260MHz 1563.42-1587.52 MHz	Rx* Only Rx* Only
	AI Cameras	2.4-2.483GHz 5.150-5.350GHz	100mW 200mW
Below Ground	RFID applications	70-119 kHz 119-135 kHz 13.553-13.567 MHz 865-868 MHz 865-868 MHz 865-868 MHz 915.2-915.4 MHz 915.4-919 MHz 919.2-921 MHz	42dBuA/m @ 10m 72dBuA/m @ 10m 60dBuA/m @ 10m C*1,2,3: 100mW C*4,7,10,13: 2W C*5,6,8,9,11,12,14,15: 500mW 100mW (Passive Tags Only) 4 W 4W @ 920MHz
Above or Below Ground	Radar	915.1-915.2 MHz 1215-1300 MHz 2.7-2.9 GHz 5.57-5.65 GHz 24.05-24.25GHz	25mW Spectrum Approval Dependant Spectrum Approval Dependant Spectrum Approval Dependant 100mW
	Lidar	331.49 THz 193.55 THz	Outside the Microwave Frequency Band.

*C – Channel
*Rx – Receive

All technologies/systems that implement intentional transmitters/transceivers, used in South African mines, must be limited to transmit power or 500mW, even if the specified band of operation states otherwise. This is stated in the ME-2-2003 document [9]. The ME-2-2003 document discusses the use of radio transmitter frequencies and radiated power transmitted by equipment used in underground mines. A new version of the document was submitted for review and approval, but it is still marked as a draft document and has not yet been approved.

There are three ITU regions in the world, numbered as ITU Regions 1, 2 and 3. Each region has their own frequency band allocation and contains different countries which in turn can have their own regulatory body that regulates the frequency spectrum allocations. ICASA is the regulating body that regulates the frequency allocations in South Africa. Below is a map showing the ITU regions:

