SMR OFCOM/ICNIRP Compliance

The Implications of Requirement to Demonstrate ICNIRP Compliance for SMR

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Author	Ken Marsden, Laura Alexander
Owner	SMR Radio Officer
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Executive Summary

This paper is the Scottish Mountain Rescue formal response to the OFCOM consultation summarised below.

The OFCOM consultation 'Proposed measures to require compliance with international guidelines for limiting exposure to electromagnetic fields (EMF)' had a closing date for responses of 15th May 2020. The closing date has been postponed. Within the document, OFCOM

1. Propose to include a specific condition in Wireless Telegraphy Act licences requiring licensees to comply with the relevant levels from the ICNIRP Guidelines. This condition would apply to all equipment which can transmit at powers above 10 Watts EIRP (effective Radiated Power) including, for example, the licences of mobile phone companies, TV and radio broadcasters
2. Propose to apply a similar approach for equipment that is exempt from the requirement to have a licence and that can transmit at powers above 10 Watts, such as certain types of satellite terminals.
3. Proposing that spectrum licensees keep records (including the results of any measurements, tests and calculations) that demonstrate how they have complied with the ICNIRP Guidelines. (OFCOM, 2020)

Mountain Rescue along with many other organisations, Coastguard, Lifeboat, taxis, radio amateur and countless other PMR (private mobile radio) users fall within these proposals in that

1. SMR (Scottish Mountain Rescue) uses fixed base, repeater and mobile transmitter equipment that can transmit at powers above 10W EIRP
2. Would therefore have to comply with the third proposal regarding record keeping of 'measurements, tests and calculations'

It is the firm view of Scottish Mountain Rescue that our radio transmissions do not pose a risk of exposure to the public above the current ICNIRP Guidelines. Any license condition compelling Scottish Mountain Rescue to measure, test or calculate and keep records will place additional financial and administrative burden on a charity providing a vital emergency service. This additional level of compliance will not in any way reduce the risk of public exposure to the EMF's radiated by our rescue activities. Detailed evidence for this can be found in the main body of the report, but in summary:-

1. For a typical mountain rescue vehicle with a $\lambda/4$ whip antenna & $25W$ radio set (83W EIRP) it is necessary for a person to be **within 1.8m of a continually radiating** antenna to be subjected to the ICNIRP general public reference level for 30 minutes time averaged exposure. For the higher 6 minutes time averaged reference level, a person would need to be within 0.8m of a continuously radiating antenna.
2. Unlike broadcast TV, radio and mobile phone base station transmissions, Mountain rescue **transmissions are not continuous**. Transmission times are short, typically less than 20 seconds, infrequent and intermittent, and communications are simplex mode.
3. Due to the intermittent nature of communications, transmissions from mountain rescue radio equipment will fall well below the ICNIRP general public time averaged reference levels even when very close to our antennae.
4. The general public are in any case discouraged from lingering around mountain rescue vehicles for operational and privacy reasons, and are unlikely to be within 2m of an antenna for any period of time.

Furthermore:-

5. By making ICNIRP compliance a condition of licence, OFCOM would require countless organisations reliant on infrequently transmitting PMR based radio systems to demonstrate compliance with the ICNIRP guidelines. These are organisations which do not have the technical skills required to do this, and certainly in the case of Scottish Mountain Rescue, doing this would not improve public safety.

Recommendation

Having considered the content of this report, and given that:-

At a worst case 25 W transmit power with a 5/8λ whip vehicle antenna (see Table 4-2) would have an EIRP of 166 W. An individual would need to be within 1.14 m of a continuously transmitting antenna for 6 minutes to reach the public exposure limit.

1. There is no mountain rescue scenario which would broadcast continuously for even half that period
2. It would not be expected for anyone to be that close to a mobile antenna for that period of time in any case.

It is recommended to OFCOM that:-

- Any PMR radio system, fixed or mobile, radiating intermittently below 200 W EIRP, should not be subject to the proposed conditions.

This would ensure public safety without placing an unnecessary regulatory financial burden on not for profit organisations which rely on low power, fixed and mobile, intermittent communications devices to provide vital services to the public.

The rest of this document details the common types of antennas and transmission systems used by Scottish Mountain Rescue and calculates the distance from the radiating antenna to reach either 27.7V/m or 62V/m for time averaged exposure over 30 minutes or 6 minutes.

