

**Home Office response to the questions raised by
Barry Trower in his report for the Police Federation on
TETRA health and safety issues**

Bold: Barry Trower's questions to the Home Office

Normal: Home office replies

Italic: Comments by Alasdair MacLean PHILIPS, Powerwatch, have been added marked by AMP: on 4th February 2002

- 1. With all of the research written here showing dangers from electric, magnetic, pulsed microwave electromagnetic fields, why with the officers' safety at risk are we still sticking to our ridiculous safety limit, which only measures heat?**

The only established risk to health resulting from exposure to radio frequency electromagnetic fields arises from heating. Maximum levels of exposure given in terms of the power absorbed and hence the heat generated provide a reliable quantitative measure of the safety of radio frequency systems. The safety guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), soon to be adopted by the National Radiological Protection Board (NRPB), were published in 1998. The Stewart report (2000) states that "Both the NRPB and ICNIRP guidelines are based on the need to avoid known adverse health effects. At the time these guidelines were drawn up, the only established adverse effects were those caused by the heating of tissues". There is still no established evidence of adverse health effects at power absorption levels below the guidelines.

AMP: It is misleading nonsense to write that only heating effects from RF exposure have been established as a health risk. The peer-reviewed scientific literature is full of papers showing, often replicated, biological effects that are likely to have serious health consequences (e.g. heat-shock-protein cellular stress responses) occurring at levels far below those that cause heating. The current MTHR (see www.mthr.org.uk web site) research programme is mainly funding further investigations in this area. The UK Government (in the "Maastricht Treaty" and "Our Common Future" and other papers) is pledged to apply a precautionary approach when the science suggests problems that are not yet proven; this is the case with TETRA. Plenty of concerning evidence about the biological effects of RF carriers modulated with low frequency pulsing has been published, some of it decades ago.

- 2. Can more information be given to the officers on our Government's non-lethal weapons programme concerning pulses into the brain around 17.6 Hz, or stored information from other research papers?**

This is not an element of the Home Office programme of less-lethal technologies for law enforcement and we are unaware of any UK Government programme that undertakes such research.

AMP: Whether or not the UK Government has a non-lethal weapons programme is debatable, however there is a wealth of literature, including official US Government sources (where they have a Freedom of Information Act), showing that such non-lethal weapons capability has been developed in both Eastern and Western countries. References can be supplied, if required.

- 3. Can the signals from the transmitter to the officer be rechecked as they are listed in the manual as continuous waves, whereas they have been measured independently to be shown to be pulsed? This is important because pulsed radiation is arguably more aggressive than continuous.**

The signals transmitted by Airwave base stations have been checked by the manufacturer and by the NRPB. A technical note on "Power modulation spectra of signals used in "TETRA" was published in a revised version of the NRPB report on "Possible health effects from TETRA" on the NRPB website in November 2001. Both sets of results confirm that the Airwave base stations transmit a continuous wave.

AMP: The NRPB measurements are correct, but their interpretation of them is flawed.

I have now examined a BT Airwave TETRA base-station signal in some detail at BT's Martlesham site on Friday 25th January 2002 with John V Collins and Trevor Morsman, both of BT Exact Technologies.

This consists of an RF (microwave) signal carrier or around 400 MHz with a series of three bursts of amplitude modulation (AM) repeating every 56.7 milliseconds (i.e. at a frequency repetition rate of 17.65 Hz, or times per second).

Each block of four is as shown on page 60 of the NRPB TETRA Report (NRPB Vol.12 No.2) technical addendum.

This (AM burst of 14.4 ms) (unmodulated carrier 1.7 ms) is repeated twice followed by a double length burst (two slots) lasting 26.7 milliseconds. This sequence is continuously repeated.

The modulation bursts went +3dB and -9dB (uV/m) relative to the nominal carrier level. The average RF power in the signal, averaged over a full four-slot time frame would be approximately that of the level of the inter-burst sections - i.e. effectively a constant carrier with no apparent pulse modulation. The NRPB explain that they average the signal over four 16 block multi-frames (i.e. over about 3.6 seconds. They are correct to say that if averaged over this time period there is no overall low frequency pulsing.