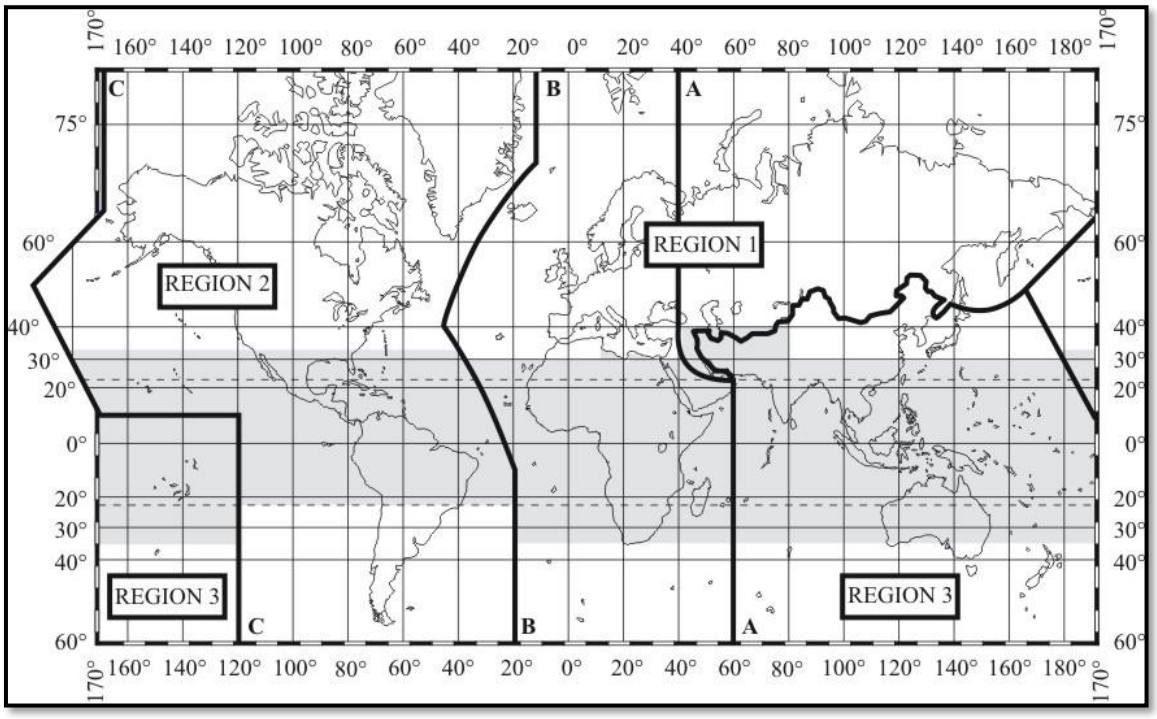


Figure 6 - ITU Regions of the World

When considering the acquisition of a new system/technology from a different country (other than those specified under ITU Region 1), then the new system must comply to the allocated frequency band in South Africa. ICASA will have to approve the use of the new system in South Africa (Either Type Approval or Spectrum License).

8. VEHICLE TO ANYTHING (V2X)

V2X refers to a set of communication standards that enable vehicles to communicate with their surroundings, including other vehicles, pedestrians, infrastructure and the Internet. The two main V2X technologies used are: Dedicated Short Range Communications (DSRC) and Cellular-V2X.

Both the listed technologies operate in the frequency range of 5.85GHz – 5.925GHz. DSRC is based on the IEEE 802.11p standard. C-V2X is based on the 3GPP Standard and uses Mobile Cellular communications to enable V2X technology to operate correctly.

The frequency band (5.85GHz – 5.925GHz), is a dedicated band specified by ICASA and the Radio Regulations for ITU regions 1, 2 and 3 to be:

Table 2 - 5.85GHz – 5.925GHz Band Allocation for ITU Regions 1,2 and 3

ITU Region 1 (South Africa)	ITU Region 2	ITU Region 3
FIXED	FIXED	FIXED
Fixed Satellite	Fixed Satellite	Fixed Satellite
Mobile	Mobile	Mobile
	Amateur	Amateur
	Radio Location	

* FIXED means radio communications between fixed locations, such as buildings that don't move as opposed to mobile communications

The abovementioned frequency band is not specified in the Radio Frequency Spectrum Regulations 2015, thus if a new V2X technology is proposed to be used in this frequency band it will be subject to a spectrum approval license from ICASA.

9. CONCLUSION AND RECCOMENDATIONS

A frequency register or frequency spectrum management plan is a necessity for any mining organisation to function optimally. Sources to ease the process of compiling a register and conducting risk assessments will be provided with the document, including a template for a frequency register and an Excel sheet that would ease the calculation of field strength for inclusion in frequency risk assessments to ensure compliance with all the necessary regulations.

For additional information regarding EMC testing, methodology and capable laboratories, refer to the EMC test methodology document.

10. ANNEX A: ME-2-2003 DOCUMENT

ME-2-2003

Enquiries: F Wilmans
Tel: 012 317 9117

Chief Inspector of Mines		Ms Hermanus
Chief Director:	Other Mines, Mine Health and Mine Surveying	Mr Mojapelo
	Coal, Offshore and Mine Equipment	Mr Zondi
	Gold, Platinum and Mine Safety	Mr Botha
Director:	Occupational Hygiene	Mr Rowe
	Mine Surveying (Acting)	Mr Loggenberg
	Occupational Medicine	Dr Ohaju
	Mine Equipment	Mr Wilmans
	Mine Safety	Mr Ndiweni
	Management Support and Internal Control	Mr Doyle
Principal Inspector:	Gauteng (Mr Erasmus)	011 339 6910
	KwaZulu-Natal (Mr Dube)	034 218 1365
	Western Cape (Mr Smith)	021 419 6260
	Northern Cape (Mr Klopper)	053 830 0827
	Northwest (Mr Moagi)	018 462 9039
	Northern Province (Mr Kent)	015 291 1757
	Free State (Mr Dow)	057 352 2270
	Mpumalanga (Mr Msiza)	013 690 2390
	Eastern Cape (Mr McLoughlin)	041 585 9097

CONTROL OVER THE USE OF RADIO FREQUENCIES AND RADIATED POWER TRANSMITTED BY EQUIPMENT USED IN MINES

The use of wireless communication and control systems in mines is rapidly increasing. Wireless technology improves productivity but could also pose a risk to the health and safety of persons. Unintended detonation of explosives and equipment malfunction incidents have been reported due to electromagnetic interference from hand held two-way radios, cellphones, remote control units for motor vehicle central locking/immobilisers and automatic doors and gates.