1 Calculation of Electromagnetic Field Strengths

The Federation of Communication Services (FCS) code of practice FCS 1331 (Federation of Communication Services (FCS), 2013) calculates the E field radiated by an antenna using the following equation,

$$E = \frac{\sqrt{30 \times P \times G}}{d}$$

E is the Field Strength in V/m
P is the Equivalent Isotopically Radiated Power in Watts ($EIRP$)
G is the Gain of the antenna (relative to isotropic) expressed as a number.
d is the Distance from the antenna in m

Therefore to calculate the distance, d, from an antenna for a given electric field strength, E,

$$d = \frac{\sqrt{30 \times P \times G}}{E}$$

2 Antennas Used By Scottish Mountain Rescue

For equipment that can radiate in excess of 10 Watts EIRP, SMR uses a variety of antennas depending on whether the transmitter equipment is installed within a mobile vehicle, a fixed building (team base, member's home or other key place), fixed or temporary repeater sites. All antennas can be characterised in terms of their gain.

2.1 Antenna Gain

A theoretical isotropic antenna radiates power equally in all directions. The dipole, and any other antenna, radiates more power in some directions than others. The antenna is said to have directivity or gain. The gain of a dipole antenna is $2.2dB$ relative to an isotropic antenna. This is expressed as $2.2dBi$. $2.2dB$ is 1.66 times.

2.2 Specific Antenna Types

Antennas used for mountain rescue fall in to the following categories

- Mobile vehicle $\lambda/4$ whip antenna, roof of bonnet mounted
    - Typical gain $5.2dBi = \times 3.32$
- Mobile vehicle $5\lambda/8$ base loaded antenna , roof of bonnet mounted
    - Typical gain $8.2dBi = \times 6.64$

The use of these types of antenna are common throughout the SMR and other PMR users.

- Fixed repeater end fed $\lambda/2$ dipole or λ colinear mounted on a tower >10m agl
    - Typical gain $2.2dBi$ and $5.2dBi$ respectively $(\times 1.66 \ \& \ 3.32)$
- Mobile repeater end or centre fed $\lambda/2$ dipole or λ colinear mounted on a temporary pole <5m agl
    - Typical gain $2.2dBi$ and $5.2dBi$ respectively $(\times 1.66 \ \& \ 3.32)$
- Fixed base radio end or centre fed $\lambda/2$ dipole mounted internal or external to the building, may be <2m agl
    - Typical gain $2.2dBi$ $(\times 1.66)$

There may be other bespoke installations using more directive antennas to radiate more power in one direction that another. These may be used to provide an in band link between repeater sites or to cover a

particular mountain area.

3 ICNIRP

The focus of the OFCOM consultation is the exposure of the general public to EMF's in compliance with the ICNIRP guidelines. SMR are aware of the relatively high EMF's radiated primarily from vehicles and some fixed radio installations to which the general public may be exposed. For the avoidance of doubt, the general public also includes mountain rescue volunteers & other agencies who are not covered by the higher occupational reference levels.

The ICNIRP guidelines set occupational and general public 'reference' levels of exposure to non-ionising radiation electric field strengths expressed in V/m. These reference levels are further broken down to exposure time averaged over 6 minutes or 30minutes.

The general public exposure levels at 155MHz (typical of mountain rescue) are

- 62V/m averaged over 6 minutes
- 27.7V/m averaged over 30 minutes

Refer to Figure 3-1 and Figure 3-2.

Table 6. Reference levels for local exposure, averaged over 6 min, to electromagnetic fields from 100 kHz to 300 GHz (unperturbed rms values).[a]

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} (V m^{-1})	Incident H-field strength; H_{inc} (A m^{-1})	Incident power density; S_{inc} (W m^{-2})
Occupational	0.1 – 30 MHz	$1504/f_M^{0.7}$	$10.8/f_M$	NA
	>30 – 400 MHz	139	0.36	50
	>400 – 2000 MHz	$10.58f_M^{0.43}$	$0.0274f_M^{0.43}$	$0.29f_M^{0.86}$
	>2 – 6 GHz	NA	NA	200
	>6 – <300 GHz	NA	NA	$275/f_G^{0.177}$
	300 GHz	NA	NA	100
General public	0.1 – 30 MHz	$671/f_M^{0.7}$	$4.9/f_M$	NA
	>30 – 400 MHz	62	0.163	10
	>400 – 2000 MHz	$4.72f_M^{0.43}$	$0.0123f_M^{0.43}$	$0.058f_M^{0.86}$
	>2 – 6 GHz	NA	NA	40
	>6 – 300 GHz	NA	NA	$55/f_G^{0.177}$
	300 GHz	NA	NA	20

Figure 3-1. ICNIRP Exposure Reference Levels Averaged Over 6 Minutes ((ICNIRP), 2020)

Table 5. Reference levels for exposure, averaged over 30 min and the whole body, to electromagnetic fields from 100 kHz to 300 GHz (unperturbed rms values).[a]

