Interference Testing And Consultancy Services (Pty) Ltd

ITC SERVICES (PTY (Ltd
Reg 1988/002032/07
Plot 1165 Kameeldrift East, Pretoria 0035
Private Bag X13 Lynn East 0039
Republic of South Africa
Tel +27 12 8081730

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WP 8677/23	0.5	Ukuqala Solar

SUBJECT

RFI Assessment of the Proposed PV Plant Site applicable to: Ukuqala Solar and Switching Station with OHL to Gamma Substation

KEYWORDS

electrical equipment, electrical infrastructure, EMI, RFI, OHL

DISTRIBUTION

Landscape Dynamics

SUMMARY

The Ukuqala Solar Project is a set of 2 PV facilities (Portion D and Portion E), for near future construction, located close to De Aar in the Northern Cape province. The purpose of this document is to report on the possible RFI from the PV facilities to surrounding electrical/electronic equipment, to assess whether any mitigation will be required to the PV facilities' power generation equipment.

According to the DFFE screening report, the Weather Radar Installation is the only highly sensitive installation close to the proposed PV facilities. This means that there is a possibility that the proposed PV facilities (Both Portions) will interfere with existing electrical/electronic equipment or electrical/electronic infrastructure.

Literature study revealed that there will be no interference from either Portion D or Portion E to the surrounding very high RFI sensitive areas. This statement is only valid when assuming that the PV plant inverters and sun tracking equipment comply to CISPR 11 class A specifications, as a technology partner has not yet been selected to provide actual EMC data.

AUTHOR	SIGNATURE
H Goosen	
DATE	17/02/2023
APPROVED	**SIGNATURE**
DATE	17/02/2023

1. DEFINITIONS AND KEYWORDS

AMA	Astronomy Management Authority
Electrical equipment	Any electrical machinery, electrical systems, appliances, or devices, including any wireless data communication used for the operation of these facilities, used for construction, distribution and transmission power systems, exploration, farming, household, manufacturing, maintenance, or mining purposes
Electrical infrastructure	Any infrastructure or facility, including any wireless data communication used for the operation of the electrical infrastructure, to be used in any way for electricity generation, electricity distribution, electricity transmission, or for a distribution or transmission power system, and electrical facilities and equipment used for these applications
EMI	Electromagnetic Interference
OHL	Over Head Line
RF	Radio Frequency
RFI	Radio Frequency Interference
PV	Photo Voltaic
DFFE	Department of Forestry, Fishery and Environment

Table 1: Definitions

2. BACKGROUND

The Ukuqala Solar Project is a set of 2 PV facilities (Portion D and Portion E), for near future construction, located close to De Aar in the Northern Cape province. The Radio Frequency Interference (RFI) that a new PV facility will emit, and the influence on existing electrical/electronic equipment must be evaluated. RFI from a PV facility is generally emitted from the inverters and sun tracking systems if they are installed, as solar panels do not emit any RF.
RFI and electromagnetic interference (EMI) can influence sensitive facilities such as airports, RF high sites, railway line control equipment, cell phone towers, EMI sensitive equipment in the area, etc. If a PV facility influences existing infrastructure, EMI mitigation will have to be implemented.

According to the DFFE screening report, the Weather Radar Installation is the only highly sensitive installation close to the proposed PV facilities. This means that there is a possibility that the proposed PV facilities (Both Portions) will interfere with existing electrical/electronic equipment or electrical/electronic infrastructure.

When considering the cumulative effect of other PV facilities on the RFI emissions, the total RFI caused by several PV plants could increase in a worst-case scenario. Refer to Section 8 for further information.

Figure 1 below, shows the RFI sensitivity results according to the DFFE screening report.