Equipment such as tag readers, leaky feeder radio communication systems, cellphones, two-way radios, radio controlled continuous miners, overhead crane control, locomotive controllers and shaft E-cams communication systems are using a variety of carrier frequencies up to 2,4 Giga Hertz and are now in operation in mines. Unintended radio frequencies may interfere with other electronic equipment such as lockbell systems, telemetry systems, electronic and electric blasting systems, gas measuring equipment, instrument data and control loops. The likelihood of an ignition of flammable gas by means of electromagnetic radiation is remote, but possible, as steelwork underground can provide the “ideal” antenna.

More research is required to determine the risk associated with radio frequencies prior to the inclusion of the necessary standards and legislation for the mining industry.

As an interim measure until a South African National Standard has been developed the maximum transmitted power of wireless transmitters and cellphones used in mines must be limited to **500 milli Watt**. Only intrinsically safe type ia certified cellphones and two-way radios may be used in a hazardous location.

Mines using radio transmitting equipment in excess of 500 milli Watt radiated power must carry out a risk assessment in order to motivate the continued use of such equipment taking into consideration the above mentioned risks.

Persons performing blasting operations on surface must ensure that cellphones, wireless transmitters and remote control units cannot interfere with a blasting system.

Signed on 26/03/2003
MS M A HERMANUS
CHIEF INSPECTOR OF MINES
2003-03-26

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11. ANNEX B: DRAFT DOCUMENT – MS-2-2010

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Regional Operations – Gold and Platinum
Regional Operations – Other Mines
Support Services Unit
Technical Support Unit
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Northern Cape	053 832 5631
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Free State	057 352 2270
Mpumalanga	013 690 2390
Eastern Cape	041 585 9097

Legal Officer: G Ndamse
Snr Admin Clerk: Pride Shongwe

CONTROL OVER THE USE OF RADIO TRANSMITTER FREQUENCIES AND RADIATED POWER TRANSMITTED BY EQUIPMENT USED IN UNDERGROUND MINES

1. **Risks associated with radio transmitting equipment in the mining environment**

Unintended initiation of electric detonators (referred to as electric initiators in this document) and equipment malfunction incidents in mines have been reported where the likely cause has been determined to be electromagnetic interference from hand-held two-way radios, cellphones, or other radio transmission devices.

Wireless systems are being introduced in mines to advance efficient, automated and safer mining technologies, and this document is intended to provide guidelines to minimize risk to the health and safety of persons and mine installations that might be caused by use of such transmission equipment.

Examples of present day wireless systems are wireless networks, HSDPA and GPRS (cellular) systems, tag readers, leaky feeder radio communication systems, two-way radios, remote vehicular control, radio controlled continuous miners, overhead crane control, locomotive controllers and shaft cage communication systems, to name a few. Such wireless communication systems using a variety of carrier frequencies up to 2,4 GHz and above are being introduced or are waiting to be introduced into mines. The main concern is that electromagnetic emissions from radio frequency transmitters and wireless systems may interfere with other electronic safety-critical equipment such as lockbell systems, telemetry systems, electronic and electric blasting systems, gas measuring equipment, instrument data, control loops and winding or traction equipment. Likelihood of an ignition of flammable gas by electromagnetic radiation is remote but possible, as underground steelwork, for example, could provide an effective antenna leading to sparking.

