Defence
Safety Authority

DSA 03.OME Part 2 (JSP 482) - Defence Code of Practice (DCOP) and Guidance Notes for In-Service and Operational Safety Management of OME

Defence OME Safety Regulator

DOSR

DSA VISION

Protecting Defence personnel and operational capability through effective and independent HS&EP regulation, assurance, enforcement and investigation.

PREFACE

AUTHORITY

1. This document is crown copyright and the intellectual property rights of this publication belong exclusively to the Ministry of Defence (MOD). However, material or information contained in this publication may be reproduced, stored in a retrieval system or transmitted in any form provided it is used for the purposes of furthering safety and environmental management.

STATUS

2. This document:

   a. Is uncontrolled when printed.

   b. Will be updated as part of a continuous improvement programme but at least 12-monthly from the period of document issue date.

REQUESTS FOR CHANGE

3. Proposed changes, recommendations or amendments to DOSR Regulations and Guidance publications can be submitted by anyone using the DOME Request for Change Function (RFC) available for every Dome publication in the DOME library located **here** or by completing the Word version of the Change Proposal Form available from the DOME Library, see figure 1 below for the location.

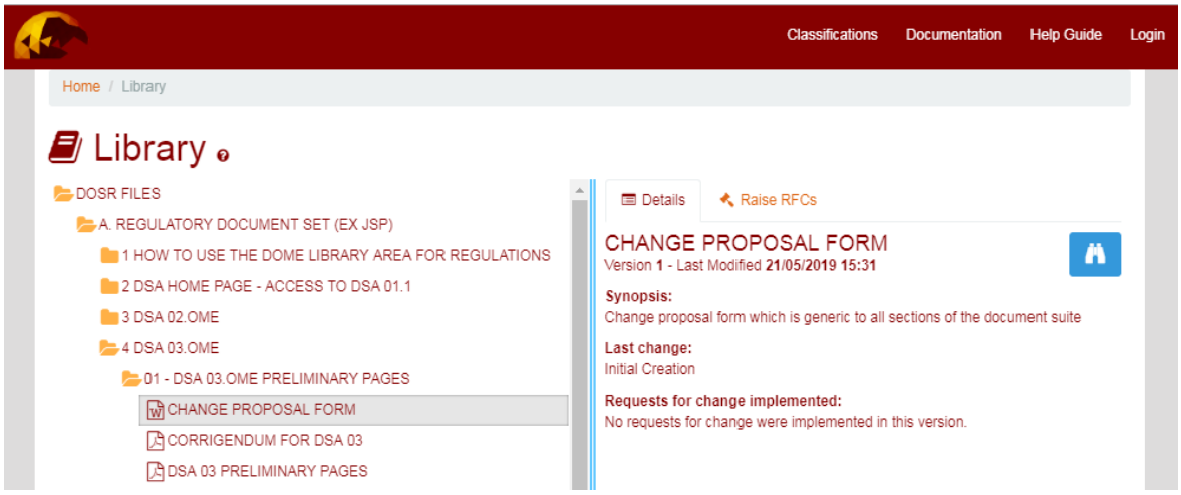

Figure 1. Change Proposal Form (Word version) Location

4. Any post and grammar change proposals can be approved or rejected by the DOSR PRG Authors without involvement of the associated Working Group.

5. Technical change proposals will need to be submitted to the associated Working Group for review and approval or rejection.

6. When incorporating changes care is to be taken to maintain coherence across regulations.

7. Changes effecting Risk to Life will be published immediately.

8. Other changes will be incorporated as part of routine reviews.

REVIEW PROCESS

9. The DOSR PRG team will ensure these OME Regulations remain fit for purpose by conducting reviews through the DOSR Governance Committees, involving all Stakeholders.

FURTHER ADVICE AND FEEDBACK

10. The document owner is the DOSR. For further information about any aspect of this document, or questions not answered within the subsequent sections, or to provide feedback on the content, contact:

Job Title	DOSR-Policy, Regulations and Guidance
E-mail	DSA-DOSR-PRG@mod.gov.uk
Address	Juniper #5004, Level 0, Wing 1, Abbey Wood North, Bristol, BS34 8QW

AMENDMENT RECORD

Version 1.0					
No	**Section**	**Para**	**Amendment Summary**	**Agreed**	**Date**

Intentional Blank Page

CHAPTER 24

Hazards of Electromagnetic Radiation to Ordnance (HERO)

CONTENTS

1 HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE (HERO)

1 Introduction

1.1 This chapter is solely concerned with the threat posed to electrically initiated weapons, ordnance, munitions or explosives (WOME) by emissions from transmitters.

1.2 Any WOME containing an electro-explosive device (EED) is susceptible to uncommanded initiation due to the coupling of electromagnetic (EM) energy on its firing circuitry.

1.3 This chapter provides the statutory and MOD regulations to be observed when using transmitters in the vicinity of WOME. Guidance on compliance with the regulations is also supplied.