MAP OF RELATIVE RFI THEME SENSITIVITY

Sensitivity	Feature(s)
Very High	Less than 18 km form a Weather Radar installation

Figure 1 - DFFE Screening Report RFI Results (Portions D and E combined)

MAP OF RELATIVE RFI THEME SENSITIVITY

Figure 2 - Portion D

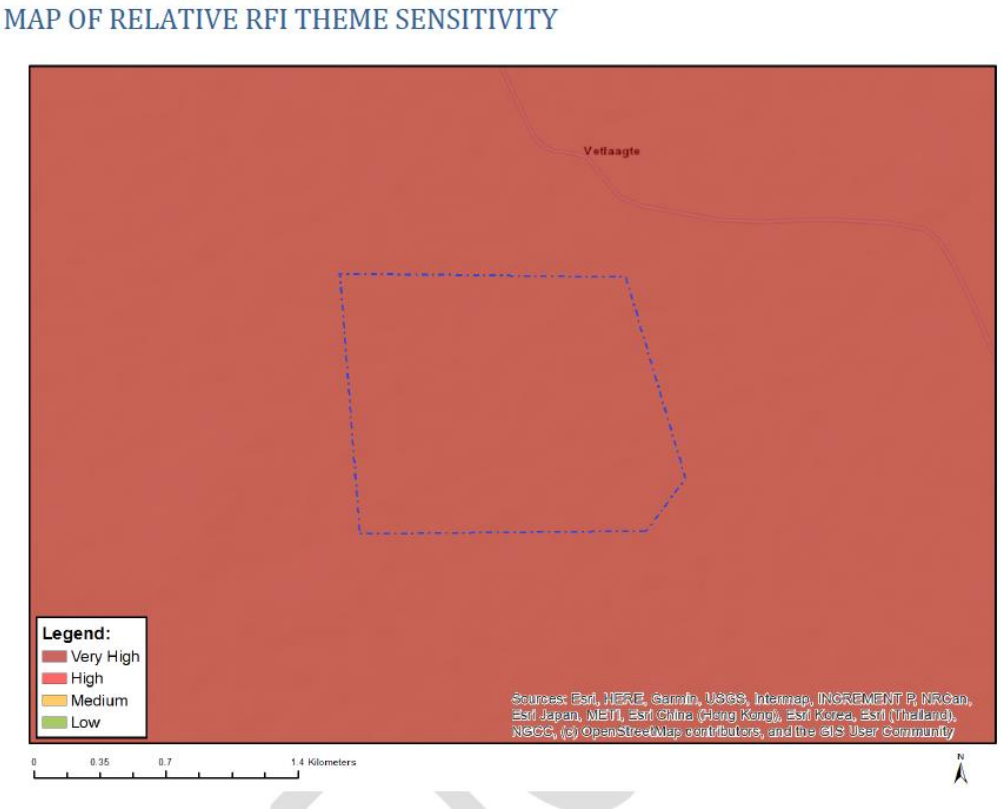

Figure 3 - Portion E

3. AIM

The aim of this document is to provide a RFI statement with motivation regarding the RFI from the PV facility inverters and sun tracking systems in the very high RFI sensitive area identified by the DFFE screening report. The sphere of radio frequency influence from the PV plants will be noted and discussed.

As the project is still in early planning stage, no Technology Partner has been selected yet. It is therefore assumed that the inverters and sun tracking systems to be used will comply to CISPR 11 Class A [7]. Receiver sensitivities, inside the indicated very high sensitivity area, are assumed, and listed in Table 3.

4. LOCATION

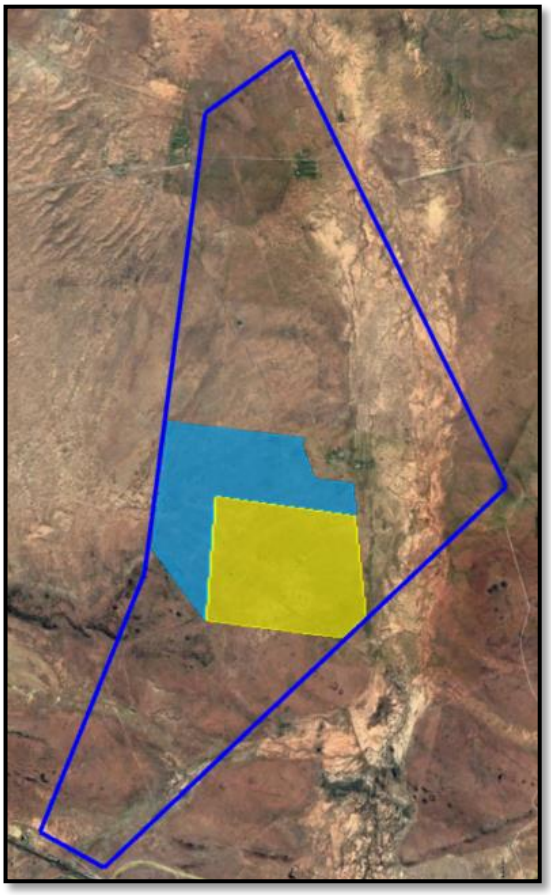

Figure 4 - Entire Proposed PV site

Figure 4 above is the entire proposed PV plant site. Within this area two PV facilities will be constructed within Portions D (Blue) and E (Yellow).