2. Minimizing the risk of interference between radio transmitting devices and other mine electronics

Prevention of electromagnetic interference between two pieces of electronic equipment is achieved through electromagnetic compatibility (EMC) testing and compliance. Ideally both the transmitter and nearby mine electrical and electronic equipment should both have been tested for compatibility. Whilst standards for such testing have been in existence for many years, testing to these standards has only recently been made mandatory or will still become mandatory as directed by the Independent Communications Authority of South Africa[i]. Emission testing in 2.1 and 2.2, below, is required and although susceptibility testing in 2.3 is not yet compulsory it is **strongly recommended** that such testing be specified in the procurement of new mine electronic equipment:

2.1. Spurious emissions from any new electronic equipment destined for use on mines should comply with the requirements appropriate to the type of equipment, as given in the standards listed in reference 1. SANS 211[ii], SANS 215[iii] or SANS 222[iv] are the most likely tests to be applicable in the mining environment. Emission limits for industrial and commercial establishments are applicable.

2.2. Radio communications equipment and other wireless systems should be guided by the requirements of the Electronic Communications Act, No. 36 of 2005 embodying the South African Table of Frequency Allocations[v,vi] (SATFA). Licence exemptions[vi] are normally sought in terms of section 31(6) of the Act. Should it be necessary to utilize equipment underground that is not compliant with SATFA requirements, exemption from this mining directive may be applied for together with a motivation and appropriate risk assessment.

2.3. Any new electrical or electronic system for use in the mining environment, particularly systems handling any safety-critical function including, for example, communication, information or data transfer or control should be tested for immunity to electromagnetic interference, using appropriate test standards listed in reference 1. Typical compliance tests would include an appropriate selection of SANS 61000-4-2/3/4/5/6/8 and 11[vii] standards. Annex 1 to this document lists preferred test levels and performance criteria.

2.4. Equipment and systems for firing electric initiators should comply with appropriate tests from the EMC test provisions in SANS53763-26:2008[ix] Annex A. Systems for firing electronic initiators should additionally comply with SANS1717-1:2005[x] Clause 5.3 Test for the electromagnetic compatibility of EDD's (electronic delay detonators) and blast initiation systems.

3. Maximum power limit for radio transmitters and necessity of risk assessment

This Directive sets the maximum effective radiated power[xi] (ERP) for any wireless communication system in mines at **500 milliwatts**.

Where mines are already using, or planning to use, wireless communications systems that exceed 500 milliwatts ERP, a risk assessment should be performed to determine control measures that may be required in the use of that communication system in the proximity of any critical and safety-critical systems.

Caution in specifying operating power levels is advised and the minimum power level consistent with reliable operation for the application is strongly advised. Where radio transmitter exclusion zones are necessary, these must be effectively enforced.

Radio transmitter exclusion distance from critical electronic equipment is the distance required to attenuate the signal of a transmitter of known ERP to a level where, as determined from tests in SANS 61000-4-3[8], the critical equipment remains functional. Calculation of field strength as a function of distance may be performed as in SANS 762[xii].

4. Recommendations for the use of radio transmitters in the proximity of electric initiators

The recommendations in 4.1 and 4.2, below, are general procedures in establishing radio transmitter exclusion distances from electric initiators. Annex 2 to this document gives an example of radio transmitter safety data issued by one South African manufacturer for their most sensitive electric initiators.

4.1. Radio transmitter exclusion distance for electric initiators – manufacturers recommendations

Where available, the recommendations of the manufacturer on radio transmitter usage in the proximity of the specific initiator in use should be diligently obeyed.

4.2. Determining radio transmitter exclusion distance for electric initiators – procedure

In cases where manufacturers exclusion distance information for radio transmitters is unavailable or where it is inadequate or inappropriate for the intended application, the following approach to determine safe working distances should be undertaken:

For exclusion distances in the range 9kHz to 60GHz and for radiated powers ranging from milliwatts to hundreds of kilowatts for both mobile and fixed installations, an analysis and risk assessment in accordance with SANS 762:2008[xiii] should be executed to determine safe working distances from a particular radio frequency source and for other safety measures required. From the manufacturers specification of the sensitivity of the electric initiator to be used, an initiator with matching or similar sensitivity listed in Table 1, page 14 of SANS 762 should be used for the assessment.