1.4 Transmitters, as electrical equipment, shall meet all requirements in accordance with DSA03.OME (JSP 482), including electromagnetic compatibility (EMC) requirements when used in a licensed area.

2 STATUTORY LEGISLATION

2.1 There are two pieces of legislation that the MOD has to comply with regarding EM fields in the vicinity of EED: the EU Physical Agents (EMF) Directive and the Health and Safety at Work Act (1974).

2.2 The EU Physical Agents (EMF) Directive (2013/35/EU) is extant in the UK. The directive has introduced the obligation on employers to protect employees against the risk of direct and indirect EM field effects, which includes the inadvertent initiation of EED in WOME. The Health and Safety at Work Act (1974) is covered elsewhere in this document.

2.3 This chapter sets out regulations enabling compliance with the above legislation.

2.4 Site staff are responsible for managing a safe system of work for activities involving WOME when operating transmitters. It is imperative that any potential threats posed by transmitters are assessed, controlled and mitigated.

3 DEFINITIONS

3.1 **Electro-explosive device (EED)** - An EED is a one shot explosive or pyrotechnic device used as the initiating element in an explosive train and is activated by the application of electrical energy.

3.2 **Electromagnetic radiation (EMR)** - EMR is the transmission of energy via varying electric and magnetic fields. For the purposes of this annex, EMR is limited to the radio frequency (RF) spectrum between 10 kHz and 40 GHz.

3.3 **Electromagnetic interference (EMI)** - EMI is a disturbance that affects an electrical circuit due to EMR emitted from an external source.

3.4 **Hazards of Electromagnetic Radiation to Ordnance (HERO)** - HERO is the potential for EMR to cause either direct initiation of EED, or the interference of electronics that may cause WOME to initiate. HERO replaces RADHAZ and RF hazards. RADHAZ could refer to the threat posed to WOME, personnel or fuels and flammables, whereas HERO is WOME specific.

3.5 **Transmitter** - A transmitter is an electronic device which intentionally produces EMR as part of its function. Transmitters found commonly on MOD controlled facilities include (but

are not limited to) mobile phones, handheld and vehicle based communication radios (such as TETRA / Airwave radios), radars, vehicle trackers and intruder detection systems.

3.6 **Weapons, Ordnance, Munitions and Explosives (WOME)** - For the purposes of this annex WOME is solely concerned with items that contain EED or are vulnerable to accidental initiation due to electromagnetic interference (EMI).

3.7 **WOME HERO Categories** - With respect to HERO, WOME can be considered in five discrete states of varying susceptibility. Table 1 contains the definitions for WOME HERO categories, describing the states in which WOME is found.

Categories	WOME Activities
1	(Dis)assembly of WOME and testing of sub systems by personnel or machine generally in defence munitions organisation sites. Also covers casualty/damaged and unidentified WOME.
2	Testing of WOME - the connecting of additional electrical circuitry to WOME.
3	Storage and transportation of WOME in DOSR Approved Packaging. This is the only configuration that is allowed on the UK transport network.
4	Storage and internal transit of WOME not in approved packaging; or whilst handling, loading/unloading to platform e.g. vehicle, gun, aircraft or launch platform.
5	WOME loaded to its platform/launcher for its intended use (e.g. to aircraft or in its launcher).

Table 1 WOME HERO CATEGORIES

4 HERO REGULATIONS

4.1 Introduction

4.2 The following regulations enable activities involving WOME to remain safe where transmitters are used or present. They provide a way to comply with the legislative requirements described above.

4.3 HERO Regulation 1 – Transmitter Exclusion Zones

4.4 Transmitters are prohibited from being used within licensed areas where items of WOME are in Category 1 or 2 conditions.

4.5 HERO Regulation 2 – HERO Management

4.6 The site shall characterise the EM environment and assess its effect on WOME in all WOME HERO category conditions found on site. Responsibility for the management of HERO lies with the Head of Establishment / Base Commander / Commanding Office as the Duty of Care holder.

4.7 Guidance for complying with this regulation can be found in Annex A.

4.8 **HERO Regulation 3 – Casualty / Damaged / Unidentified WOME**

4.9 In the event of an incident/accident involving WOME, items which do not normally present a high HERO risk may become vulnerable. Pending a detailed inspection of the casualty/damaged WOME by appropriate personnel, the following restrictions shall be imposed:

(1) Portable transmitters listed in Annex B shall not be brought close to the casualty/damaged WOME until the applicable Category 1 & 2 distances described in Annex B Tables 1 to 5 can be implemented and managed safely.

(2) Portable transmitters not listed in Annex B Tables 1 to 5 shall be kept at least 170 metres away from the casualty / damaged WOME.

(3) Fixed transmitters up to 800 metres away will also pose a threat to the casualty/damaged WOME; where possible, fixed transmitters must be disabled.

Note for (1): 170 metres is the minimum safe distance for a BOWMAN UK VRC 329 100W radio with 2 dB added to output power to account for variability between systems.