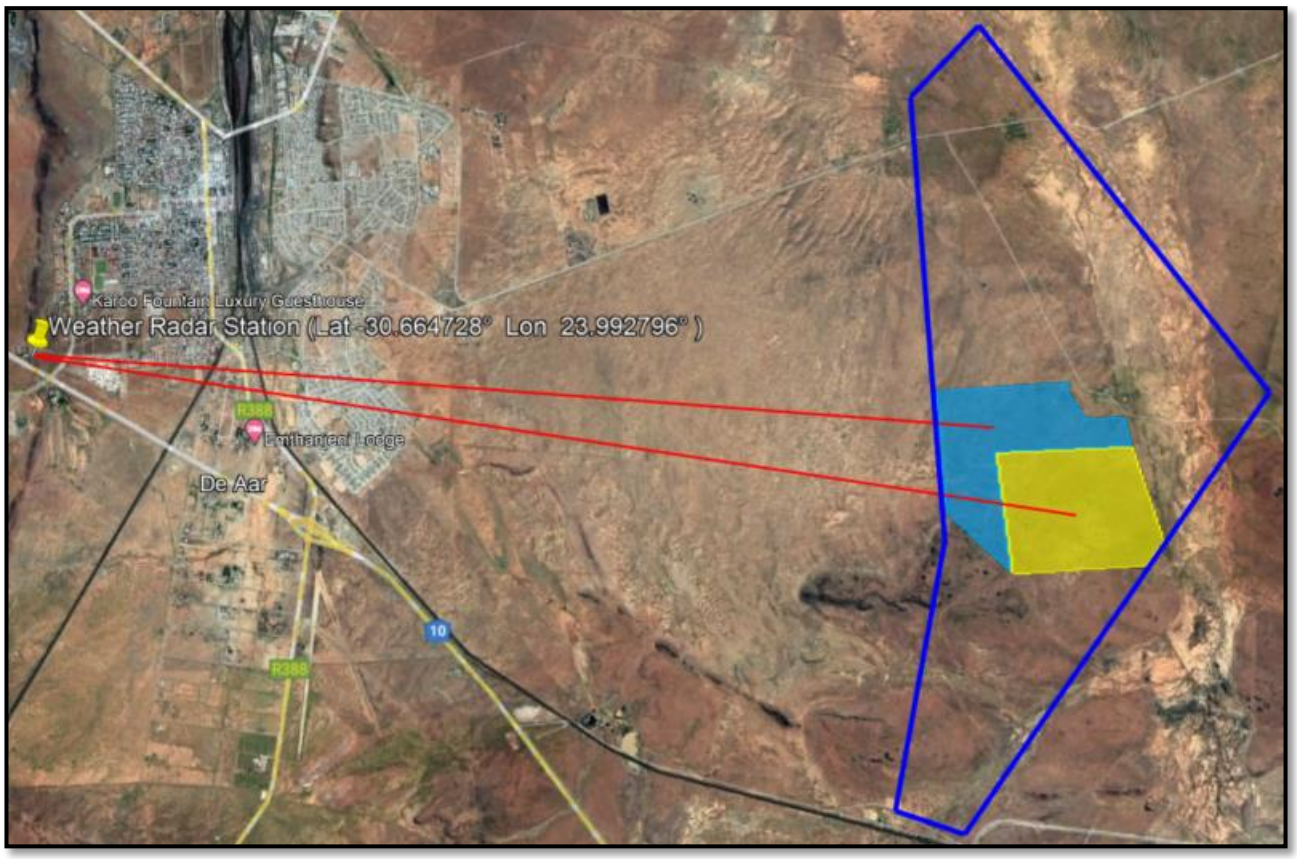

Figure 5 – PV Facilities to the Weather Radar Installation

Figure 5 above shows the location of the Weather Radar Installation flagged by the DFFE screening report as the Very High RFI Sensitive location.