Note: If the transmitter power to the antenna (not ERP in this case) is less than the power required to fire a particular initiator, this may be recorded as a case where there is insignificant risk of initiation.

5. Electronic initiation systems

Electronic detonators and initiation systems approved for use in South Africa must meet stringent EMC requirements[9,10] and the risk of initiation by radio signals is minimal. In all cases the manufacturers recommendations for use in the presence of radio transmissions should be observed.

6. Misfired initiators

Any misfired, damaged, expired lifetime or otherwise non-conforming electric/electronic initiators must be regarded as unsafe in the presence of radio transmitters. Precautions must be taken to ensure that any such initiator bound for destruction or return are subjected to minimal radio frequency exposure.

7. Hazardous locations

Only intrinsically safe IS type certified wireless equipment, including cellular phones and two-way radios, may be used in a hazardous location.

Notwithstanding the power limit of 500 mW earlier in this document, an assessment in terms of BS 6656[xiv] should be undertaken to determine site-specific power limits and other restrictions on the use of radios in that hazardous location.

8. Spectrum management: Maintaining a radio frequency (RF) register

An increasing number and variety of radio and wireless communication systems are being used in underground mining operations to improve safety, communication and efficiency. As many of these new wireless systems must communicate safety-critical data reliably, it is necessary to manage the radio frequency spectrum in mines to ensure that mutually compatible systems are used in all areas.

Mines are thus required to keep an RF Register of all transmitting devices used on the mine (This list is to include wireless systems used for the IT infrastructure). A typical list should include the following basic information:

Wireless unit: model	Manufacturer	Supplier	ICASA approved?	Fixed/ mobile	Area of use	Modulation type	Power setting	ERP/ antenna gain

9. Other concerns

Persons performing blasting operations must ensure that cellphones, radios and other transmitting devices are outside the radio transmitter exclusion zone for the blasting system and initiators.

Signed on: _____

CHIEF INSPECTOR OF MINES

10. References

[i] Notice 215 of 2008 Government Gazette no. 30753, 7 February 2008. Notice of intention to make regulations in respect of technical standards for electronic communications equipment.
[ii] SANS 211 CISPR 11 Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement.
[iii] SANS 215 CISPR 15 Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
[iv] SANS 222 CISPR 22 Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
[v] Notice 890 of 2008, Government Gazette no. 31264, 22 July 2008. Draft South African table of frequency allocations (SAFTA)
[vi] Notice 1442 of 2004, Government Gazette no. 26584, 15th July 2004. South African table of frequency allocations (SAFTA).
[vii] Notice 432 of 2008, Government Gazette no. 30955, 7th April 2008. Columns A, B and C of the table are applicable.
[viii] SANS 61000-4-2 (IEC 61000-4-2) Electrostatic immunity discharge test.
SANS 61000-4-3 (IEC 61000-4-3) Radiated, radio frequency, electromagnetic field immunity test.
SANS 61000-4-4 (IEC 61000-4-4) Electrical fast transient/burst immunity test.
SANS 61000-4-5 (IEC 61000-4-5) Surge immunity test.
SANS 61000-4-6 (IEC 61000-4-6) Immunity to conducted disturbances, induced by radio-frequency fields.
SANS 61000-4-8 (IEC 61000-4-8) Power frequency magnetic field immunity test.
SANS 61000-4-11 (IEC 61000-4-11) Voltage dips, short interruptions and voltage variations immunity test.
[ix] SANS53763-26:2008 Explosives for civil uses — Detonators and relays Part 26: Definitions, methods, and requirements for devices and accessories for reliable and safe function of detonators and relays Annex A Electromagnetic compatibility and interference testing.

