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Collision Prevention System EMI/EMC Test Instruction

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1. SCOPE

1.1 INTRODUCTION

This is a companion document to WP8068_4/23, Collision Prevention System EMI/EMC Test Methodology. Test instructions contained in this document are based on well-established CISPR, ISO and IEC procedures and methods.

Although it is advantageous to make use of ISO 17025 accredited laboratories, their scope of accreditation will not cover custom tests and tests not performed at their laboratory's location. ISO 17025 accreditation requires test personnel competency evaluation and rigorous calibration and system evaluations that instils confidence in the tests and results although the specific method is not on the schedule of accreditation. The test is not part of ITC Services or any of the accredited laboratories' SOA. The report will therefore not carry the SANAS accredited logo.

1.2 PURPOSE

This document details the EMC test requirements, the tests area, test conditions, Equipment Under Test (EUT) set-up, EUT pass/fail criteria, and description of the test procedure for each test method.

2. APPLICABLE AND REFERENCED DOCUMENTS

Referenced and Applicable Documents	
[1]	Integrated Collision Prevention Systems Testing Regime Rev 4 – SECDI/MCSA
[2]	Collision Prevention System Test Verification Project – Final Report Rev 2 – UP/MCSA
[3]	ISO 17025 General requirements for the competence of testing and calibration laboratories
[4]	WP8068_4/23, Collision Prevention System EMI/EMC Test Methodology
[5]	WP8068XX Standards Gap analysis
[6]	SANS 212/ CISPR12 Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of off-board receivers.
[7]	SANS 225/ CISPR 25 Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of on-board receivers.
[8]	SANS 211/ CISPR 11 Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement
[9]	Mine Health and Safety Act No. 29 of 1996
[10]	Government Gazette Vol.690 No. 47790 – 21 December 2022 – *Commencement of the Regulations Relating to Trackless Mobile Machinery.*
[11]	ICASA. *National Radio Frequency Plan 2021.* No.46088
[12]	Government Gazette Vol.597 No. 38641 – 30 March 2015 – *The Radio Frequency Spectrum Regulations 2015*
[13]	Government Gazette vol. 490 Cape Town 18 April 2006 No. 36 of 2005: Electronic Communications act, 2005.
[14]	MS-02-2010: *Control over the use of radio transmitter frequencies and radiated power transmitted by equipment used in underground mines.*
[15]	NASA-STD-4003A – 2016-01-19 *Electrical bonding for NASA launch vehicles, spacecraft, payloads, and flight equipment*

3. ABBREVIATIONS AND DEFINITIONS

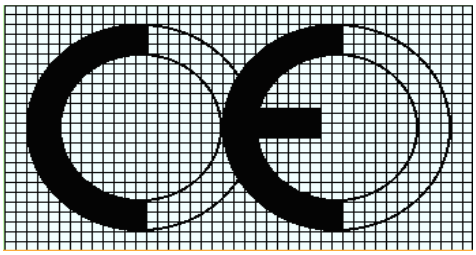
ACRONYMS AND ABBREVIATIONS	
AI	Artificial Intelligence
CAS	Collision Avoidance Systems
CE	Conformité Européene
CPS	Collision Prevention Systems
DMRE	Department of Mineral Resources and Energy
DSRC	Dedicated Short-Range Communications
EIRP	Effective Isotropic Radiated Power
EMESRT	Earth Moving Equipment Safety Round Table
EMI	Electromagnetic Interference
ESA	Electronic Subassembly
FAR	Full Anechoic Room
GLONASS	GLObalnaya NAvigatsionnaya Sputnikovaya Sistema
GPS	Global Positioning System
GSM	Global System for Mobile Communication
ICASA	Independent Communications Authority of South Africa
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISM	Industrial, Scientific, Medical
ISO	International Organization for Standardization
ITU	International Telecommunications Union
NAVIC	
OEM	Original Equipment Manufacturer
PAT	Personal Alarm Tag
PDS	Proximity Detection Systems
QZS	Quasi-Zenith Satellite System
RF	Radio Frequency
RFI	Radio Frequency Interference
RFID	Radio Frequency Identification
SAC	Semi-Anechoic Chamber
SBAS	Geosynchronous Satellite Systems
SRD	
TMMs	Trackless Mobile Machines
UHF	Ultra-High Frequency
V2X	Vehicle-to-Anything
VLF	Very Low Frequency

Table 1: Acronyms and abbreviations

3.1 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 “standardised” template declaration drawn up by the manufacturer to demonstrate the fulfilment of the EU requirements relating to a product bearing the CE mark.

