HSSH Sub-Panel – Telephone Masts Review

Wednesday 24th January 2007 – 3.00pm in the States Chamber

Witness – Mr W. Harris , Department of Electronics

1. Please could you outline your roles and responsibilities at the Department of Electronics?

2. What requirements are there on you to undertake emission testing on mobile telephone base stations in Jersey?
    - Requirements are embodied in our Ofcom and JCRA licences to operate on the allocated frequencies and at specified power levels, within ICNIRP levels, using type approved equipment

3. Would you outline the differences between mobile masts/ mobile base stations and tetra masts including the different levels of emissions?
    - The technology is very similar but the mobile system is designed to be a telephone system, TETRA is a mobile radio system
    - Both use TDMA, GSM bandwidth is 200kHz against 25kHz For TETRA
    - TETRA is designed to serve the relatively small public safety community (<1000 users) and has no profit motive, it is owned by the emergency services
    - The GSM system is designed to serve the community, requiring greater much capacity than TETRA and is a commercial business
    - The GSM system dwarfs TETRA in numbers of channels
    - Multiple channels – typically 10 against 2 for TETRA
    - The power levels are similar
    - TETRA uses just one transmitter antenna whereas mobile masts carry sectorised antennas to serve areas of particular interest

4. Would you confirm how many tetra masts there are in total on the Island?

There are six base station sites providing wide area coverage.

5. How often are these tested for emissions?

Three monthly routine maintenance and additional visits, as required

6. When did your department start emission testing?

Forms part of routine maintenance

7. How frequently does that testing take place?

Minimum 3-monthly

8. How do you undertake testing for cumulative emissions given the potential for mast saturation?

Currently, we test only our own systems and, hitherto, have no brief to test the telecom operators. Site sharers are responsible for ensuring that their systems stay within the terms of their licences.

9. Where do you obtain information on safe levels of emissions?

We follow the ICNIRP guidelines, ensuring that those emissions for which we are responsible remain significantly below the recommended levels.

10. What is your view on the ICNERP standards adopted as safe by the industry do you consider they are sufficient?

We consider the ICNIRP guidelines to be sufficient, this is borne out by the European Union (EMF Directive) and World Health Organisation.

It adopted the same levels as the NRPB but increased the margin for general public by a factor of 5.

11. What resources do you have available to undertake general testing of mobile telephone mast emissions?

We currently use spectrum monitors to carry out maintenance tasks, having established a datum when the system was commissioned. We remain within both the terms of our Ofcom licence and ICNIRP guidelines.

We shall acquire a general survey instrument during the current months.

12. Would you recommend that testing be undertaken by an independent authority such as Offstead as is the case in Guernsey?

We are very happy to recommend so. The terms of our JCRA licence allow for the JCRA to have the TETRA system audited at any time.

THE TETRA SYSTEM

- Used by all of the Island's emergency, security and public safety services
- Uses long-established sites, no new sites
- Six site system, two channels per site
- Located in the Home Office band 380-400MHz with transmissions on approximately 390MHz
- Uses Time Division Multiple Access (TDMA)
- Use diversity reception techniques to enhance coverage from low power portable radios
- Normally three directional antennas on each site, covering areas of particular interest
- One antenna doubles as a transmitter antenna
- Antenna gain is approximately 6dB
- Power into the transmit antenna is 7.5 watts; 6dB power gain gives approximately 30 watts in the direction of the main lobe for each of the two base transmitters (i.e. a total of 60 watts)
- The transmissions are not pulsed, all eight time slots at each site are permanently active

MEASUREMENT

- TETRA transmitters are self-monitoring with power roll-back in the event of any malfunction; automatic reporting to control centre
- Standardised test procedures to measure power output, antenna and feeder quality
- Engineering tests - spectrum monitor to analyse transmitter outputs
- Consensus measurements; comparative measurements between all transmitters

2. RSSI - TETRA mobiles can be used in a test mode to show received signal strength which, in turn, can be translated into field strength in uwatts/m using specialised software. — Motorola Airwave

3. Access to Narda SRM-3000 Selective Radiation Meter for measuring field strength and %age ICNIRP

4. Personal Protection Equipment
   - Narda RF Personal Monitor for climber safety

5. Action this year
   - Intend to purchase a Narda NBM520 broadband Field Meter, available in June
   - Work in liaison with site sharers to maintain multiple transmitting source records