[x] SANS1717-1:2005 The design of detonator initiation systems for use in mining and civil blasting applications Part 1: Electronic initiation systems Clause 5.3 Test for the electromagnetic compatibility of EDDs and blast initiation systems.
[xi]Government Gazette, 30 July 2002 No. 23695 page 49: The maximum effective radiated power. In the case of an omni-directional antenna it is the maximum effective radiated power in any direction. In the case of a directional antenna it is the effective radiated power in the direction of maximum gain. The ERP is specified in watts (W).
[xii]SANS 762:2008 (BS 6657:2002) Assessment of inadvertent initiation of bridge wire electro-explosive devices by radio frequency radiation — Guide. Clause 9.4.3 - Calculation of effective field strength.
[xiii] SANS 762:2008 (BS 6657:2002) Assessment of inadvertent initiation of bridge wire electro-explosive devices by radio frequency radiation — Guide
[xiv]BS6656:2002 Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation. Guide

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ANNEX 1

Table 1 lists the test levels for the tests listed in Clause 2.3, above that might be indicated by risk assessment for equipment to be used in a safety-critical application. Test levels increase in severity from 1 to 4.

Table 2 lists the class of performance in these tests. The actual tests performed and test levels to be used in Table 2 are determined by risk assessment based on the application and environment.

EMC test and performance parameters are to be agreed between the manufacturer/supplier and mine authority.

Table 1: Test levels

Test Number	Test Level
SANS 61000-4-2	4
SANS 61000-4-3	3
SANS 61000-4-4	4
SANS 61000-4-5	4
SANS 61000-4-6	3
SANS 61000-4-6	4
SANS 61000-4-11	Lowest and highest declared voltages

Table 2: Performance classification

Classification	Description of Classification
a	Normal performance within limits specified by the manufacturer, requestor or purchaser
b	Temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention;
c	Temporary loss of function or degradation of performance, the correction of which requires operator intervention
d	Loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.
Comment	The manufacturer's specification may define effects on the EUT which may be considered insignificant, and therefore acceptable.

Note that in *Class c* and *Class d* it may be difficult to restore functionality in a mine, hence *Classes a* or *b* are preferred. For safety-critical functions *Class a* is preferred unless otherwise indicated in a risk assessment.

ANNEX 2

Example of radio transmitter exclusion data taken from AEL material safety data sheet PSDS 029 for the "Type 0" instantaneous electric detonator, Clause 3 – Hazard identification.

Radio Exclusion Distance – General Rules:
*After deployment, including connection to a blasting circuit, but not connected to a shot exploder: A uniform radio exclusion distance of fifteen meters **(15m)** from any blasting circuit is recommended for radio equipment rated at 25W or less in the frequency range 100MHz to 2.5 GHz (Including cell phones).*

A two-meter (2m) radio exclusion distance must be observed for initiators coiled, packaged and sealed by AEL when using transmitting equipment rated at 25W or less in the frequency range 100MHz to 2.5GHz

(Cell phones and other two-way radio communication systems operating at up to 25W in this band may thus be used with this exclusion distance when storing and transporting original AEL-packaged product.)

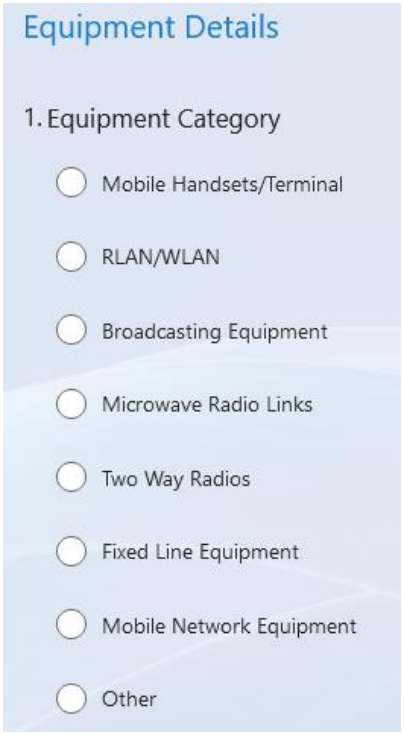
No exclusion distance is required for transmissions of 25 W or less outside the 100 MHz to 2.5 GHz range for initiators coiled, packaged and sealed by AEL.