However, each burst of modulation is amplitude modulated to a depth of about 85% with a mix of high-band audio type signals. The NRPB do consider the modulation of the burst in Appendix 1, and the effects of the modulation in Appendices B and C where they admit that each 14.2 (or 26.7) burst contains a high level of amplitude modulation noise in the range from about 5 to 25 kHz.

There is some disagreement about the details of the frequency spectra of this noise, but that is immaterial. What matters is that each burst is effectively an amplitude modulated burst of 'coloured' high-frequency noise in the range from about 5 to 25 kHz. This is real amplitude modulation on the carrier taking the microwave signal to double amplitude and down to almost zero (about one-eighth of nominal carrier level). This will be detected as a burst of noise by a simple diode detector receiver (e.g. a 'crystal set' in its simplest form). This will remove the very fast microwave (400 MHz) component and leave the noise either as bursts of discrete audio frequency hiss (5 to 25 kHz) at 70.4 Hz and 17.6 Hz or, with typical biological living tissue time constants, as a series of extremely low frequency pulses spaced at 70.4 Hz with a longer pulse occurring at 17.6 Hz.

BT Airwave and the NRPB do not accept that non-linear biological systems are capable of detecting amplitude modulation. In fact, if you look at a standard text on EMF effects (Handbook of Bio Effects of EMFs, Polk & Postow, 2nd Edition, 1996) that clearly states (pp542-545 among others) that animals and probably humans can detect and sometimes hear pulsed microwave radiation. As far back as the early 1960s Allan Frey (one of the main and early researchers in this area suggests in a number of published studies that the mechanism isn't always thermal, but can be direct action of RF fields on neurons in both humans and animals).

The Polk & Postow book states (p543) that pulses in the range 10 to 70 microseconds produce the greatest perceived loudness. The TETRA symbol rate of 56 microseconds (18 kHz) and the sampling rate of 28 microseconds (36 kHz) is within this band. Most reports and investigation into microwave hearing effects suggest frequencies about 5 kHz are the most bio-active, thus the AM bursts in the TETRA base-station signal are very likely to produce sleep disruption in sensitive people. It may well also have other important health consequences.

So with TETRA BS signals we have high levels of amplitude modulation of a 5 to 24 kHz noise signal in bursts separated by about 1.7 milli-seconds of continuous (CW) microwave carrier. This signal could well be significantly biologically active and should not be dismissed by 'time averaging' the power of a complete time frame (or longer period).

Any pseudo-random AM RF signal (like medium wave radio transmission) will time average to a continuous carrier - completely missing the shorter-term amplitude modulated information/data.

No living tissue (animal or people) work has been carried out on TETRA type signals to see how these AM pulse bursts on TETRA BS signals are detected and what, if any, health effect this might have on biological living systems.

I hope this helps to clarify the pulsing nature of the TETRA base station signal.

To summarise, the signal is as shown in the NRPB TETRA Report. However, they analyse it in an incorrect manner that removes the amplitude modulation bursts by averaging them over a long time frame. The non-linear nature and time constants of simple diode receivers and biological living tissue do not do this, and discrete bursts of electrical signal do result from exposure to the signals from a TETRA base-station.

The pulsing from TETRA handsets is much stronger, as set out in the NRPB Document. Again, no human or animal work has been done or published on possible biological or long-term health consequences of exposure to such a signal.

The following questions arise from the NRPB report on TETRA (Volume 12, Number 2, 2001).

4. Section 21 - How much radiation, and of which type is emitted from the case?

Transmitters are designed to radiate from the antenna but weak electromagnetic emissions may also emanate from the case. Measurements of the total power absorbed, expressed as the specific absorption rates (SAR), are specifically designed to take all of the signals radiated from the handset into account. The SAR figures, therefore, include emissions from both the antenna and the case. These global SAR figures are well within ICNIRP guidelines for the Airwave handsets currently in use. The Home Office will ensure all Airwave equipment to be deployed also meets the guidelines.

AMP: There are also real 17.6 Hz magnetic field pulses caused by current surges from the battery every transmit time slot, that will be biologically active but, because of their low frequency, will not add to the SAR value.