NATIONAL & INTERNATIONAL GUIDANCE ON EXPOSURE TO MOBILE PHONE FREQUENCIES

WHOLE BODY

Organisation	Exposure	Basic Restriction	Investigation
NRPB	Occupational	0.4W/kg	25.1Wm2 (all)
ICNIRP	Occupational	0.4W/kg	10Wm2
	Public	0.08W/kg	2Wm2

(reduced from NRPB by a factor of 5 for GP)

FIELD MEASUREMENTS - Date: 19th January 2007

1. Using Narda SRM3000 Selective Radiation Meter (loaned by Jersey Telecom)
2. Location –

- Communications Services, adjacent to the new houses

  80mV/m

  20 uwatts/m2

  1.9nW/cm2

  0.0012% ICNIRP
- Les Platons, bus stop by radar site

  200mV/m

  120uwatts/m2

  12nW/cm2

  0.005% ICNIRP
- Gorey, adjacent to closest residence

  1.6V/m

  6.9mW/m2

  690nW/cm2

  0.3% ICNIRP
- Five Oaks, JMMB car park

  27mV/m

  3.7uwatts/m2

  200pW/cm2

  0.00011% ICNIRP

POWER DENSITY1

Decay in power density with distance, for ~~10~~ 60 watt transmitter, P= ~~10~~ 60

At 50 metres = 1.8 mW/m2 (@ -3dB = 0.9 mW/m2) — ref 3dB points on polar diagram

p= P/4(pi)r2 = 60/(13) x 50 x 50 = 0.0003Wm2 = 1.8 milliwatts/m2

At 100 metres = 462 uW/m2

p= 10/13x100x100 = 60/130000 = 0.000077Wm2 = 462 microwatts/m2

At 1000 metres = 4.8 uW/m2

P=10/13x1000x1000 = 60/13000000 = 0.0000008Wm2 = 0.8 microwatts/m2

STANDARDS BODIES

1. NRPB – now the Health Protection Agency
   1.1. Advisory Group on Non-Ionising Radiation (AGNIR – Independent)

2. International Commission on Non-Ionising Radiation Protection (ICNIRP) – similar to NRPB but identifies General Population exposure five times less than NRPB

3. EU Physical Agents (Electromagnetic Fields (EMF)) Directive – proposed 17 December 2002 - controlling exposure of workers, based on ICNIRP

NRPB already allowed a significant safety margin

ICNIRP (1998)

1. A two-tier system
    a. 10w/kg – occupational
    b. 2W/kg – general population*
    c. Averaging mass of 10g over 6 minutes

*Precautionary approach when considering the variety of conditions that might exist in the general population, age, susceptibility to thermal effects etc.

Reference levels are 6.5 to 11 times lower than NRPB.

e.g. 800-1000MHz = 4 - 5Wm2
2000-3000MHz = 9 - 9.5Wm2

N.B. The NRPB did not support ICNIRP's rationale for the reduction for the general population but supported further epidemiological studies.

ICNIRP – basis for the Eu. EMF directive for occupational users

Used by the World Health Organisation

ENGINEERING PRACTICE

2. Use of best engineering practice
    a. Application of planning rules to the public sector
    b. Use of existing communications sites
    c. Limited number of sites requires altitude to provide an effective communications system
    d. Base station power lower than old analogue systems; old 25w, 2 channels TETRA 7.5 watts approx, continuous transmission, no pulsing
        - Use of exclusion zones – very close proximity to an antenna

Reputation

Professional

SYSTEM AUDITS

1. All equipment must be type approved to ETSI standards
2. The Licence Holder is duty bound to ensure that it operates in accordance with the terms of its Ofcom and JCRA licences.
3. The JCRA licence provides for the JCRA to authorise a person to carry out a system audit, at the Licensee's reasonable cost.
4. The Licensee is required to adhere ITU, ICNIRP standards and guidelines
5. Ofcom is one organisation that could carry out a base station emissions audit.
6. Public confidence
    a. Ombudsman
    b. Communication
    c. Accessibility of information
    d. Leaflets to households
    e. Ongoing research

RESEARCH

1. Home Office – Imperial College study (TETRA) – commissioned in 2003 – to address issues raised by the NRPB Advisory Group on Non-Ionising Radiation (AGNIR)
    i. Examines the effect of TETRA on the health of Police Officers