EMC
Electromagnetic Compatibility. The goal of EMC is the correct operation of different equipment in a common electromagnetic environment by limiting the intentional and unintentional radiation, propagation and reception of electromagnetic energy.

ERP
Effective radiated power: Power transmitted by a device including system gains and losses.

Good quality earthing and bonding
A value of <5mΩ

Intentional Transmitter
Any device that is designed to produce radio waves.

Site Spectrum Control Register
A document or table that lists the intentional transmitters deployed on site. This includes 2-way radios, vehicle transmitters, point to point links, IP cameras etc. Minimum information required is the type of equipment, transmission frequency and the transmitter level.

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.

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. WiFi, Bluetooth, Zigbee, Short Range Devices, GSM etc. are examples.

Unintentional Radiator/Emitter
A device that creates radio frequencies as a byproduct, which is unintentionally emitted 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 with all the regulations stipulated by ICASA as well as a site-specific Frequency Register. This will be issued by the person on the mine that is responsible for safety. The intension is that the permit grants permission to TEMPORARILY use a transmitter on the site until it has been established that there is compatibility between the new device and the current devices. The validity will be as long as it takes to ensure compatibility. If there is incompatibility, the new device will then be removed from the site.

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). This will be issued by the person on the mine that is responsible for safety, however, the CoC has no expiry time, unlike the permit mentioned above.

4. MINE SITE AMBIENT EMISSIONS (CUSTOM TEST)

The purpose of the ambient test is to measure a baseline of the electromagnetic ambient at mines that can inform the CPS developers and suppliers about the expected electromagnetic environment that the CPS system must function in. Emphasis is on the possible false triggering of the CPS and desensitisation of the CPS.

SANS 211 forms the basis of the test procedure as it covers radiated emissions in the 9 kHz up to the 400 GHz frequency range. As the measurements are ambient emissions only, no limit line will be applied.

4.1 GENERAL REQUIREMENTS

- Permission to take photos during tests shall be confirmed during the initial site visit/ discussions.
- Site specific data should be completed in the test plan based on the input from the site team.
- No electronic devices such as smartwatches, cell phones, etc can be brought to the test area by personnel involved in the test. Caplamps which have CPS tags installed will be discussed with the onsite team.
- Tests should be done during normal site operations (during production).
- Availability of the Site Spectrum Control Register or similar document prior to the site measurements.

4.2 CRITICAL CPS FREQUENCY BANDS

The following frequency bands are considered critical for various CPS. The list is not necessarily exhaustive and may be supplemented with information available from CPS suppliers. The frequency bands mentioned below have been sourced from the Government Gazette.

ID	F_{low}	F_{high}	Application
1	70 kHz	135 kHz	Vehicle mount generator for detection zone
2	915 MHz	918 MHz	Vehicle to Tag communication (SRD)
3	1176.45 MHz	1575.42 MHz	GPS/ Galileo/ BeiDou/ NAVIC/ SBAS/ QZS
4	1202.025 MHz	1609.3125 MHz	GLONASS
5	2400 MHz	2483.5 MHz	WiFi/ Bluetooth
6	5725 MHz	5875 MHz	WiFi

Table 1: Critical CPS Frequency Bands

4.3 SPECIFIC INTENTIONAL RADIATORS

Site specific frequency bands should be listed in the test plan prior to tests as transmission levels could damage sensitive measurement equipment. The table below shows the information necessary to evaluate the risk to measurement equipment and should be available from the site engineer(s) responsible for the management of electronic devices on each respective site:

ID	F_{low}	F_{high}	Transmit Power (ERP)	Application
1			5W	2-way radio (Security)
2			5W	2-way radio (Maintenance)
3			5W	2-way radio (Operations)
4			2W	PTP Dedicated Data Link
5			100mW	Wireless camera
6			100mW	WiFi

Table 2: Specific Intentional Radiators

4.4 TEST PARAMETERS

Although the following is recommended, engineering judgement should be applied, and deviations shall be motivated and described in the test report.

Parameter	Data	Comment
Frequency band	10kHz to 6GHz	Keep standard
Test Point	Waypoint (Lat Lon data)/ Shaft and location	Plot on map for test report
Test antenna height	1.5m	Antenna height to be reported in the test report.