5. Section 24 - What safeguards are in place to guarantee that the earphones are absolutely leakproof and with the rough and tumble world of the police officer, how often are the earphones going to be checked for leaks? Who will do this, and what type of apparatus will be used?

The earphones are audio devices, not radio frequency transmitters: the handset converts the radio signal into a sound signal which is then transmitted via a copper wire into the earphone transducer. The equipment is designed to minimise any radio energy reaching the earphone. A Consumers Association Which report on 'hands-free' kits for ordinary mobile 'phones has suggested that, under certain circumstances, radio frequency currents could reach the earphone and lead to exposure. Work will shortly be undertaken to check this and any necessary precautions will be taken should it turn out that earphones could be significant sources of exposure.

AMP: I look forward with interest to the results of this work. The TETRA handset must, of course, be used by an actual person, in the various ways that police officers will, for these tests as this will considerably affect the results. The routing of the earphone cable must be varied and the various

results noted. Appropriate advice can then be given to officers regarding the siting of the handset and the routing of the earphone cable.

6. Section 25 - What experiments have been done to measure how the officers inside the vehicle are insulated from the transmitting device?

Measurements made by Motorola and by the Home Office show that the signal levels are well below international safety guidelines inside a vehicle using Airwave mobile transmitters with a maximum power of 3 Watts and an antenna mounted along the centreline of the roof. Additional studies will soon be undertaken to measure such exposures, including vehicles with antennas mounted at the side of the vehicle.

AMP: No comment.

7. Section 28 - If a police car is to be used as a relay transmitter, again, what measurements have been taken to ensure the officers are insulated from the electromagnetic waves?

Police cars will only be equipped with the Airwave mobile transmitters mentioned above. These have a maximum power of 3 Watts and produce electromagnetic fields inside the vehicle that are well below the safety guidelines.

AMP: No comment.

8. Section 37 - Why is a pulsed frequency of 17.6 Hz being used when it is known to interfere with the brains' beta rhythm and it was warned against by the Stewart Committee?

Work on the definition of the TETRA standard started in 1988 and the documents describing the TETRA technology were adopted by the European Telecommunications Standards Institute in 1996, several years before the publication of the Stewart report. In any case, the evidence that pulsed radio signals specifically affect the electrical rhythms of the brain is controversial and no risk to human health has been demonstrated.

AMP: As senior NRPB, and other Government agencies' staff take part in ETSI, CENELEC and WHO meetings, why were these serious health concerns not raised in the early 1990s so that testing work could have been completed before the TETRA system was chosen by the Home Office?

9. Section 39/40 - If TETRA becomes widespread to all of the emergency services, reserve officers, traffic wardens, security officers, what is the expected output to be from handsets and the main transmitters? Transmitters generally increase their powers to cope with additional calls. Will this be the case for TETRA?

With the guidelines issued by the Home Office, the maximum output power from Airwave handsets is fixed at 1 W and that from Airwave vehicle-mounted transmitters is limited to 3 W, irrespective of call traffic. Adaptive power control used in TETRA technology results in lower powers than the maximum whenever possible. The maximum power from Airwave base stations is also fixed.

AMP: As the Home Office apparently didn't have any adverse health concerns about the TETRA system, why have they restricted the powers to 1W for handsets and 3 W for vehicles and 10W for base-stations, when most TETRA systems being advertised use 3 or 4 W for handsets, 20 to 50 watts for vehicles and 40 to 80W for base-stations? Their choice of lower power than available will result in poorer radio coverage, more dropped calls, and the need for thousands more base stations. At present it is unclear what caused them to specify lower power than normal for the police TETRA system.

10. Section 61 - Has a neurosurgeon been consulted to comment on the effect of TETRA penetrating deep into the head?

Detailed measurements of specific absorption rates inside the human head have been made for Airwave handsets, showing that the levels are below international guidelines. These guidelines have

been set on the basis of medical advice. If at any point new evidence suggests the guidelines are not met, appropriate medical advice will be sought.

AMP: See my response to Q.4, re. not just SARs, and Q.22 below re. neurosurgeon.

11. Section 63 - Why does very little information exist on the SAR produced by TETRA hand portables, why has no numerical modelling been carried out? Can this be done before TETRA is used nationally?