2. Essex University (TETRA) – Mobile Telephone Health Research programme - Health study of TETRA masts and short term effects on health – already completed study on GSM & 3G

3. MTHR – research project on hypersensitivity

4. WHO EMF Programme

5. EU EMF Directive – based on ICNIRP for occupational users

6. Uncertainties of research

7. Early studies were not confirmed

8. Prof Lawrie Challis study proposal – seeking funding

GOOD PRACTICE

1. Keep calls short
2. Use landline when at home
3. Check the SAR value before buying
4. Use handsfree kit
5. Send text rather than make a call
6. Try to use in good signal areas
7. Keep the phone away from the head, within reason
8. Avoid touching the aerial and keep away from sensitive organs
9. Switch off when not in use

MOTOROLA'S TETRA TERMINALS

4. NRPB BASIC RESTRICTIONS ON EXPOSURE IN THE FREQUENCY RANGE 10MHz TO 10GHz

- Tissue region – SAR limit
    1. Head 10W/kg* averaged over 10 grams of tissue over 6 minutes
- Motorola MTP/MTH
    1. Ear - 0.49W/kg
    2. Body - 0.25W/kg
    3. Face - 0.1Wkg

*'These restrictions apply equally to workers and members of the general public. Provide protection against harmful thermal effects for all exposed individuals under all conditions' (NRPB, 1999a,b)

Investigation level:
400 - 800 MHz – Electric field = 100 Volts/m (26 Wm2) if exceeded
800 - 900 MHz – 26 – 33 Wm2
1800 -1900 MHz – 100 W/m2

Remote speaker-microphones

The main exposure to the body is expected to be at waist level from the antenna and case of the hand portable and to be roughly comparable to that occurring in the head when the hand portable is held in one of the normal use positions, since the distance of the body from the antenna is similar. For the same reason, this should also be the case when a lightweight hands-free kit is used, although there could be some exposure from the earphone if RF current is induced in the cable. Future systems with an antenna attached to the speaker-microphone rather than to the hand portable will move the exposure from waist level to nearer the shoulder and head but the exposure could be less than in other positions since the antenna should be somewhat further from the body.

Vehicle-mounted terminals

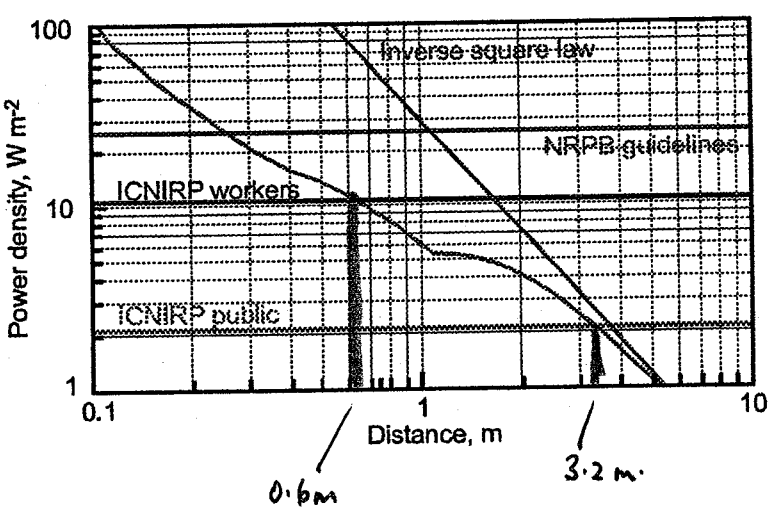
The antenna is located outside the vehicle and, since its distance from the passengers inside the vehicle would normally be substantially greater than if they were using a hand portable, their exposure should be appreciably less even though the power is somewhat higher. The situation is complicated by the metal body of the vehicle. It is not evident that this could be relied upon to provide shielding since the non-conducting parts (eg windows) of the vehicle are comparable to the wavelength of the radiation (see Figure 12).