Note for (3): 800 metres is the minimum safe distance for Watchman radar and has been selected as the worst case transmitter found on a MOD establishment.

4.10 Unidentified WOME (such as foreign WOME) shall be treated as casualty / damaged WOME until its susceptibility can be established.

5 **CONSIDERATIONS**

5.1 Aerodromes/airfields can demonstrate compliance with HERO Regulation 2 using existing HERO site surveys and management plans developed under AP 110A-0102-1D.

ANNEX A

HERO MANAGEMENT

CONTENTS

1 HERO MANAGEMENT

1.1 Introduction

1.1.1 This annex provides a methodology allowing demonstration of compliance with the regulations set out above. By following the methodology sites will both understand and control the HERO risks to WOME on site, and have means of assessing the risk to temporary or transitory WOME if needed.

1.1.2 Through DOSR or the relevant IE, site staff may request the advice and support of Technical Advisor (HERO) and the Defence Ordnance Safety Group (DOSG) whilst discharging their responsibilities. The level of support provided will be based upon the specific circumstances of each site and resource availability.

2 SITE RESPONSIBILITIES

2.1 Site staff are responsible for ensuring that the site HERO assessment and any resulting management plan is updated regularly, taking account of any changes with respect to WOME and the local EM environment. This will include recalculation of minimum safe distances for WOME, and maintenance of the site HERO map (if applicable). These documents will provide an easy to understand visual guide that denotes transit routes and potential explosion sites (PES).

2.2 The site must manage the threat to WOME posed by HERO. The site HERO management plan must account for day to day activities involving WOME as well as unusual situations and activities such as casualty / damaged or unidentified / foreign WOME.

3 **METHODOLOGY**

3.1 Assessing a site and the possible HERO threat can be achieved with the following steps:

(1) Identify the locations that WOME related activities take place.

(2) Identify WOME, WOME activities and the respective WOME HERO categories these activities relate to.

(3) Identify transmitters on, or near the site.

(4) Assess the threat to WOME from identified transmitters.

(5) Create or update HERO management plan.

(6) Mitigate identified threats to WOME.

3.2 Identify locations of WOME related activities.

3.3 Potential explosion sites (PES) such as licensed locations, processing buildings and explosive storage areas (ESA) where activities involving WOME should be listed. These include licensed locations such as (but are not limited to):

(1) Explosives process buildings.

(2) Explosives storage buildings.

(3) Dangerous Air Cargo (DAC) pans.

(4) Rail-road transfer points (RRTP).

(5) Jetties or wharfs.

(6) Ready use lockers.

(7) WOME & aircraft transit routes.

(8) HAS or hangers.

(9) Armed aircraft parking slots.

(10) Ground based air defence sites.

3.4 WOME locations should be listed by a site unique serial number (such as a facility number), and a location provided (preferably by latitude and longitude, however a grid reference system used locally on site maps is acceptable).

3.5 Identify WOME and related activities.

3.6 Once the locations of WOME activities have been identified, the WOME found at those locations must be listed.

3.7 Once the WOME is identified, the applicable WOME HERO categories are to be determined.

3.8 A template enabling compilation of the above in a single document is provided at Table 1 of Annex D.

3.9 Identify transmitters that pose a threat to WOME.

3.10 Site staff responsible for the site HERO assessment should create and maintain a database of transmitters found on or near the site.

3.11 The database should detail the specifications of any transmitters that operate between 10 kHz and 40 GHz including the following:

(1) Identification of each transmitter by a unique serial number.

(2) Transmitter name and description.

(3) The frequency band at which the transmitter is capable of operating.

(4) Whether the transmitter is continuous wave or pulsed.

(5) The antenna gain as a ratio.

(6) The peak output power to the antenna.

(7) The mean power output of the transmitter in Watts.

(8) The pulse repetition frequency (PRF) in pulses/second for pulsed transmitters.

(9) The pulse width (PW) in microseconds for pulsed transmitters.

(10) The location of the transmitter (preferably by latitude and longitude, however a grid reference system used locally on site maps is acceptable).

NOTE: A template enabling compilation of the above in a single document is provided at Table 2 of Annex D.

3.12 Transmitters for consideration include (but are not limited to):

(1) Communication installations such as microwave links, management radio base stations, Terrestrial Trunked Radio (TETRA), WI-FI or mobile phone masts. Mobile communication devices such as mobile phones and handheld management radios shall also be considered.

(2) Radar installations. Where applicable, both fixed (such as those found on airfields) and transitory (such as ship radars) shall be considered.

(3) Airfield navigation aids.

3.13 Provision must be made for externally controlled transmitters that may affect WOME within the site boundaries. Effort must be made to liaise with authorities or agencies (such as mobile phone operators) that control said transmitters in order to assess the threat they pose.

4 **ASSESS THE THREAT TO WOME FROM TRANSMITTERS**

4.1 Once WOME & related activities and transmitters have been identified, the threat posed to the WOME by identified transmitters must be assessed.