The SAR produced by Airwave hand portables has been measured by manufacturers and independently via studies commissioned by the Home Office. There is no reason to believe that numerical modelling would provide more accurate information, but we are currently consulting experts on this issue, which is also being addressed by the Mobile Telephone Health Research Programme co-ordinated by the Department of Health.

AMP: See my response to Q.4, re. real ELF magnetic fields and not just SARs.

12. Section 63 - Can all of the information relating to the experiments of measuring radiation inside the head (Gabriel 2000) be made available to the Police Federation for scrutiny, along with an independent peer review assessment from scientists, totally unconnected with the NRPB or communications industry?

The Gabriel report was written for the DTI on SAR measurements of a Dolphin handset, which uses a different frequency from Airwave. We plan to make available to the Police Federation SAR measurements carried out for the Home Office for Airwave handsets. The management committee for the Home Office TETRA health and safety studies includes independent experts, who will indeed provide an assessment of the results.

AMP: No comment.

13. Section 65 - If the SAR's could be up to 4 times larger than those in table 6, what risk assessment has been carried out for officers receiving radiation with a SAR of over 8 W/kg? Can this information be made available to the Police Federation?

The ICNIRP guidelines for occupational users are 10 W/kg for exposure of the head or the trunk. The factor of 4 relates to the introduction of multiple time slot equipment. If future Airwave developments include the use of more than one in four time slots, appropriate risk assessments will be carried out.

AMP: No comment.

14. Section 66 - With the main exposure expected to be at waist level, what research has been carried out relating this to the known deaths of officers from spine cancer from carrying transmitters on their belts? Could this research be made available to the Police Federation?

As far as we know there is no evidence of a link between spine cancer and the wearing of transmitters at waist level. The NRPB report states that "The new epidemiological information that has become available since the IEGMP report, like that available to the IEGMP, does not support the existence of a hazard of cancer from RF radiation in general, or specifically from the use of mobile phones". Measurements show that exposure from TETRA handsets worn at waist level is well within ICNIRP guidelines.

AMP: I am also worried about liver and kidney exposure. ICNIRP guidelines are non intended to protect from non-thermal outcomes such as cancer.

15. Section 66 - Has an ear, nose and throat specialist been contacted for an opinion concerning radiation from the cable being transmitted into the glands of the neck? If not, could this be done?

Measurements of specific absorption rates at neck level give levels below international guidelines. These guidelines have been set on the basis of medical advice. If at any point new evidence suggests that these guidelines are not met, appropriate medical advice will be sought and appropriate action will be taken.

AMP: No comment.

16. Section 67 - As vehicles cannot be relied upon to provide shielding for the officers, can further improvements to insulate the officers be recommended, then scientific studies carried out to test this insulation and all data be made available to the Police Federation?

The currently available measurements inside vehicles show that signals from vehicle-mounted Airwave transmitters are well below international guidelines. These and any further measurements will be made available to the Police Federation.

AMP: No comment.

17. Section 68 - If international guidelines could be exceeded, what risk assessment has been carried out for the officers and passers-by who may be using pacemakers, insulin pumps, have metal plates in their bodies, or be epileptic? Could this risk assessment be made available to the Police Federation? Similarly, for Section 68, concerning base station transmitters which will also exceed guidelines?

Airwave equipment fully complies with international guidelines. However, as is the case for all mobile communications systems, risk assessments for TETRA systems have been carried out by the Medical Devices Agency. They are published in MDA Notice SN2001(06).

AMP: I am concerned about TETRA handsets and vehicle radios interfering with life-support equipment at road traffic accidents. Vital signs monitoring equipment is generally intended to detect low frequency pulsing in the 2 to 30 Hz range, and TETRA radios transmit pulses at 17.6 Hz. What specific tests have been carried out on the susceptibility of ambulance and para-medical electronic equipment such as is used on casualties at RTAs?

18. Section 76 - Why have no measurements of exposures been made inside or outside vehicles? Could these be done and the data be made available to the Police Federation along with how averages are calculated?

Measurements of power density have been carried out both inside and outside vehicles and further measurements are planned. The results will be made available to the Police Federation.

AMP: No comment.

