

PERSONNEL ELECTROMAGNETIC RADIATION HAZARDS: AN INTRODUCTION AND MANPACK RADIO ISSUES

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This article provides some insight into the complexity of the management issues associated with personnel electromagnetic radiation hazards (RADHAZ). The nature of the adverse effects of electromagnetic radiation on the human body is briefly discussed. The rationale behind the derivation of safe exposure levels is presented. Methods of estimation of specific absorption rate (SAR) are discussed, and data showing variation of SAR distribution within a standing body in a uniform field are illustrated. Computer modelling strategies for personnel RADHAZ investigations are discussed, including the creation of whole-body models, a methodology for manipulating body models to anatomically realistic stances, as well as the range of other factors and effects that need to be considered. Some images are included, showing computed field distributions from a generic manpack radio with the wearer standing and prone. An appendix discusses current personnel RADHAZ standards, policy and management within the Australian Defence Organisation (ADO).

BACKGROUND

The increased use of electromagnetic emitters for communications and control has led to a corresponding increase in the strength and pervasiveness of the electromagnetic environment, both in Defence and civilian communities. Possible adverse effects on human health of exposure to electromagnetic radiation are of concern, particularly where levels may be sufficiently high to cause permanent damage. The increasing numbers of mobile phones, together with concerns of personnel hazards arising from exposure to electromagnetic radiation (personnel RADHAZ), has led to considerable effort being spent on the determination of field strengths and absorbed energy levels from such devices. Although the numbers are less, similar concerns arise from the use of manpack and other radio equipment by Defence personnel. Apart from legislative aspects, duty of care requires that such exposure is maintained below acceptable limits.

While the main thrust of media attention relating to mobile phones has focussed on possible development of brain tumours, a range of other responses have been attributed to different exposure levels. High field levels can cause death, burns, blindness and development of cataracts and tumours. Lower field levels produce more subtle effects including audible clicking, headaches and other discomfort, behavioural changes, short-term memory loss, as well as possible stimulation of changes at the cellular and DNA levels, which may provide a trigger for the eventual tumour development [1]. At these low levels, however, factors other than intensity can also have an important influence. These include the frequency, modulation and orientation of the field, the exposure regime, the latency period, and possibly the presence of toxins in the body, which may increase the predisposition of an individual to tumour development. At sufficiently low field levels tumour development may be slow or not occur at all. The question then arises as to what levels of exposure can be considered safe.

Both the mobile phone and the manpack radio present special problems as the source of radiation is in very close proximity to the body, and the fields are far from uniform. While numbers of manpack radios are less, concerns are similar and can be greater, particularly as nominal power levels up to

20W are available, rather than 1W or less for mobile phones. The nature of the interactions with the body is also different due to the different wavelengths involved.

Contrary to popular belief, the antenna is not the only source of radiation of a hand-held or worn transmitter such as a manpack radio. As the output signal is applied between the antenna and the case, the case is also part of the radiating structure. The wearer, being in close proximity to the case, is capacitively coupled to the case and as currents are coupled into the body, it becomes an extension of the radiating system. The whole (antenna, case and wearer) is in effect a vertical dipole antenna—the body, capacitively coupled to the case, becomes the lower element. If the wearer touches the radio case while it is transmitting, s/he will in effect be shorting out the body/case capacitance. If sufficient power is available (such as a nominal 20W from the RAVEN HF manpack), an arc can be drawn between the finger and the case, and a small burn may result. As the handset is connected to the case, an arc can sometimes be drawn from its metal fittings. Neither of these effects (the induced body currents and the arc) implies any defect in the equipment, but is a consequence of the wearer providing or modifying the current path from the radio set to the body, and thence to ground. The restricted space between the body and case is a region of high field gradients, and often exhibits the highest field strengths. Because of the restricted space and high field gradients, levels are difficult to measure directly, and other techniques such as computer modelling need to be applied.

DERIVATION OF SAFE EXPOSURE LEVELS

To better understand the effects of radiation, investigations continue into the relationship between exposure and adverse effects on the human body. Present epidemiological evidence does not imply causality between low-level exposure and adverse effects. Neither has it established the absence of any hazard. While the most evident effect of exposure is tissue heating, a number of other factors may be involved in eventual tumour development (see Figure 1). While these are masked at moderate radiation levels, they often result in conflicting results from studies involving low-level exposure. A thorough characterisation of low-level effects requires studies involving large sample sizes and long-term exposure, and a definitive answer cannot be expected in the short term.

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