4.2 Annex B contains pre-calculated minimum safe distances for a number of transmitters that are commonly found on MOD sites. These distances can be used as part of a site assessment.

4.3 For transmitters not found in Annex B, Annex C contains the methodology for calculating HERO minimum safe distances. Annex C shall be used to calculate transmitter minimum safe distances for each WOME HERO category that is applicable to WOME on site.

4.4 Airfields will also have to consider the effect of transmitters on both host and visiting aircraft flight critical systems. Susceptibility data for specific aircraft can be found in the relevant RAF or Royal Navy publications.

5 CREATE OR UPDATE HERO MANAGEMENT PLAN

5.1 Once minimum safe distances for the applicable HERO categories have been calculated for all WOME and transmitters, a HERO management report (and map, if necessary) can be prepared.

6 HERO MANAGEMENT REPORT

6.1 A HERO management report shall detail all collated information including:

(1) WOME susceptibility data, activities and associated WOME HERO categories.

(2) Transmitter specifications and source of information.

(3) Calculated WOME minimum safe distances.

(4) Transitter minimum safe distance encroachments onto PES.

(5) Mitigations used or restrictions imposed with respect to WOME HERO issues.

6.2 A template for recording HERO minimum safe distances can be found at Table 3 of Annex D.

6.3 The HERO management report should define a review period and detail how and when it will be updated in order to keep the assessment extant. A maximum review period of two years is recommended.

7 HERO MANAGEMENT MAP

7.1 Production of a HERO management map for larger sites with complex WOME arrangements and HERO issues is recommended.

7.2 A HERO management map of the site should be appropriately scaled and capable of displaying all required detail.

7.3 A HERO map should be prepared for use using information from the HERO management report in the following manner:

(1) The ESA are to have a thick red line drawn around its boundary. PES inside the ESA must be coloured in red and identified by their unique serial number.

(2) Any PES not within a defined ESA is to be coloured in red and identified by their unique serial number.

(3) Each transmitter is to be marked on the map with a green crosshair and is identified by its unique serial number.

(4) Transmitter farms or areas that are densely populated with transmitters may be indentified on the HERO map as an area with a boundary marked in green. Should this option be used, a larger scale map capable of displaying individual transmitters should be created for this area.

(5) Site WOME transit routes to and from any PES must be marked in blue.

(6) For airfields, aircraft taxi routes and runways must be marked in yellow.

7.4 Once the HERO map has been prepared, permanently mark all encroachments on the map with a green circle of the relevant scaled distance. Label at the circumference with the transmitter serial number and HERO category of the encroachment.

8 MITIGATING IDENTIFIED THREATS TO WOME

8.1 When a minimum safe distance encroaches upon a PES or transit route, local staff must manage the encroachment and assess and mitigate the threat.

8.2 Exclusion zones around high power transmitters can be used.

8.3 When minimum safe distances cannot be achieved, or the employment of restrictions or management aids are impractical, or will have a detrimental effect on operations, a practical HERO survey can be carried out to ascertain HERO threat to PES, taxi routes etc. The results of a HERO survey can be used as evidence to mitigate any identified threats to WOME.

8.4 DOSG / TA (HERO) can provide advice regarding the level of survey required.

Intentional Blank Page

ANNEX B

COMMON TRANSMITTER MINIMUM SAFE DISTANCES

CONTENTS

Paragraph

Tables

Reference:

Safe Distance Assessment for Standardised Transmitters (Document Ref. ST3-2014-033)

1 Introduction

1.11 Many commercial off the shelf (COTS) items use well documented standardised transmitters. TA (HERO) has produced WOME minimum safe distances for a number of transmitters.

1.12 The minimum safe distances are calculated using a generic worst case piece of electrically initiated WOME, and will act as a “catch all” for all in service UK WOME containing EED.

1.13 Please note that it is still the responsibility of the document user to confirm that the transmitter in question conforms to the specifications listed with the respective safe distances.

1.14 Should questions arise over the specifications of transmitters, advice can be sought from the equipment manufacturer.

2 Common Transmitter Minimum Safe Distances

Power Class	**TETRA Max. Power**	**Frequency (MHz)**	**Category 1 & 2 OR Damaged UK Service WOME (m)**	**Category 4 & 5 OR Undamaged UK Service WOME (m)**	**Category 3 OR DOSR Approved Packaging UK Service WOME (m)**
1	30 W (45 dBm)	380 - 400	**15.84**	**3.12**	**0.20**
2	10 W (40 dBm)	380 - 400	**9.15**	**1.81**	**0.11**
3	3 W (35 dBm)	380 - 400	**5.01**	**0.99**	**0.06**
4	1 W (30 dBm)	380 - 400	**2.89**	**0.57**	**0.04**

Table 1Terrestrial Trunked Radio (TETRA)