Exposure scenario	Frequency range	Incident E-field strength; E_{inc} (V m^{-1})	Incident H-field strength; H_{inc} (A m^{-1})	Incident power density; S_{inc} (W m^{-2})
Occupational	0.1 – 30 MHz	$660/f_M^{0.7}$	$4.9/f_M$	NA
	>30 – 400 MHz	61	0.16	10
	>400 – 2000 MHz	$3f_M^{0.5}$	$0.008f_M^{0.5}$	$f_M/40$
	>2 – 300 GHz	NA	NA	50
General public	0.1 – 30 MHz	$300/f_M^{0.7}$	$2.2/f_M$	NA
	>30 – 400 MHz	27.7	0.073	2
	>400 – 2000 MHz	$1.375f_M^{0.5}$	$0.0037f_M^{0.5}$	$f_M/200$
	>2 – 300 GHz	NA	NA	10

Figure 3-2. ICNIRP Exposure Reference Levels Averaged Over 30 Minutes ((ICNIRP), 2020)

4 Mountain Rescue Radio Transmission Equipment

Typical radio equipment used by mountain rescue teams falls into the following categories

1. Vehicle mobile radio with external $\lambda/4$ or $5\lambda/8$ antenna mounted on the roof or bonnet
    - Transmitter power limited to 25W
2. Fixed base radios with $\lambda/2$ dipole antenna mounted indoors or outdoors
    - Transmitter power limited to 25W
3. Fixed repeater radio equipment with end fed $\lambda/2$ or λ antenna mounted on a tower or other structure
    - Transmitter powers limited to 10W or 25W depending on individual license conditions
4. Mobile repeater radio equipment with external $\lambda/2$ dipole antenna, typically deployed to improve communications coverage for a specific rescue incident
    - Transmitter powers limited to 10W or 25W depending on the license conditions

The OFCOM proposal is that all equipment transmitting at powers $> 10W\ EIRP$ would be required to comply with the ICNIRP guidelines regarding public exposure.

- ‘Licensees would also be required to keep records (including the results of any measurements, tests and calculations) that demonstrate how they have complied’

Very simply, if any radio equipment operated by mountain rescue, once connected to an antenna, was capable of radiating $10W\ EIRP$ or greater, then that equipment would be subject to the ICNIRP guidelines regarding public exposure.

As a simple example, a mobile repeater radio set to 6W (37.8dBm), connected to a dipole antenna of gain 2.2dB would radiate 10W EIRP (40dBm).

4.1 Electric Field Strengths Radiated by Mountain Rescue Transmissions

The calculation of the radiated electric field strength needs to take into account ICNIRP public exposure reference level, 62V/m averaged over 6 minutes, 27.7V/m averaged over 30minutes.

Using the equation from Section 1, $d = \sqrt{(30 \times P \times G)/E}$, Table 4-1 shows the calculated distances for different antenna types for the general public exposure limit averaged over 30 minutes. Table 4-2 shows the calculated distances for different antenna types for the general public exposure limit averaged over 6 minutes

Table 4-1. Distance from Radiating Antenna for General Public Exposure Limit 27.7V/m Averaged over 30mins

Transmitter Power	Antenna Type	Antenna Gain	EIRP (W)	Radius Gen Public Exposures Limit 27.7V/m	Comments
25.0W	λ/2 Dipole	1.66	41.5W	1.27m	Typical fixed base antenna installation
25.0W	λ/4 Whip	3.32	83.0W	1.80m	Typical vehicle mount antenna
25.0W	λ Dipole	3.32	83.0W	1.80m	End fed Co-linear or 1/4λWhip antenna
25.0W	5λ/8 Whip	6.64	166.0W	2.55m	High gain vehicle antenna

Table 4-2. Distance from Radiating Antenna for General Public Exposure Limit 62V/m Averaged over 6mins

Transmitter Power	Antenna Type	Antenna Gain	EIRP (W)	Radius Gen Public Exposures Limit 62V/m	Comments
25.0W	λ/2 Dipole	1.66	41.5W	0.57m	Typical fixed base antenna installation
25.0W	λ/4 Whip	3.32	83.0W	0.80m	Typical vehicle mount antenna
25.0W	λ Dipole	3.32	83.0W	0.80m	End fed Co-linear or 1/4λWhip antenna
25.0W	5λ/8 Whip	6.64	166.0W	1.14m	High gain vehicle antenna

4.2 Electric Field Strengths and Public Exposure During Rescues

Given that mountain rescue volunteers are not workers trained or monitored to operate in the presence of electromagnetic radiation, it is reasonable to apply the more cautious public exposure reference levels when assessing the maximum fields they should be exposed to.

ICNIRP sets two general public exposure reference levels

- 27.7 V/m averaged over 30 minutes
- 62 V/m averaged over 6 minutes

The calculated distances for typical mountain rescue installations for the two reference levels are summarised in Table 4-1 and Table 4-2.