The exposure received by a user outside the vehicle reduces rapidly as the distance from the antenna increases. The fields around vehicle-mounted antennas should couple into the head in a similar way to those around the antennas used with hand-portables because both types of antennas are essentially omni-directional and have little gain. Based on this assumption, the data in Table 6 suggest that, for both 3 W and 10 W vehicle-mounted terminals, the ICNIRP basic restrictions for the general public (ICNIRP, 1998) could be exceeded if a person's head were within a few centimetres of a vehicle-mounted transmitting antenna for several minutes. If more than one time-slot were used, the ICNIRP guidelines for occupational users could also be exceeded in similar circumstances.

Base stations

The maximum power radiated from TETRA base station transmitters is similar to that from mobile phone base station transmitters, ie a few tens of watts. At these power levels there will be regions in the immediate vicinity of the base station antennas where guidelines could be exceeded. Examples of calculations of power density in the vicinity of antennas are given below. Measurements made at locations of public access are also reported.

FIGURE 13 Plane-wave equivalent power density as a function of radial distance from a antenna consisting of a stack of four dipoles designed to give a gain of 11.5 (10.6 dB) and a radiated power of 33 W

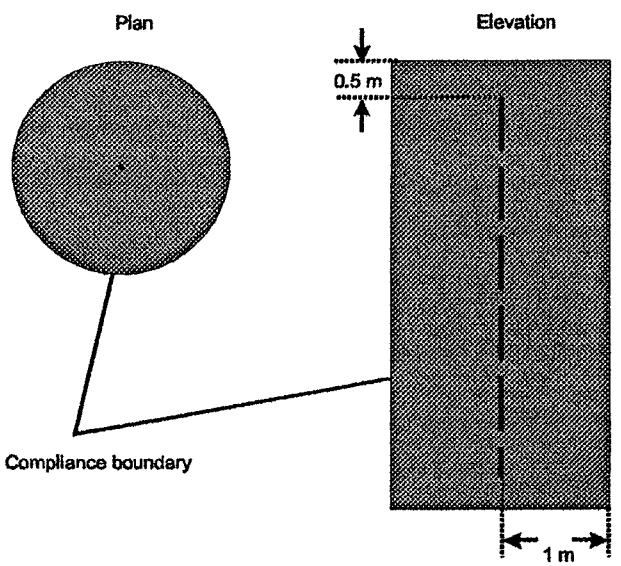


Near the antennas

70 As an example, NRPB has calculated the power density from an antenna consisting of a stack of four dipoles transmitting a total power of 33 W at a frequency of 425 MHz. Figure 13 compares the calculated power density with investigation/reference levels taken from the NRPB and ICNIRP guidelines (NRPB, 1993; ICNIRP, 1998).

71 From either measured or calculated data similar to those in Figure 13 it would be possible to derive a compliance boundary for a particular antenna. This is defined as the surface surrounding the antenna and at a distance from it at which the exposure equals the guideline level. Within the surface, guideline reference levels are exceeded while outside they are not. Hence exposures can be controlled by restricting access to the *exclusion zone* - the zone within the compliance boundary. In the case of an omni-directional antenna, the compliance boundary is expected to be approximately cylindrical as shown in Figure 14.

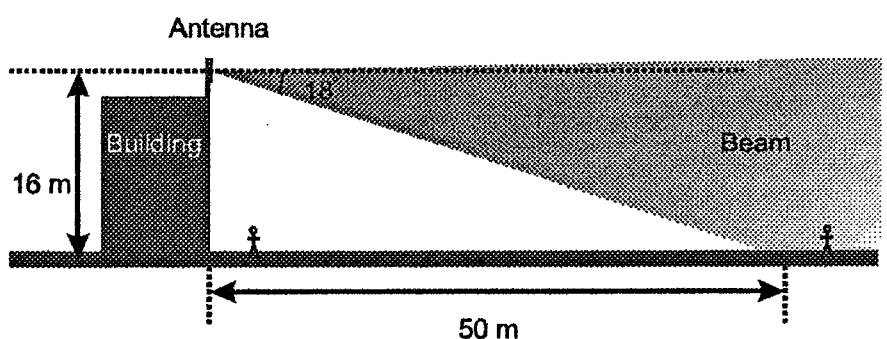
FIGURE 14 Example of a compliance boundary around an omni-directional TETRA base station antenna formed from a stack of four dipole elements



Ambient RF levels

72 Locations outside the exclusion zone, where the general public can be exposed, tend either to be beneath the main beam or within the beam but several tens of metres away. In both cases their exposure should be well below guideline levels (Figure 15).