Mobile Telecoms Handset Max. Power	**Category 1 & 2 OR Damaged UK Service WOME (m)**	**Category 4 & 5 OR Undamaged UK Service WOME (m)**	**Category 3 OR DOSR Approved Packaging UK Service WOME (m)**
8 W (39 dBm)	**3.50**	**0.68**	**0.08**
5 W (37 dBm)	**2.76**	**0.55**	**0.06**
2 W (33 dBm)	**1.75**	**0.35**	**0.04**
1 W (30 dBm)	**1.24**	**0.25**	**0.03**

* Using 890 MHz as the calculation frequency

Table 2 Mobile Telecoms Handsets (Mobile Phones) - 2G, 3G and 4G/LTE excl. GSM 400

Bluetooth Max. Power	**Frequency Range (GHz)**	**Category 1 & 2 OR Damaged UK Service WOME (m)**	**Category 4 & 5 OR Undamaged UK Service WOME (m)**	**Category 3 OR DOSR Approved Packaging UK Service WOME (m)**
100 mW (20 dBm)	2.400 - 2.4835	**0.15**	**0.03**	**0.01**

Table 3 Bluetooth

WI-FI Max. Power	**Frequency (GHz)**	**Category 1 & 2 OR Damaged UK Service WOME (m)**	**Category 4 & 5 OR Undamaged UK Service WOME (m)**	**Category 3 OR DOSR Approved Packaging UK Service WOME (m)**
10 W (40 dBm)	2.4	**1.45**	**0.29**	**0.04**
10 W (40 dBm)	5.0	**0.70**	**0.14**	**0.05**

* Assumes 2.15 dBi gain.

Table 4 WI-FI

Mobile Telecoms Base Station Maximum Effective Isotropic Radiated Power (EIRP)	**Category 1 & 2 OR Damaged UK Service WOME (m)**	**Category 4 & 5 OR Undamaged UK Service WOME (m)**	**Category 3 OR DOSR Approved Packaging UK Service WOME (m)**
640 W / 28.06 dBW	**34.75**	**6.85**	**0.75**

* Using 800 MHz as the calculation frequency. Assumes that GSM 400 MHz not in use in UK.

Table 5 Mobile Telecoms Base Stations – 2G, 3G and 4G/LTE excluding GSM 400

3 **Bowman Personal Role Radio (PRR)**

3.1 The Bowman Personal Role Radio (PRR) has been assessed by TA (HERO) as being safe for use by personnel handling Category 3, 4 and 5 WOME. They are not suitable for use around Category 1 or 2 WOME, or in flammable/explosive atmospheres.

Intentional Blank Page

ANNEX C

CALCULATION OF WOME MINIMUM SAFE DISTANCES

CONTENTS

1 Introduction

1.1 The following allows the user to calculate a WOME minimum safe distance for a transmitter. The formulas are detailed below, with worked examples showing use at the end of this Annex.

1.2 DOSG / TA (HERO) can provide specific guidance when assessing pulse sensitive WOME. Currently, in service pulse sensitive WOME includes:

(1) Phalanx 20mm round.

(2) LW30 30mm round.

(3) Mauser 27mm round & cocking cart.

(4) 4.5” Naval Shell.

(5) Tube Vent Electric L4A2.

2 Calculation of WOME MINIMUM safe distances

2.1 In order to calculate the safe distance from a transmitter, a number of the transmitters parameters are required:

(1) $\mathbf{P_{AVERAGE}}$ - Average output power (measured in Watts / W).

(2) **G** - Transmitting antenna gain (measured in dBi and then converted to a ratio).

(3) **f** - Frequency of transmission (measured in MHz)

2.2 Pulsed transmitters will have the following parameters:

(1) **P_{PEAK}** - Peak output power (measured in Watts / W)

(2) **PRF** – Pulse Repetition Frequency (measured in Hertz / Hz)

(3) **PW** – Pulse width (measured in seconds / s)

2.3 The gain of the transmitter must be converted from dBi to a ratio using the following formula:

$$Ratio = 10^{\frac{Number \cdot in \cdot dB}{10}} \quad \text{... (1)}$$

2.4 Once the above transmitter specifications have been obtained, the transmitter safe distance can be calculated using the appropriate formula below.
To convert a peak power to an average power, you can use the following formula:

$$P_{AVERAGE} = P_{PEAK} \times PRF \times PW \quad \text{... (2)}$$

3. Store specific calculations

3.1 Category 1 – 5 susceptibility data for specific WOME can currently be found from a number of sources, including (but not limited to) the Royal Navy document BRd 2924 Volume 2 (RF Hazards in the Naval Service), and RAF document AP 110A-0102-1D Hazards of Electromagnetic Radiation to Ordnance (HERO). Figures below 32 MHz are reported in V/m rather than W/m^2, and care should be taken to convert these accordingly.

3.2 This WOME specific susceptibility data can be used to calculate minimum safe distances that are often less restrictive than using generic, worst case WOME minimum safe distances.

3.3 The following formula can be used in conjunction with WOME specific susceptibility data to calculate a minimum safe distance to a transmitter:

$$d = \sqrt{\frac{PG}{4\pi S}} \quad \text{... (3)}$$

Where:

d is the minimum safe distance.
P is the output power (measured in Watts / W)
G is the gain of the transmitting antenna (as a ratio)
S is the maximum safe power density, or susceptibility, of the WOME under consideration (measured in W/m^2).