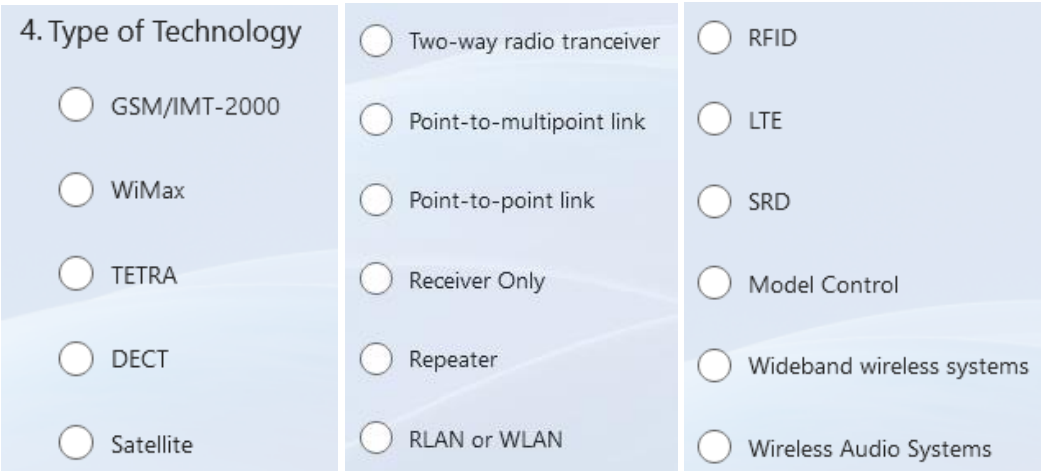
Radio Exclusion Distance – Application-specific Risk Assessment:
*For transmission powers and frequencies not covered by the general rules, above, or where exclusion distances in the general rules are too large for a particular application, a risk assessment in accordance with SANS 762:2008** is strongly recommended in order to obtain safe working distances from a particular radio frequency source.*
This standard facilitates determination of exclusion distances in the range 9kHz to 60GHz and for radiated powers ranging from milliwatts to hundreds of kilowatts for both mobile and fixed installations. The sensitivity of the AEL IED electric detonator is equivalent to the "Type II" electro-explosive device listed in Table 1, page 14 of SANS 762.

***SANS 762:2008 (BS6657:2002) South African National Standard – Assessment of inadvertent initiation of bridgewire electro-explosive devices by radiofrequency radiation – Guide.*

Any misfired, damaged, expired lifetime or otherwise non-conforming initiator must be regarded as unsafe in the presence of radio transmitters. Precautions must be taken to ensure that any such initiators, bound for destruction or return, are subjected to minimal radio frequency exposure.