5. TYPICAL PV FACILITY ARCHITECTURE

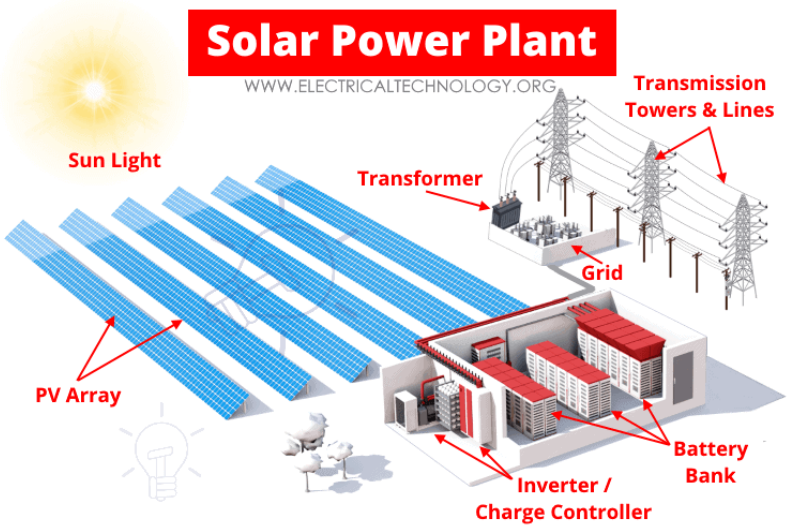

Figure 6 - Typical PV facility architecture

5.1 PV PLANT COMPONENTS AND LAYOUT

A typical PV plant consists of PV panels, sun tracking systems, batteries, inverters, and cabling. In this case the inverters and the possibility of a sun tracking system will be the highest generators of unintentional RF signals. The inverter is used to convert the DC power produced by the PV modules to AC power.

Cabling on the DC side can act as an unintentional antenna radiating between 30MHz – 300kHz, assuming the typical cable length will be between 10 to 100 meters [4].

5.2 PV TRACKING SYSTEM

A tracker system will adjust the PV panel angle towards the sun throughout the day by tracking the sun position in an East-West direction. The motors and controllers used in the tracking system can be a source of unintentional RF signals. A tracker system usually consists of the following components:

- Drive unit for solar tracking (motor and motor controller);
- Internal communication system;
- Site wide communications.

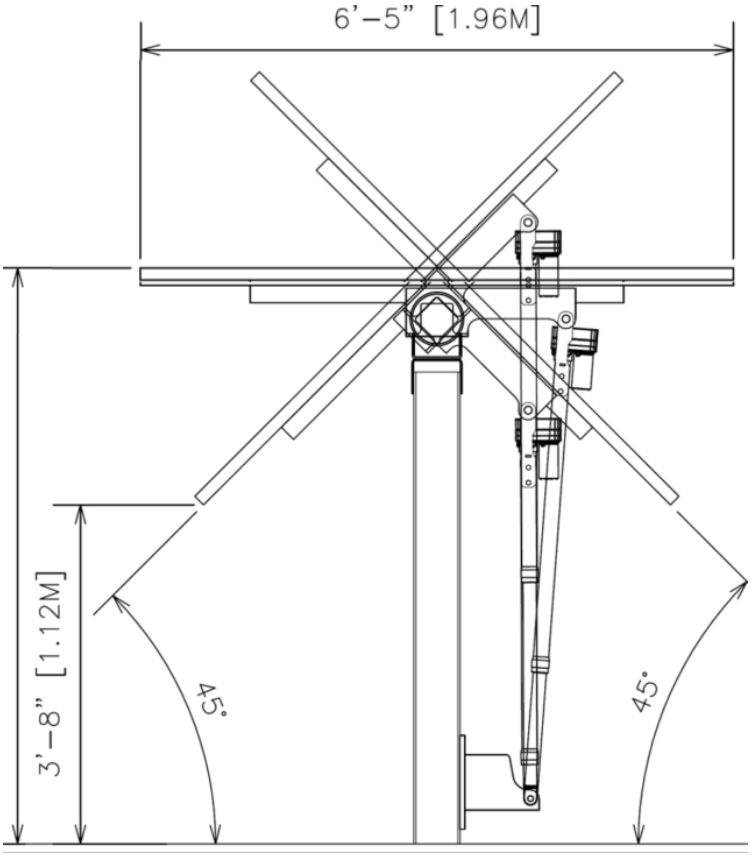

Figure 7 – Typical PV Tracker system

6. GENERAL GOOD PRACTISE RFI MITIGATION METHODS

There are some steps that can be considered when designing a new PV plant to minimise the amount of RFI or EMI that can be emitted, including the below:

- Properly ground the PV modules to reduce common mode impedance.
- Shield the DC cabling and ensure that the shield is bonded to earth with a 360 degree termination on both ends of the cable.
- Only use inverters with CE approval.
- Ensure that there is proper electrical bonding on the PV modules, switching modules and grid connection cables as well as the cable trays.
- Ensure all grid related connections are according to specification (no gaps between connections)
- Use approved grid cable connectors to avoid unwanted corona and/or sparking.
- Avoid sharp edges at the end of cable connections.

The purpose of electrical bonding is to provide structural homogeneity with respect to the flow of electrical currents, including high frequency currents for proper operation of filters and fault current paths. Bonding prevents or safely discharges static charges. Sufficient bonding ensures a good ground connection. A good ground connection of equipment will prevent unintentional emissions from occurring.

7. CLEARANCE ZONE

The clearance zone around a PV facility is the separation distance needed, between the edge of the PV plant (source) to a specific EMI sensitive location or infrastructure (victim), for the PV plant to have no RFI on existing electrical infrastructure. It is assumed that the inverters that will be used comply to CISPR11 Class A specification [7]. (57 dBµV/m @ 3m which relates to an EIRP of -38.16dBm). The recommended clearance zones are listed in Table 2.
It is stated in the Electronic Communications Act [8] that no product used or manufactured in South Africa may cause unintentional RFI or EMI, intentional or unintentional transmissions, on existing electrical equipment. Thus, to prevent the PV facility's unintentional RFI to cause unintentional interference on existing electrical equipment a clearance zone is used.

Table 2 - Clearance Zone Distances [2, 3]

EMI sensitive location	Distance Between the Edge of a PV plant and an EMI sensitive location in meter
Existing Radar equipment ex. Weather radar	152.4 m
Navigational and communication equipment	45.72 m
Equipment sensitive to EMI	45.72 m
Airfield/Airport Radar system	76.20 m

7.1 COVERAGE MAP, TYPICAL RECEIVER SENSITIVITIES AND SITE TRANSMIT POWER

Coverage maps generated using Radio Mobile RF software [5] is shown below in Figures 8 and 9. In Figure 8 the received power level from Ukuqala Portion D to the Weather Radar Installation is -165.7dBm. In Figure 9 the received power level from Ukuqala Portion E to the Weather Radar Installation is -172.3dBm.

The received power at the Weather Radar Installation seen in Figures 8 and 9 are both below the respective sensitivity levels listed in Table 3 (-94dBm).