FIGURE 15 Exposure of people near to base stations



≃ 2 milliwatts/m²

73 NRPB has made measurements of the power density of radio signals at publicly accessible locations in the vicinity of several TETRA base stations. Examples are shown in Table 7 and exposures have always been small fractions of guidelines. The measurement at 42 m distance is higher than the measurement at 20 m because it is sufficiently far away for the main beam to be encountered at ground level.

TABLE 7 A selection of indoor and outdoor measurements of power density representative of typical exposure from TETRA base station transmitters

Source antenna height (m)	Measurement position height (m)	Horizontal distance (m)	Line of sight	Indoor/ outdoor	Power density ($mW\ m^{-2}$)	% ICNIRP public reference level
16	1	42*	Yes	Outdoor	4.0	0.19
16	1	20†	Yes	Outdoor	0.47	0.0022
16	1	16	No	Indoor	0.028	0.00013
16	5	34	Yes	Indoor	0.62	0.0030
16	1	11	No	Indoor	0.025	0.00012
16	1	30	No	Indoor	0.159	0.00076

Agrees with DoE measurements.

* Within main beam.

† Outside main beam.

Conclusions on exposure of people

74 Measurements of the maximum exposure from a 1 W TETRA hand portable used for speech transmission (one time-slot per frame) indicated an SAR below the ICNIRP basic restrictions for occupational and general public exposure. A similar measurement for a 3 W hand portable resulted in an SAR above the ICNIRP basic restrictions for the general public, but not for occupational exposures for which the system is designed. SAR values would increase if more than one time-slot were used and the hand portable were still held close to the body. They would remain below occupational guideline values with the 1 W hand portable, even if four time-slots per frame were used. However, for the 3 W hand portable, the guideline values for occupational users would be approached or exceeded if three or four time-slots were used per frame.

75 The conclusions in paragraph 74 are for the particular make of hand portable on which measurements have been made. The SARs from other makes could differ and this could lead to different conclusions in relation to guidelines. However, the SARs given in Table 6 for a 1 W hand portable are so far below occupational guidelines that it seems unlikely that modification of the conclusions would be necessary for other makes when they are used for speech transmission.

76 No measurements appear to have been made of the exposures received inside or outside vehicles with externally mounted antennas (3 W or 10 W). However, the users inside a vehicle are normally appreciably further from the antenna than when they are using a hand portable and it seems unlikely that guidelines would be exceeded even if four time-slots per frame were used. The exposure received by a user outside the vehicle depends on their distance from the antenna. For both 3 W and 10 W vehicle-mounted terminals, the ICNIRP basic restrictions for the general public (ICNIRP, 1998) could be exceeded if a person's head were within a few centimetres of a vehicle-mounted transmitting antenna for several minutes. If more than one time-slot were used, the ICNIRP guidelines for occupational users could also be exceeded in similar circumstances.

77 The exposure values from base stations should be less than the ICNIRP guidelines for the general public if the exclusion zones are correctly set by the operators. The waveforms of the electromagnetic fields from base stations are continuous and are not pulse modulated as they are from mobile terminals.