12. APPENDIX C: ICASA APPLICATION TECHNICAL REQUIREMENTS






Wireless Audio Systems
Wireless Microphones
Paging Systems
Broadcast
Inductive loop system
Smart Metering
Telecontrol or Telemetering
Monitoring Equipment
Passive Component
GSM
WCDMA
LTE UE
LTE BS
NR
AIS
Alarm
ANT+
Assistive Listening Devicee (ALD)
BFWA
BLE
Bluetooth
BT +BDR
BT BDR/EDR
Galileo
GPS
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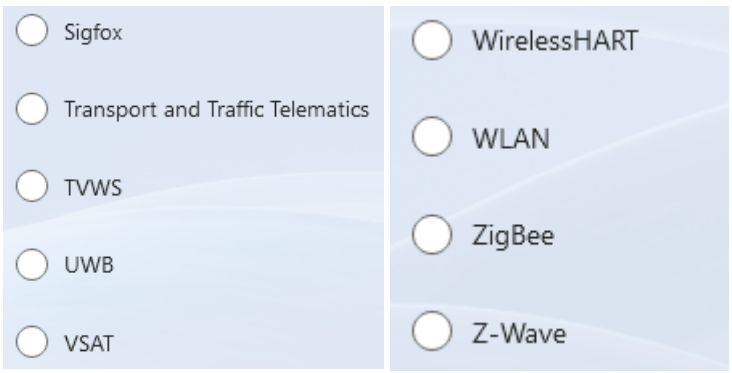
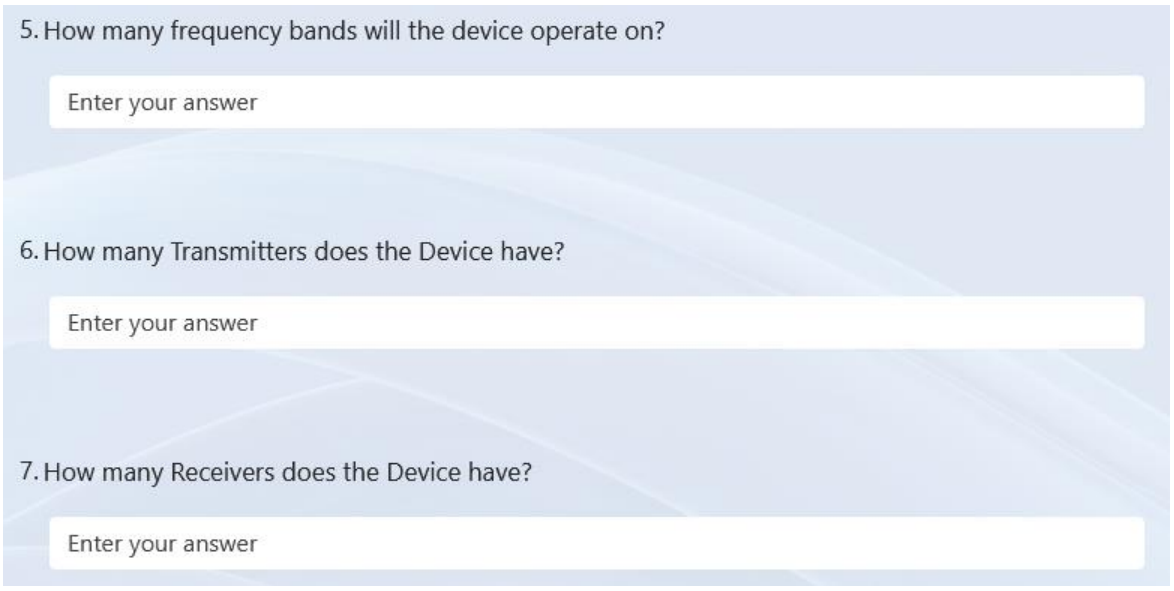
LoRa
LoRaWAN
Medical Implant
NB-IoT
NFC
Radar
RLAN


Sigfox
Transport and Traffic Telematics
TVWS
UWB
VSAT
WirelessHART
WLAN
ZigBee
Z-Wave


5. How many frequency bands will the device operate on?
Enter your answer
6. How many Transmitters does the Device have?
Enter your answer
7. How many Receivers does the Device have?
Enter your answer

Technology 1 (Tx only, Rx only or Tx and Rx)

If all the Technologies from the device have been entered, skip the extra entry sections.

8. Name of Technology

Enter your answer

9. Choose the technology operation configuration *

- ○ Tx only
- ○ Rx only
- ○ Tx and Rx

Technology 1 Tx and Rx

10. Tx Frequency band upper and lower limits (for example 2400MHz to 2500MHz) - Separate multiple bands by a comma.

Enter your answer

11. Rx Frequency Bands upper and lower limits.

Enter your answer

12. Indicate the applicable channel spacing for the Transmitter (for example 1 MHz)

Enter your answer

13. Indicate the applicable channel spacing for the Receiver (for example 1 MHz)

Enter your answer

END OF DOCUMENT