

Radiofrequency Electromagnetic Radiation from Mobile Telephone Base Stations

In October 2014, the Environmental Epidemiology Program (EEP), Utah Department of Health, received a request from private citizens living in Alpine, UT for technical assistance regarding the potential health effects from exposure to radiofrequency (RF) electromagnetic radiation emanating from mobile telephone base stations.

Electromagnetic radiation consists of waves of electric and magnetic energy moving together through space, forming a physical field. Electromagnetic waves can be characterized by a frequency measured in hertz (Hz); one Hz equals one complete cycle of the electromagnetic wave per second. The radiofrequency (RF) portion of the electromagnetic spectrum ranges between 3 kilohertz (kHz, or one thousand Hz) and 300 gigahertz (GHz, or one billion Hz). Microwaves, such as those used in a microwave oven, form the upper part of the RF spectrum from 300 megahertz (MHz, or one million Hz) to 300 GHz (FCC, 2012).

It is important to note that the term “radiation” does not mean “radioactive”. Unlike X-ray radiation and gamma radiation, which are extremely high frequency, RF radiation is a form of non-ionizing radiation and does not have the energy necessary to break molecular bonds and strip electrons from atoms. Visible light, infrared light, and microwaves are other forms of non-ionizing radiation.

People can be exposed to radiofrequency radiation in their everyday lives from a wide variety of sources, including radio and television broadcasting; mobile telephones and associated base stations; cordless telephones; Bluetooth devices; wireless routers; pagers; communications equipment for businesses and fire and police departments; microwave and satellite communications; radar; industrial heating and sealing equipment; and medical devices like magnetic resonance imaging (MRI) (FCC, 2012). Mobile telephone use has been increasing rapidly: in 2006 there were over 1.4 million base stations worldwide, and there are an estimated 6.9 billion subscriptions globally in 2014 (WHO, 2006; WHO, 2014). With increased usage has come intensified public concern over potential adverse health effects arising from exposure to mobile telephone and base station RF radiation.

Mobile telephones and associated base stations radiate in the ultra high frequency (UHF) range, typically in several bands between 700 MHz and 2,500 MHz. The exact frequency bands differ between technologies (e.g., GSM, UMTS, CDMA, 4G, etc.) and countries (ICNIRP, 2014). In the U.S., the Federal Communications Commission (FCC) and the Food and Drug Administration (FDA) share regulatory responsibility for mobile telephones. Other federal health and safety agencies, such as the Environmental Protection Agency (EPA), the National Institute for Occupational Safety and Health (NIOSH), and the Occupational Safety and Health Administration (OSHA), have been actively involved in monitoring and investigating issues related to RF exposure. All mobile telephones sold in the U.S., as well as all base stations, must comply with FCC guidelines on RF exposure (FCC, 2014).

The total RF power radiated by a given base station is dependent on the number of transmitters, the power of each transmitter, and the type of antenna. Typically, the maximum power radiated in any direction is between 10 and 50 watts. By contrast, radio and television broadcast stations

range in frequency from about 540 kHz for AM radio to 800 MHz for UHF television and may have power levels exceeding 100,000 watts (FCC, 2012). The actual amount of RF radiation that a person will be exposed to is far less than the transmitting power and decreases rapidly with distance; a person twice as far away from an antenna will receive roughly a quarter of the RF radiation. The most accurate assessment of personal exposure levels is accomplished through on-site field measurements. While the theoretical level of personal exposure from base stations can be calculated, it is complicated by a number of factors such as the height, tilt, and direction of the antenna; absorption from trees; and reflections off buildings (ICNIRP, 2014).

Mobile telephones are low power transmitters, with peak powers in the range of 0.1 to 2 watts. However, given that they are typically used in very close proximity to the body, RF exposures from mobile telephones can be up to 1,000 times higher than those associated with typical exposure from base stations (IARC, 2013; WHO, 2006; WHO, 2014). RF absorption from FM radio and television broadcast stations are also considerably higher than those from base stations (up to five times greater) due to the frequencies used. Radio and television broadcast stations have been in operation for more than fifty years without any adverse health effects being established (WHO, 2006).

The principal mechanism of interaction between radiofrequency energy and the human body is heating of the tissues (also called thermal effects). However, at the frequencies and power levels used by base stations and mobile telephones, the majority of the energy is absorbed by superficial tissues like the skin and results in at most a negligible rise in temperature (WHO, 2006; WHO, 2014; FCC, 2012). The human body can easily adjust to small increases in temperature, just as it does during strenuous activities like exercise.

A large number of studies have investigated both the short-term and long-term non-thermal effects of RF exposure typical of base stations. To date, evidence for adverse health effects at these levels of exposure is ambiguous and unproven, and no causal link between exposure to RF radiation from base stations and harmful biological effects has been established (Berg-Beckhoff et al., 2009; FCC, 2012; FCC, 2014; ICNIRP, 2014; SCENIHR, 2013; WHO, 2005; WHO, 2006; WHO, 2014).

The International Agency for Research on Cancer (IARC) recently classified RF electromagnetic radiation as “possibly carcinogenic to humans” (Group 2B) based on limited evidence in humans and experimental animals (IARC, 2013). This decision was based largely on the results of two studies that investigated associations between various types of brain and head cancer and mobile telephone use. There were substantial limitations in both studies, and increased cancer risk was largely limited to people with the longest cumulative amount mobile telephone use (e.g., greater than 1,640 hours) (IARC, 2013). It is critical to note that neither study examined RF exposures from base stations, which, as mentioned above, are several orders of magnitude lower than those from mobile telephones.

Report prepared by:

Nathan LaCross, Ph.D., MPH
Epidemiologist
Environmental Epidemiology Program
Bureau of Epidemiology
Utah Department of Health

Craig J. Dietrich, Ph.D.
Toxicologist
Environmental Epidemiology Program
Bureau of Epidemiology
Utah Department of Health

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