4 **Non store specific calculations (worst case)**

4.1 When the susceptibility of WOME is unknown, a set of equations based upon generic worst case WOME can be used to derive safe distances for Categories 1 to 5.

4.2 To enable the use of the formula below, the user must know the frequency, power, and gain of the threat transmitter.

4.3 The frequency will enable the selection of the correct formula for Categories 1, 2, 4 & 5, and the correct WOME susceptibility for Category 3.

4.4 The formula used to derive a safe distance for Categories 1, 2, 4 and 5 is dependent on the frequency of the transmitter under consideration.

5 **Category 1 & 2 WOME – processing and testing**

Transmission Frequency Range	**Safe Distance Equation**
0.1 ≤ f < 2.0 MHz	$d = (5.5f)\sqrt{PG}$ ... (4)
2.0 ≤ f < 80.0 MHz	$d = 10.95\sqrt{PG}$ ... (5)
80.0 ≤ f <100,000 MHz	$d = \frac{876}{f}\sqrt{PG}$ ... (6)
Where: **d** is the minimum safe distance in metres **P** is the output power in Watts **G** is the gain as ratio (calculated using Equation 1 above) **f** is frequency denoted in MHz (e.g. if the transmitter frequency is 32 MHz, “32” would be used in the formula)	

Table 1

5.1 The above formula can be used to calculate minimum safe distances for WOME of unknown susceptibility in a Category 1 or 2 state.

5.2 Selection of the correct equation to use is dependent on the frequency of the transmitter under consideration. For example, if a transmitter operates at a frequency of 32 MHz, Equation 5 would be used. If a transmitter operates at a frequency of 900 MHz, Equation 6 would be used.

6 Category 3 WOME – storage and transport

Frequency Range	Average Power Density (W/m^2)	Peak Power Density (W/m^2)
10 kHz - 3 MHz	106	106
3 MHz – 32 MHz	106	106
32 MHz – 150 MHz	30	30
150 MHz – 225 MHz	80	80
225 MHz – 400 MHz	100	100
400 MHz – 790 MHz	50	5000
790 MHz – 1 GHz	150	5000
1 GHz – 2.5 GHz	1000	30000
2.5 GHz – 4.5 GHz	2400	265000
4.5 GHz – 6 GHz	500	140000
6 GHz – 8 GHz	1500	3200
8 GHz – 12 GHz	1500	265000
12 GHz – 18 GHz	1500	86000
18 GHz – 40 GHz	500	36000

Table 2 – Minimum Service RF Environment

6.1 WOME in its DOSR approved packaging should meet the levels prescribed by the Minimum Service RF Environment (detailed above in Table 2).

6.2 The selection of susceptibility for Category 3 WOME is determined by the frequency of the transmitter under consideration. Table 2 is used in the following manner:

(1) Select the frequency band the transmitter under consideration falls into.

(2) Determine the correct maximum safe power density / susceptibility for the corresponding frequency band.

(3) Use said figure as S in Equation 3 (for example, if a transmitter operates at 900 MHz, the figure used for S is 150 W/m^2).

(4) If a transmitter spans more than one frequency band, the lowest figure for S must be used in Equation 3.

7 Category 4 & 5 WOME – handling and loaded

Transmission Frequency Range	Safe Distance Equation
f < 37.5 MHz	$d = (0.12f)\sqrt{PG}$ … (7)
f ≥ 37.5 MHz	$d = \frac{169}{f}\sqrt{PG}$ … (8)
Where: **d** is the minimum safe distance in metres **P** is the output power in Watts **G** is the gain as ratio (calculated using Equation 1 above) **f** is frequency denoted in MHz (e.g. if the transmitter frequency is 32 MHz, "32" would be used in the formula)	

Table 3

7.1 The formula in Table 3 can be used to calculate minimum safe distances for WOME of unknown susceptibility in a Category 4 or 5 state.

7.2 Selection of the correct equation to use is dependent on the frequency of the transmitter under consideration. For example, if a transmitter operates at a frequency of 32 MHz, Equation 7 would be used. If a transmitter operates at a frequency of 900 MHz, Equation 8 would be used.

8 **Co-located transmitters**

$$d_{COMBINED} = \sqrt{(d_1^2) + (d_2^2) + (d_3^2) + (d_4^2) + (d_5^2) ..... + (d_x^2)} \quad \ldots (9)$$

8.1 Transmitters operating in the same frequency bands (as listed in Table 2) may constructively interfere resulting in the production of enhanced field strengths that may pose a larger threat to WOME.

8.2 Users should use Equation 9 to calculate a minimum safe distance that accounts for the enhanced field strengths produced by co-located transmitters.

8.3 The equation is used with calculated individual transmitter minimum safe distances (d_1, d_2, d_3 etc). An example of use is shown below.