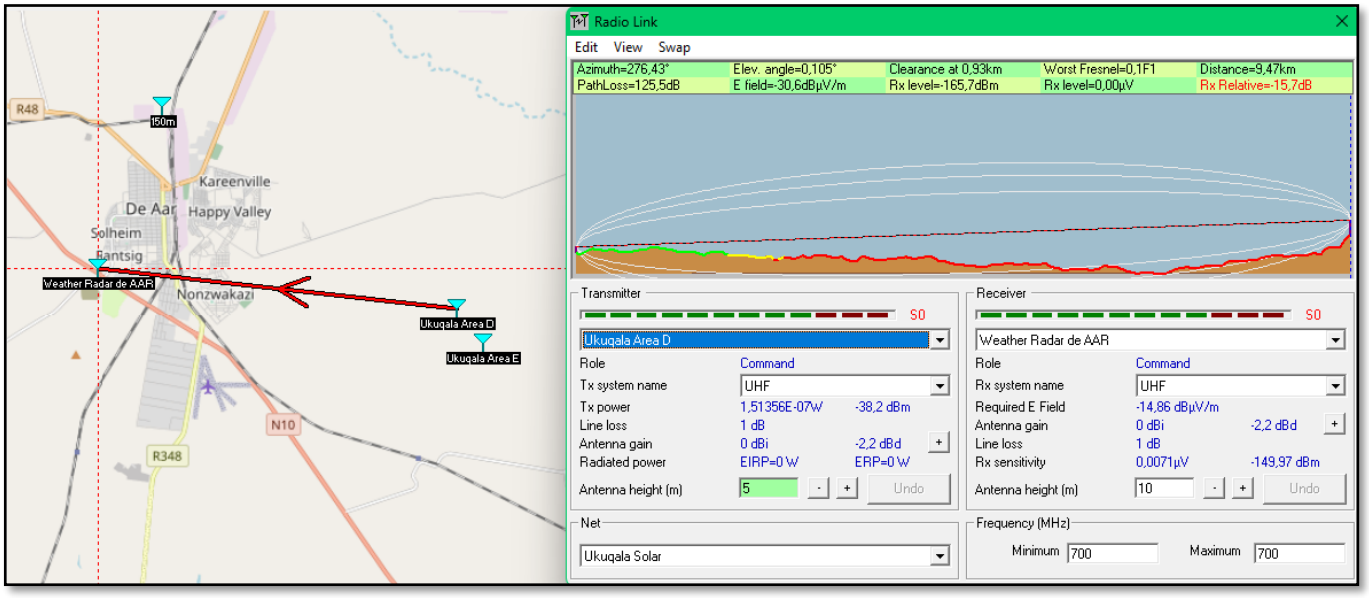

Figure 8 - Receive Power Level from Ukuqala Portion D to the Weather Radar Installation

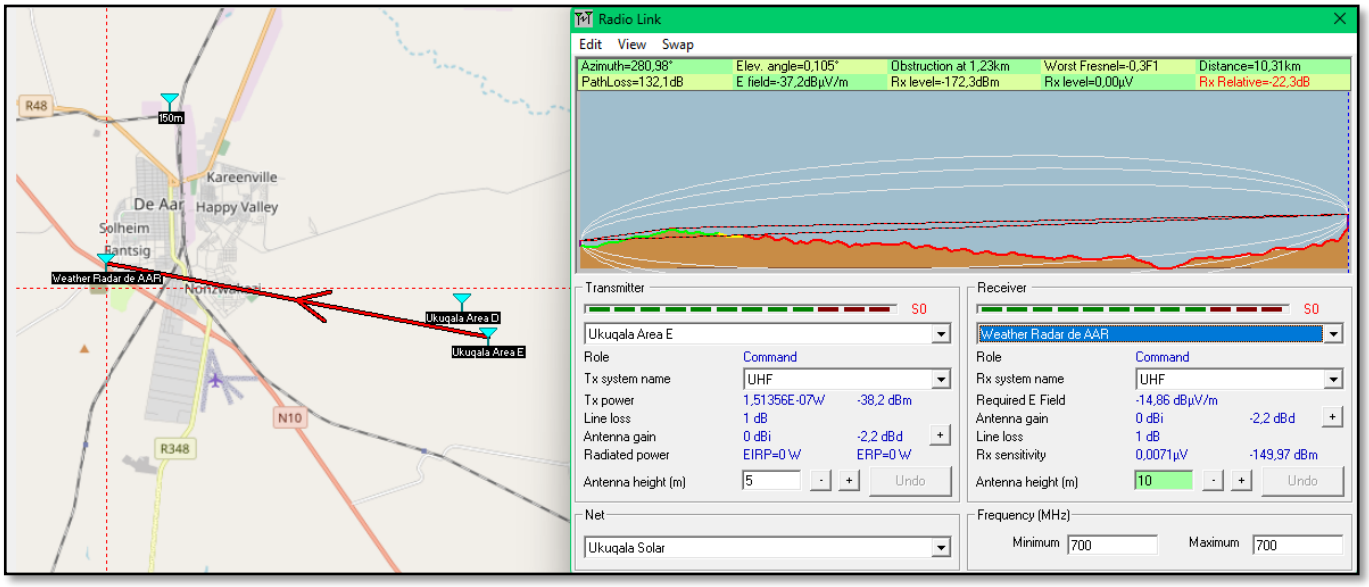

Figure 9 - Receive Power Level from Ukuqala Portion E to the Weather Radar Installation

