



# Electromagnetic energy and its effects

## What is RF EME?

Electromagnetic energy (EME) is the energy stored in an electromagnetic field. It is a part of our natural environment, emitted by sources like the sun, the Earth and the ionosphere, as well as artificial sources such as mobile phones and base stations, broadcast towers, radar facilities, and electrical and electronic equipment.

EME is non-ionising radiation, meaning that it has insufficient energy to break chemical bonds or remove electrons (ionisation). In contrast, ionising radiation (such as X-rays) can remove electrons from atoms and molecules thus leading to damage in biological tissue.

Radiofrequency (RF) radiation, which is used mainly for communications purposes, is the transfer of energy by radio waves. RF radiation lies in the frequency range between 3 kilohertz (kHz) to 300 gigahertz (GHz). In these fact sheets, RF and RF EME are interchangeable terms.

## Does exposure to RF EME cause adverse health effects?

People have been living with artificial sources of RF EME in one form or another for over a hundred years, since Marconi sent the first wireless telegraphs in the 1890s. In the last few decades the EMF environment has changed with the advent of TV and more recently mobile telephony.

For decades researchers have been investigating EME's effects on humans, animals and the environment. It is now well established that exposure to sufficiently high levels of RF EME can heat biological tissue and potentially cause tissue damage. Damage results because the human body is unable to cope with the excessive heat generated by very high RF exposure. Studies have shown that environmental levels of RF EME routinely encountered by the public, however, are far below the levels needed to produce significant heating and increased body temperature. Among other established health effects is electrostimulation of excitable tissue at lower frequencies (between 3 to 100 kHz).

At low levels of exposure to RF EME, (i.e. field intensities lower than those that would produce measurable heating), the evidence for production of harmful biological effects is ambiguous and unproven.

The epidemiological (population studies) evidence does not give clear or consistent results that indicate that exposure to RF EME causes disease in people. Some studies have shown an association between heavy mobile and cordless telephone use and brain cancer (most pronounced for glioma). Limitations of the methodology prevent conclusions of causality being drawn from these observations. More rigorous long-term studies are being coordinated by the World Health Organization (WHO) and Australia is taking part in this research program.

*For further information on current and future research into EME in Australia see fact sheet 3 'Australian research into EME'.*

The weight of national and international scientific opinion is that there is no substantiated evidence that exposure to low level RF EME causes adverse health effects. However the possibility of harm cannot be ruled out. This view is backed by every major review panel on the subject including the International Expert Group on Mobile Phones (2000), the French Health General Directorate (2001), the Health Council of the Netherlands (2002), the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) RF Standard Working Group (2002), the National Radiological Protection Board (2004) and more recently the Scientific Committee on Emerging and Newly Identified Health Risks (2007), the International Commission on Non-ionizing Radiation Protection (2009) and the European Health Risk Assessment Network on Electromagnetic Fields Exposure (2010). Based on the limited association between heavy mobile and cordless telephone use and brain cancer the International Agency for Research on Cancer in 2011 classified RF EME as possibly carcinogenic to humans.

## **How is scientific evidence substantiated?**

The criteria that have to be satisfied for substantiating scientific evidence are:

- a. the publication of research results in a reputable international scientific journal that includes peer review by appropriately qualified scientists and academics. This ensures that research conforms to high standards of scientific practice and that conclusions may reasonably be drawn from the work undertaken which take into account relevant considerations; and
- b. the independent verification of research results. If a research result cannot be repeated by other independent researchers, doubts are raised about the original finding.

## **Are mobile phone base stations and handsets safe?**

The RF emissions from mobile phone base stations can be measured and have been shown to be weak in the everyday environment. Surveys performed by ARPANSA have shown that base stations operate well below the exposure limits specified in the ARPANSA Radiation Protection Standard "Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz":

**<http://www.arpansa.gov.au/Publications/codes/rps3.cfm>**

At typical levels, mobile phone base station emissions are hundreds of times below the general public exposure limit of around 4.5-10 watts per square metre (frequency dependent) as set out in the ARPANSA standard or around 5000 times below the level where significant heating can occur.