19. Section 128 - As the possibility is not excluded that TETRA might carry a risk of cancer that becomes manifest after first exposure, or there may be a hazard from the pulses around 16 Hz, would it be a good idea to allow the ladies and gentlemen of the police force an opinion in the decision making processes which may concern their long-term health? Should these long-term health risks be published for the police force so that, like members of the armed forces, they may volunteer to expose themselves to possible danger?

We see consultation with police forces as extremely important and hope they will continue to contribute to the decision-making processes on health and safety issues.

AMP: No comment.

20. Section 129 - As further research is needed, should this not be done before TETRA becomes national, and can the results be made available to the Police Federation for their scrutiny?

The Home Office is co-ordinating a large programme of work addressing the NRPB recommendations as well as issues raised by other parties. Scientific research is a lengthy process and we do not expect to see definitive results before the end of 2002 at the earliest. Police Federation will be kept informed of progress.

AMP: No comment.

21. Section 133 - Again, the possibility of a risk of cancer after many years of exposure is commented on along with the hazard of pulsed radiation at 16 Hz. I repeat my observation that this risk assessment ought to be made available with full consultation with the officers concerned who will be using the system and that they should have the final decision concerning their future health risks. Is this a possibility?

In the current state of knowledge there is no indication of adverse health effects from TETRA systems. If at any time anything arises that might indicate a risk to health, the Home Office will immediately make the information public and take appropriate measures.

AMP: There is no knowledge of adverse health effects from people using TETRA systems because no work has been done to test this! Also chronic health effects such as cancer usually take many years to become apparent. Solid tumours (e.g. brain tumours) can take up to about 25 years before they are detected. There are many studies showing concerning bio-effects due to low frequency magnetic fields and low frequency pulsing of radio-frequency fields.

22. Section 135, Section 2 - Has a neurosurgeon been contacted to assess the risk of pulsing and its effect on the signalling mechanisms between nerve cells? Could this report please be made available to the Police Federation?

The IEGMP (Stewart Committee), which included experts in brain function, did consider the evidence for biological effects of pulsing and came to the conclusion that there is no evidence of a hazard to health. The Advisory Group on Non-Ionising Radiation of the NRPB, which also includes experts on the nervous system, has come to the same conclusion, and has recommended further research on this topic. We are currently consulting experts from the Mobile Telephone Health Research Programme co-ordinated by the Department of Health.

AMP: A neurosurgeon would be unlikely to have adequate knowledge of EMF related bio-effects. The IEGMP did not assess TETRA signals it is not a public phone system and was not within their remit (IEGMP para. 4.19), however they did state (para 5.59) that systems that pulse around 16 Hz should be avoided. Sir William Stewart has since expressed his concern about TETRA on a number of occasions. Professor Ross Adey, Univ. California, who has studied the effects of EMFs on people for about 50 years, who was head of brain science for NASA in the 1960s and who has carried out research into RF effects, has expressed considerable concern about the potential adverse health effects of TETRA.

23. Section 135, Section 5 - Shouldn't the human volunteers study on TETRA be carried out before its use becomes widespread?.30/11/01 10

There is no evidence from previous human volunteer studies for a risk to health from radio frequency exposure below guideline limits, whether continuous or pulsed. However, further such research is part of the Home Office programme of work. We are commissioning human volunteer studies which are expected to start in early 2002.

24. Section 135, Section 6 - As an epidemiological study is recommended to be carried out on the use of TETRA and its effects on "a relatively stable workforce with defined patterns of work", shouldn't the police officers be asked their permission if they are going to take part in what is a long-term medical study which may result in a number of brain tumours, spine tumours, eye cancers, heart disorders and many other illnesses?

We are consulting with independent experts on the possibility of making a survey of Airwave usage. In the long term this could provide a valuable body of information for epidemiological studies. Naturally

any information collated for this purpose would have to comply with the Data Protection Act and consent would be sought whenever needed.

25. Section 135, Section 8 - Why is TETRA being used by officers if "only limited information is presently available on exposures from TETRA hand portables and further work is needed to provide more information on exposures from hand portables and from any other transmitting equipment?"

Much more complete information on exposure from Airwave systems is now available, and the Home Office programme of work will provide updated information as new equipment is brought into service.

AMP: No comments on 23 to 25 above.

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