9 **WOME Specific Calculation Examples**

Example 1 – WOME Specific Calculation

As stated above, susceptibility data specific to an item of WOME allows more accurate minimum safe distances to be calculated. Below is an example of a WOME susceptibility table taken from a publication such as AP 110A-0102-1D or BRd 2924 Volume 2:

Example WOME Item Name	**HERO Category**	**200 MHz 225 MHz**	**225 MHz 430 MHz**	**430 MHz 790 MHz**	**790 MHz 1.0 GHz**	**1.0 GHz 2.0 GHz**	**2.0 GHz 3.0 GHz**
	1	0.08	0.11	0.4	1.3	2.18	8.9
	2	0.08	0.11	0.4	1.3	2.18	8.9
	3	100	50	50	50	1000	1000
	4	10	15	20	25	25	25
	5	100	50	50	150	500	500

WOME Maximum Safe Power Density / Susceptibility (in W/m^2)

A Category 4 minimum safe distance for a specific item of WOME is required by the user for the following transmitter:

Output Power	**Gain**	**Frequency**
50 Watts	10 dBi	850 MHz

Because the frequency of transmission is 850 MHz, the Category 4 susceptibility from the 790 MHz – 1000 GHz band is used from the above table (S = 25 W/m^2)

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{10}{10}} = 10^{1}$$

Gain = 10

Using the above transmitter specifications with Equation 3:

$$d = \sqrt{\frac{PG}{4\pi S}}$$

$$d = \sqrt{\frac{50 \times 10}{4\pi \times 25}}$$

$$d = \sqrt{\frac{500}{4\pi \times 25}}$$

$$d = \sqrt{\frac{500}{314.2}}$$

$$d = \sqrt{1.59}$$

$$d = 1.26m$$

Following the above steps derives a Category 4 WOME safe distance of 1.26 m. They can be followed to calculate Categories 1, 2, 3 and 5 WOME safe distances using the respective WOME susceptibility figure.

10 **Non WOME Specific Calculation Examples**

Example 2 – Category 1 or 2 WOME - Transmitter Frequency 0.1 ≤ f < 2.0 MHz

A user has a transmitter with the following characteristics:

Output Power	**Gain**	**Frequency**
10 Watts	5 dBi	1.5 MHz

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{5}{10}} = 10^{0.5}$$

Gain = 3.16

Because the frequency of transmission is between 0.1 MHz and 2 MHz for this transmitter, the minimum safe distance can be calculated using Equation 4:

$$d = (5.5f)\sqrt{PG}$$

$$d = (5.5 \times 1.5) \times \sqrt{10 \times 3.16}$$

$$d = 8.25 \times \sqrt{31.6}$$

$$d = 8.25 \times 5.62$$

$$d = 46.37m$$

Following the above steps derives a Category 1 and 2 WOME safe distance of 46.37m for this transmitter.

Example 3 – Category 1 or 2 WOME - Transmitter Frequency 2.0 ≤ f < 80.0 MHz

A user has a transmitter with the following characteristics:

Output Power	Gain	Frequency
100 Watts	6 dBi	32 MHz

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{6}{10}} = 10^{0.6}$$

Gain = 3.98

Because the frequency of transmission is between 2 MHz and 80 MHz for this transmitter, the minimum safe distance can be calculated using Equation 5. Note that the frequency of this transmitter is not used in this formula.

$$d = 10.95\sqrt{PG}$$

$$d = 10.95 \times \sqrt{100 \times 3.98}$$

$$d = 10.95 \times \sqrt{398}$$

$$d = 218.45m$$

Following the above steps derives a Category 1 & 2 WOME safe distance of 218.45m for this transmitter

Example 4 – Category 1 or 2 WOME - Transmitter Frequency 80.0 ≤ f <100,000 MHz

A user has a transmitter with the following characteristics:

Output Power	Gain	Frequency
30 Watts	6 dBi	430 MHz

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{6}{10}} = 10^{0.6}$$

Gain = 3.98

Because the frequency of transmission is between 2 MHz and 80 MHz for this transmitter, the minimum safe distance can be calculated using Equation 6.

$$d = \frac{876}{f}\sqrt{PG}$$

$$d = \frac{876}{430} \times \sqrt{30 \times 3.98}$$

$$d = 2.04 \times \sqrt{30 \times 3.98}$$

$$d = 2.04 \times 10.93$$

$$d = 22.29m$$

Following the above steps derives a Category 1 & 2 WOME safe distance of 22.29m for this transmitter.

Example 5 – Category 3 WOME

A high power transmitter near a site has the following characteristics:

Output Power	Gain	Frequency
1000 Watts	30 dBi	2700 MHz

Because the frequency of transmission is 2700 MHz, the susceptibility from the 2.5 GHz – 4.5 GHz band is used from Table 2 (S = 2400 W/m^2)

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{30}{10}} = 10^{3}$$

Gain = 1000

Using the above with Equation 3:

$$d = \sqrt{\frac{PG}{4\pi S}}$$

$$d = \sqrt{\frac{1000 \times 1000}{4\pi \times 2400}}$$

$$d = \sqrt{\frac{1000000}{4\pi \times 2400}}$$

$$d = \sqrt{\frac{1000000}{30159}}$$

$$d = \sqrt{33.16}$$

$$d = 5.75m$$

Following the above steps derives a Category 3 WOME safe distance of 5.75m for this transmitter.