Mobile phone handsets radiate RF emissions close to the head and produce complex exposure patterns that are difficult to measure. For mobile phone handsets the ARPANSA Standard specifies exposure limits to RF EME that regulate the rate at which the user absorbs energy from the handset. This is known as the specific absorption rate (SAR). The SAR limit for mobile phone handsets in Australia is 2 watts per kilogram of tissue (averaged over 10 grams).

There is no substantiated evidence in the existing scientific literature that living close to a base station or using a mobile telephone poses a long-term public health hazard (although the possibility of harm cannot be ruled out).

*For further information on mobile phone base stations or handsets see fact sheets 6 & 5 'About mobile phone networks' and 'About mobile phones'.*

## **Are RF EME levels regulated?**

The 2002 ARPANSA Radiation Protection Standard "Maximum Exposure Levels to Radiofrequency Fields –3 kHz to 300 GHz" sets public and occupational limits of exposure to EME fields and was developed through a consultative process by the ARPANSA. The standard requires the aggregate of the RF EME emitted from all sources to comply with the exposure limit set by the standard. Signals from different sources are identifiable by their frequency.

The Australian Communications and Media Authority (ACMA) has the regulatory responsibility to protect the health and safety of persons exposed to RF EME from radiocommunications transmitters. In order to fulfil this regulatory responsibility the then Australian Communications Authority, now ACMA, adopted the ARPANSA limits into the Radiocommunications (Electromagnetic Radiation - Human Exposure) Standard 2003 and the licence conditions for radiocommunications transmitters.

All manufacturers and importers of mobile and cordless phone handsets, as well as licensees of transmitter installations (like mobile phone base stations) are required to comply with the public exposure limits in the ARPANSA Standard.

*For further information on the ARPANSA Standard see fact sheet 4 'The ARPANSA RF exposure Standard'.*

## **Has a precautionary approach been adopted?**

Throughout the world there has been a growing movement to adopt a precautionary approach. The WHO defines the Precautionary Principle as a risk management concept that provides a flexible approach to identifying and managing possible adverse consequences to human health even when it has not been established that the activity or exposure constitutes harm to health.

It is the WHO's view that scientific assessments of risk and science-based exposure limits should not be undermined by the adoption of arbitrary cautionary approaches.

As well as setting conservative exposure limits, the ARPANSA Radiofrequency Standard incorporates a requirement to minimise public exposure to RF fields where this is unnecessary or incidental to achievement of service objectives, provided this can be readily achieved at reasonable cost. In the case of mobile phone networks,

this requirement is implemented through the Communications Alliance industry code “Deployment of radiocommunications infrastructure ACIF C564:2004”:

[http://commsalliance.com.au/\\_\\_\\_data/assets/pdf\\_file/0016/1339/ACIF-C564\\_2004.pdf](http://commsalliance.com.au/___data/assets/pdf_file/0016/1339/ACIF-C564_2004.pdf)

The Australian Government’s ongoing RF EME program for research and public information is aimed at providing further scientific data to complement international research or findings on related human health issues, particularly those of relevance to Australians. It recognises public concern, and the need to ensure that standards and public health policies continue to be based on the best available scientific information.

*For further information on the Government’s program see fact sheet 2 ‘Government action on electromagnetic energy public health issues’.*

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**Fact sheets in the EME series are:**

- Fact sheet 1: *Electromagnetic energy and its effects*
- Fact sheet 2: *Government action on electromagnetic energy public health issues*
- Fact sheet 3: *Australian research into EME*
- Fact sheet 4: *The ARPANSA RF Exposure Standard*
- Fact sheet 5: *About mobile phones*
- Fact sheet 6: *About mobile phone networks*
- Fact sheet 7: *What about using a mobile phone while driving*
- Fact sheet 8: *Potential interference of mobile phones with pacemakers, hearing aids and other devices*
- Fact sheet 9: *What about base stations and telecommunications towers - are there any health effects?*
- Fact sheet 10: *What about broadcast towers - are there any health effects?*
- Fact sheet 11: *Mobile phones and children*

For further information you can visit the ARPANSA web site at:

<http://www.arpansa.gov.au>