Parameter	Data	Comment
Polarisation	Vertical	Antenna polarisation to be reported in the test report.
Resolution bandwidth	10kHz for frequencies <30MHz 100kHz for frequencies >30MHz	Balance between sweep speed and displayed noise floor
Attenuation	Fit for purpose. (Auto setting)	10dB preferred unless sensitivity is required. Out of band overload is possible
Preamp	Fit for purpose. (Auto Setting)	Off preferred unless sensitivity is required. Out of band overload is possible.
Data Capture	Export CSV data for Peak Hold and Average	Data to be shared with MCSA
Limit Line	None	Not applicable
Logging time at each location	10 minutes	Max hold
Detector	Peak and Average	100 trace average

Table 3: Test Parameters

4.5 TEST EQUIPMENT

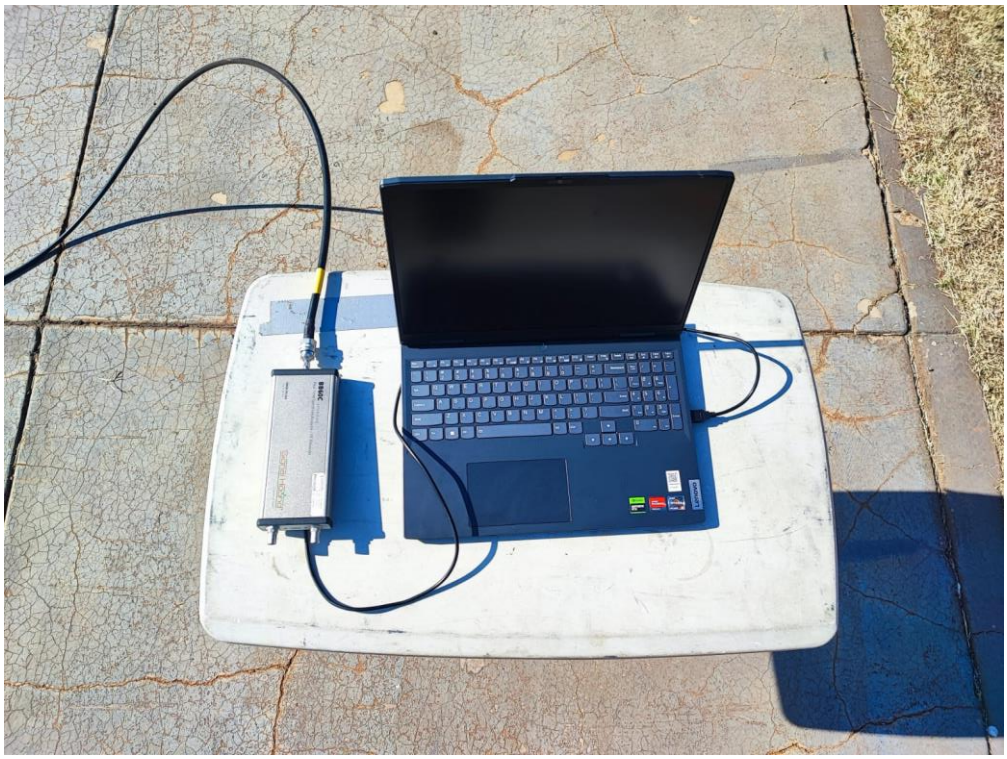
The following test equipment or fit for purpose equivalent will be used:

Item	Description	Serial Number	Estimated Dimensions
1	Signal Hound BB60	TBC	
2	Loop Antenna (10kHz to 1MHz)	TBC	
3	Omni Antenna (10kHz to 100MHz)	TBC	
	Omni Antenna (100MHz to 1GHz)	TBC	
	Omni Antenna (1GHz to 6GHz)	TBC	
4	Pre-amplifier	TBC	

Table 4: Test Equipment

The images below depict the test equipment described in the table above:

Picture 1: Antennas



Picture 2: Signal Analyser and Laptop

4.6 TEST SETUP

To measure the ambient environment on a mining site, the following setup is recommended:

1. Connect the signal analyser to a laptop.
2. Connect the antenna (the type of antenna depends on the frequency band to be measured) to the signal analyser.
3. Ensure that the hardware and software setups are applied as per Table 3.
4. Ensure that the data is stored continuously, and photographs are taken for repeatability of tests.

The images below demonstrate a typical test setup:

Picture 3: Loop Antenna (10kHz to 1MHz) Setup

Picture 4: Omni Antenna (100MHz to 1GHz) Setup

Picture 5: Omni Antenna (1GHz to 6GHz) Setup

4.7 TEST POINT IDENTIFICATION

The test location should be selected to capture a worst-case and a best-case scenario. The criteria for best- case would be maximum distance from electromagnetic noise sources and worst-case would be in close proximity (between 1m and 3m) of electromagnetic noise sources. This applies to both TMM accessibility (where the TMM will be driving/ operating) and Tag accessibility (where pedestrians will be walking/ working).

Pictures and landmarks/ checkpoints/ navigation points/ reference points to identify the test location shall be included in the test report.

END OF SECTION