Example 6 – Category 4 or 5 WOME - Transmitter Frequency < 37.5 MHz

A user has a transmitter with the following characteristics:

Output Power	Gain	Frequency
20 Watts	3 dBi	11.5 MHz

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{3}{10}} = 10^{0.3}$$

Gain =1.99

Because the frequency of transmission is below 37.5 MHz for this transmitter, the minimum safe distance can be calculated using Equation 7:

$$d = (0.12 \times f) \times \sqrt{PG}$$

$$d = (0.12 \times 11.5) \times \sqrt{20 \times 1.99}$$

$$d = 1.38 \times \sqrt{39.8}$$

$$d = 1.38 \times 6.31$$

$$d = 8.7m$$

Following the above steps derives a Category 4 & 5 WOME safe distance of 8.7m for this transmitter.

Example 7 – Category 4 or 5 WOME - Transmitter Frequency ≥ 37.5 MHz

A user has another transmitter with the following characteristics:

Output Power	Gain	Frequency
15 Watts	6 dBi	1.6 GHz or 1600 MHz

Using Equation 1 to turn the specified gain into a ratio:

$$Gain\ (Ratio) = 10^{\frac{Gain\ (dBi)}{10}}$$

$$Gain\ (Ratio) = 10^{\frac{6}{10}} = 10^{0.6}$$

Gain = 3.98

Because the frequency of transmission is above 37.5 MHz for this transmitter, the minimum safe distance can be calculated using Equation 8.

$$d = \frac{169}{f} \times \sqrt{PG}$$

$$d = \frac{169}{1600} \times \sqrt{15 \times 3.98}$$

$$d = 0.106 \times \sqrt{59.7}$$

$$d = 0.106 \times 7.73$$

$$d = 0.82m$$

Following the above steps derives a Category 4 & 5 WOME safe distance of 0.82m for this transmitter.

11 Co-Located Transmitters Example

Example 8 – Co-located Transmitters

Three transmitters are located at the same location; each transmitter has the following minimum safe distances for Categories 4 & 5:

Transmitter	Minimum Safe Distance (m)
Tx 1	3
Tx 2	4
Tx 4	4

Using Equation 9, the combined WOME minimum safe distance can be calculated:

$$d_{COMBINED} = \sqrt{(d_1^2) + (d_2^2) + (d_3^2)}$$

$$d_{COMBINED} = \sqrt{(3^2) + (4^2) + (4^2)}$$

$$d_{COMBINED} = \sqrt{41}$$

$$d_{COMBINED} = 6.4m$$

Following the above steps derives a combined WOME safe distance of 6.4m for these transmitters

.

ANNEX D

SITE WOME AND TRANSMITTER DATA SHEETS

CONTENTS

Tables

Site WOME Data Sheet
Site Name:
Name of site staff:
Date:

Page ... of …

WOME Serial	WOME Name	WOME Description	WOME HERO Category	WOME Location (Facility Number, Grid Ref or Lat & Long)	Notes
a	**b**	**c**	**d**	**e**	**g**
1	Example WOME	Explosive Widget 7	1	L07 or Lat & Long	
2	Example WOME		2		
3	Example WOME		3		
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

This sheet can be used as a template to collate all site WOME technical data, and should be kept for audit purposes.

Site Transmitter Data Sheet
Site Name: Page ... of …
Name of site staff:
Date:

Transmitter Serial	Transmitter Name / Description	Transmitter Location/ Building Number	Grid Reference / Latitude & Longitude	Average Power (Watts)	Gain (dBi)	Frequency Range (MHz)	Peak Power (Watts)	Pulse Repetition Frequency (Hz)	Pulse Width (µs)
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**
1	Example Tx 1	ATC Bdg 100.1	L07 or Lat & Long	1,250	4	2700	10,000	500	250
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

This sheet can be used as a template to collate all site transmitter technical data, and should be kept for audit purposes.
Note: Columns h, i and j are only used for pulsed transmitters.

Site HERO Minimum Safe Distances & Management Table

Site Name: Page ... of …

Name of site staff:

Date:

Transmitter Serial	Transmitter Name / Description	Transmitter Location/ Building Number	WOME HERO Category	WOME Minimum Safe Distance (m)	Issue (Y/N)	Encroachment Details (PES / ESA etc.)	Management Notes
a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
1	Example Tx 1	ATC Bdg 100.1	1	100	Y	Encroaches on PES 1	
2	Example Tx 1	ATC Bdg 100.1	3	50	N		
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

This sheet can be used as a template to collate all site HERO minimum safe distances, and should be kept for audit purposes.