England FM Transmitters

main stations in red	R1	R2	R3	R4	Pol	Max erp	Grid Ref
Belmont	**98.3**	**88.8**	**90.9**	**93.1**	**M**	**16kW**	**TF217837**
Grantham	97.7	88.1	90.3	92.5	V	50W	SK905337
Chatton	**99.7**	**90.1**	**92.3**	**94.5**	**M**	**5.6kW**	**NU105264**
Berwick-upon-Tweed	98.2	88.6	90.8	93.0	V	25W	NT980547
Holme Moss	**98.9**	**89.3**	**91.5**	**93.7**	**M**	**250kW**	**SE095041**
Barnoldswick	99.3	89.7	91.9	94.1	V	20W	SD897480
Beecroft Hill	99.4	89.8	92.0	94.2	V	200W	SE237350
Cornholme	99.3	89.7	91.9	94.1	V	20W	SD918264
Haslingden	99.5	89.9	92.1	94.3	V	83W	SD795236
Hebden Bridge	98.0	88.4	90.6	92.8	V	25W	SD988267
Idle	98.1	88.5	90.7	92.9	V	25W	SE163374
Keighley	98.5	88.9	91.1	93.3	V	1kW	SE069444
Kendal	98.6	89.0	91.2	93.4	M	100W	SD540912
Luddenden	98.3	88.7	90.9	93.1	V	84W	SE048248
Morecambe Bay	99.6	90.0	92.2	94.4	M	10kW	SD239791
Olivers Mount	99.5	89.9	92.1	94.3	M	250W	TA040869
Pendle Forest	97.8	90.2	92.6	94.6	M	1kW	SD825384
Saddleworth	99.3	89.8	91.9	94.1	V	95W	SD987050
Sheffield	99.5	89.9	92.1	94.3	M	320W	SK324870
Stanton Moor	99.4	89.8	92.0	94.2	M	1.2kW	SK246637
Todmorden	98.5	88.9	91.1	93.3	V	100W	SD957241
Walsden South	98.0	88.4	90.6	92.8	V	10W	SD937215
Wensleydale	97.9	88.3	90.5	92.7	M	54W	SD992907
Whalley	99.2	89.6	91.8	94.0	V	10W	SD729352
Wharfedale	98.0	88.4	90.6	92.8	M	40W	SE198485
Windermere	97.9	88.3	90.5	92.7	M	64W	SD383980
Les Platons (CI)	**97.1**	**89.6**	**91.1**	**94.8**	**M**	**16kW**	**CI925273**
Manningtree	**97.7**	**88.1**	**90.3**	**92.5**	**M**	**5kW**	**TM123295**
North Hessary Tor	**97.7**	**88.1**	**90.3**	**92.5**	**M**	**160kW**	**SX578742**
Axe Valley	99.1	89.5	91.7	93.9	V	80W	SY283945

Radio 1 3KW ERP

Network 16KW. ERP

Gorey TV. .006 KW.

St. H. 0.034 KW.

Fremont 20KW.

MOTOROLA
intelligence everywhere™

MTH800 RF Exposure/Specific Absorption Rate (SAR) Information

Your MTH800 TETRA handset is a radio transmitter and receiver. It is designed and manufactured not to exceed ICNIRP limits for exposure to radio frequency (RF) energy. These limits are part of comprehensive guidelines and establish permitted levels of RF energy for occupational and general population exposures. The guidelines are based on standards that were developed by independent scientific organizations through periodic and thorough evaluation of scientific studies. The guidelines include a substantial safety margin designed to assure the safety of all persons, regardless of age and health.

The exposure standard for TETRA handsets employs a unit of measurement known as the Specific Absorption Rate, or SAR. Under the guidelines for your TETRA handset, the SAR limit are 10 W/kg[1] for occupational and 2.0 W/kg.[1] for general public Tests for SAR are conducted in accordance with CENELEC[2] testing procedures using standard operating positions with the TETRA handset transmitting at its highest certified power level in all tested frequency bands. Although the SAR is determined at the highest certified power level, the actual SAR of the TETRA handset while operating can be well below the maximum value. This is because the TETRA handset is designed to operate at multiple power levels so as to use only the power required to reach the network. In general, the closer you are to a base station, the lower the power output of the TETRA handset. When the TETRA handset is not transmitting the SAR is negligible.

The tests are performed in intended use positions and locations (e.g., at the ear, in front of the face, and worn on the body) that conform to a uniform testing methodology determined by an expert standards body. The highest SAR value for this model TETRA handset is when tested for use at the ear is 0.49 W/kg[3]. The SAR values for other positions are 0.25 W/kg[3] at the body and 0.1 W/kg[4] at the face.

While there may be differences between the SAR levels of various TETRA handsets and at various positions, they all meet the governmental requirements for safe exposure.

Please note that improvements to this product model could cause differences in the SAR value for later products; in all cases, products are designed to be within the guidelines.

[1] The SAR limit recommended by international guidelines (ICNIRP) for TETRA handsets are 10 watts/kilogram for occupational and 2.0 watts/kilogram (W/kg) for general population averaged over ten grams of tissue. The limit incorporates a substantial margin for safety to give additional protection for the public and to account for any variations in measurements.

[2] CENELEC is a European Union standards body.

[3] This includes the Motorola testing protocol, assessment procedure, and measurement uncertainty range for this product – 1 watt continuous transmit

[4] Two-way radio mode (50% transmit duration) – 1watt.