Table 3 - List of typical sensitivities from EMI sensitive equipment

Receiver	Typical Sensitivities
LoRa 2.4GHz	-130 dBm
Pulse Radar/Weather Radar 1-12GHz	-94 dBm
Wifi (common 802.11g) 2.4/5 GHz	-85 dBm
GSM/LTE/GPRS 0.85-2.1GHz	-102 dBm
UHF 300MHz	-100 dBm
Bluetooth 2.4GHz	-82 dBm

8. CUMULATIVE EFFECT

Non-correlated noise sources such as PV plant inverters or wind turbines in close proximity could increase the clearance zone required around a specific renewable energy plant site, as the level of unintentional radiated emissions will be higher. A standard factor of 10 $\log_{10}$ N, where N = amount of renewable energy plants in the direct vicinity, is used to account for the increased radiated emission levels [9]. For Ukuqala PV Facility there are 29 renewable energy facilities within a 30 km radius.

For this theoretical worst-case scenario, the theoretical increase in radiated emission levels will be 14.6 dB.

Figures 10 and 11 show the received power at the Weather Radar Installation of which both are below the respective sensitivity levels listed in Table 3 (-94dBm). In Figure 10 the received power level from Ukuqala Portion D to the Weather Radar Installation is -151.1dBm. In Figure 11 the received power level from Ukuqala Portion E to the Weather Radar Installation is -157.7dBm.

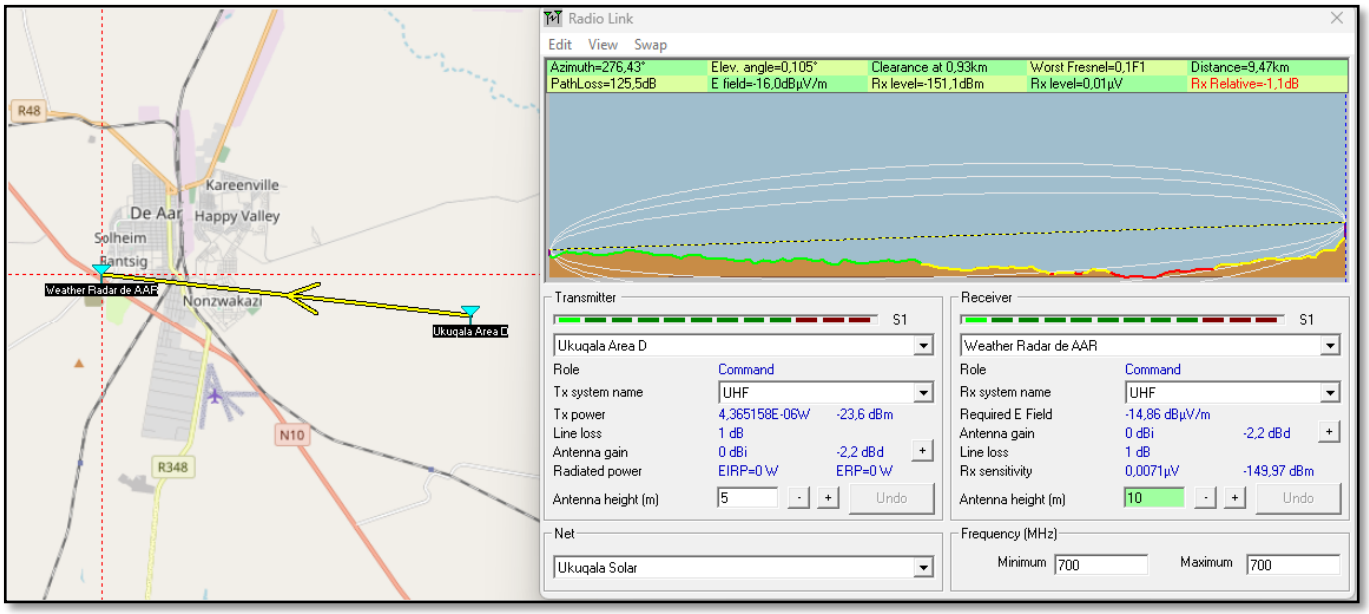

Figure 10 - Receive Power Level from Ukuqala Portion D to the Weather Radar Installation with Cumulative Effect Considered