Many mountain rescue efforts require a control vehicle often parked in a public space with little or no control over public movements. The nature of mountain rescue radio communications is very short duration transmissions. A single radio transmission is unlikely to be >1 minute. More typical transmissions are <30 seconds.

There are periods of short radio transmissions over a period of several minutes or half an hour:

- At the beginning of a rescue as team members depart to scene and the rescue effort is getting organised

There may be a lull in radio transmissions, sometimes over a period of hours with only very short intermittent transmissions:

- An ongoing search effort or it just takes a long time to reach the casualty

More short radio transmissions over a period of several minutes or half an hour:

- The casualty is located, treatment & evacuation

Another lull as the team returns to base, very short intermittent transmissions.

During the rescue period the exposure to the public & team members is from the control vehicle & the above summarised communication activity. The worst case scenario is a low level antenna mounted on a vehicle bonnet or the roof of a normal car. Under these conditions human activity within <2m of the radiating antenna is entirely possible. Antennas mounted on the roof of a transit type vehicle above head height are less directly accessible.

5 Conclusions

The OFCOM proposal is quite rightly seeking to allay public fears regarding exposure to the electromagnetic fields radiated by radio transmitting equipment. The OFCOM proposal is focussed on the roll out of 5G mobile phone infrastructure. This equipment will be radiating on a permanent basis. It is also likely that some of this equipment will be in enclosed public spaces e.g. shopping centres where the public may gather and linger (in a café, on a bench) for long periods. For reasons of security and aesthetics, radiating equipment may be very well disguised. The public may well be in close proximity to radiating equipment without knowledge for long periods.

The nature of mountain rescue radio transmissions (and other PMR transmissions) is very different from mobile phone fixed equipment. PMR transmissions are very short duration & infrequent. Certainly from a mountain rescue perspective, the public tend not to be allowed to linger for long periods around a rescue control vehicle.

It is also clear from the results in Table 4-1 and Table 4-2 that for typical mountain rescue vehicle installation radiating $166W\ EIRP$*, it is necessary for someone to be within 2.5m of a* continuously *radiating antenna to be subjected to an EMF of* $27.7\ V/m$*, the ICNIRP reference level for 30 minutes time averaged exposure. To be within an EMF of* $62\ V/m$ *someone would have to be within 1.1m of a* continuously *radiating antenna for 6 minutes time averaged exposure.*

OFCOM's proposal to bring all transmitting equipment above 10 W EIRP within the ICNIRP guidelines is unnecessary for PMR type radio equipment which operates on a simplex transmission mode. The risk of over exposure to the public, (including mountain rescue volunteers), is extremely low. By making ICNIRP compliance a condition of licence, OFCOM will be imposing an unnecessary burden on countless organisations which use simplex operated PMR based radio systems. These are organisations which do not have the technical skills required to meet a the requirement to keep records demonstrating compliance in dynamic operational situations. There is no argument for such a requirement given that it would not improve public safety.

6 Recommendations

Having considered the content of this report, and given that:-

At a worst case 25 W transmit power with a 5/8λ whip vehicle antenna (see) would have an EIRP of 166 W. An individual would need to be within 1.14 m of a continuously transmitting antenna for 6 minutes to reach the public exposure limit.

- There is no mountain rescue scenario which would broadcast continuously for even half that period
- It would not be expected for anyone to be that close to a mobile antenna for that period of time in any case.

It is recommended to OFCOM that:-

- Any PMR radio system, fixed or mobile, radiating intermittently below 200 W EIRP, should not be subject to the proposed conditions.

This would ensure public safety without placing an unnecessary regulatory financial burden on not for profit organisations which rely on low power, fixed and mobile, intermittent communications devices to provide vital services to the public.

Given that:-

At a worst case 25 W transmit power with a 5/8λ whip vehicle antenna (see Table 4-2) an individual would need to be within 1.14 m of a continuously broadcasting device for 6 minutes to reach the public exposure limit (which is considerably lower than the occupational exposure limit)

- There is no mountain rescue scenario which would broadcast continuously for even half that period
- It would not be expected for anyone to be that close to a mobile antenna for that period of time

Having considered the content of this report it should be recommended to OFCOM that:-

- Any PMR radio system, fixed or mobile, transmitting intermittently below 200 W EIRP, should not be

subject to the proposed conditions.

- Any PMR radio system transmitting intermittently above 200 W EIRP, should be subject to the proposed conditions.

This would ensure public safety without placing unnecessary regulatory of financial burden on not for profit or commercial organisations which rely on low power, fixed and mobile, intermittent communications devices to provide vital services.

7 Works Cited

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