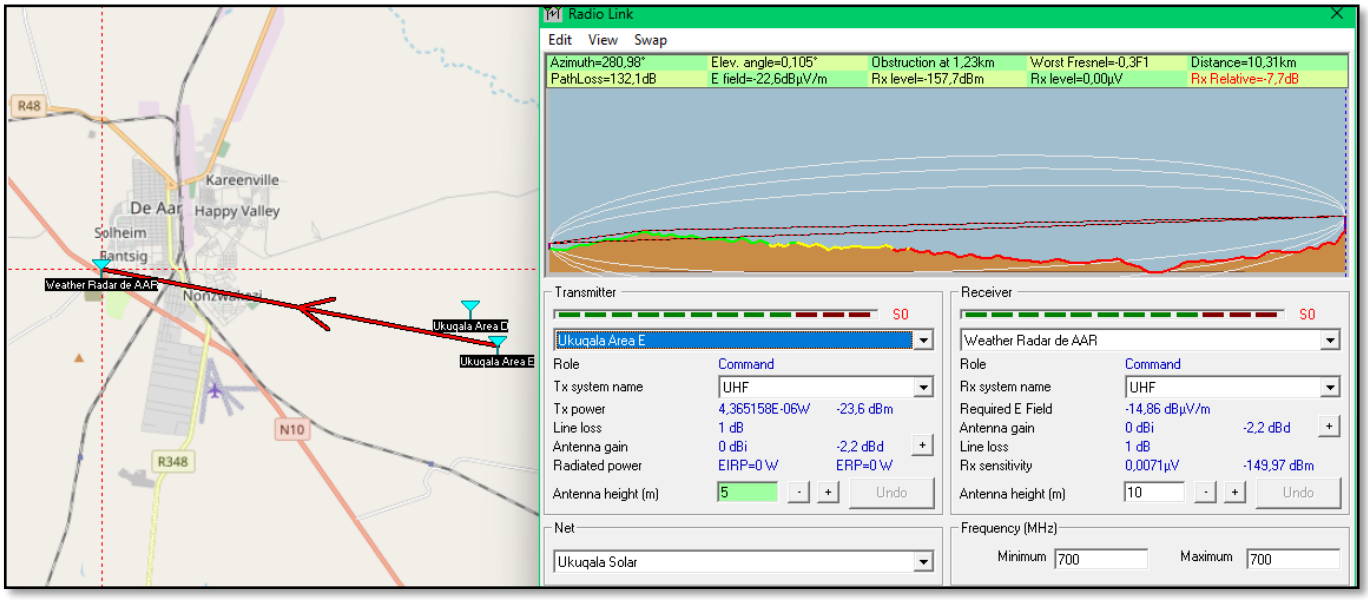

Figure 11 - Receive Power Level from Ukuqala Portion E to the Weather Radar Installation with Cumulative Effect Considered

9. CONCLUSION

According to the Radio Mobile data, the proposed PV facilities (Ukuqala Portions D and E) will have no RFI influence on the Weather Radar Installation located less than 18km away (approximately 10km). The aforementioned statement is only true when assuming that the facilities emit less RFI than the CISPR 11 class A limit levels. If the exclusion zones listed in Table 2 is adhered to when the PV facilities are constructed, they will have no RFI influence on existing electrical/electronic equipment. This statement applies to the entire proposed area seen in Figure 4. Note that both portions of the Ukuqala project are situated outside the exclusion zones listed in Table 2, and will not cause unintentional RFI to surrounding electrical/electronic equipment.

Table 3 states possible EMI sensitive receivers with their respective sensitivities that can be used in the area. According to the coverage data generated in Radio Mobile seen in figures 10 and 11, the receivers at the Weather Radar Installation and the surrounding area will not be affected by the proposed PV facilities in either Portion D or Portion E, provided that the exclusion zones in Table 2 are adhered to.

10. REFERENCED AND APPLICABLE DOCUMENTS

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[3] REPO Electro-Magnetic Interference from Solar Photovoltaic Arrays (April 2017)

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[6] SPLAT – RF Signal Propagation, Loss, And Terrain analysis tool

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Radio Frequency disturbance characteristics – Limits and methods of measurement

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