

February 10, 2012

Radio Frequency Radiation and Health: Smart Meters

Electric utilities are working to install advanced metering technology known as “smart meters” that use radio signals to communicate electricity demand through mobile telecommunications. The signals that are used – radio frequency radiation or RFR – are the same type as those used for radio and TV broadcasting for many years. Microwave ovens, radar and wi-fi devices also emit RFR, but today mobile telephones are the most common source of exposure to RFR.

There is little scientific data specific to smart meters. However, the RFR from smart meters and mobile telephones are nearly identical, so investigations on potential health effects from mobile telephones can be used to estimate potential health effects from smart meters. Smart meters, according to both mathematical modeling and field tests, emit RFR at very low levels, lower than mobile telephones. The current health protection standards established for mobile telephones in the U.S. and in most other countries around the world are generally accepted as sufficient to prevent health effects from smart meters.

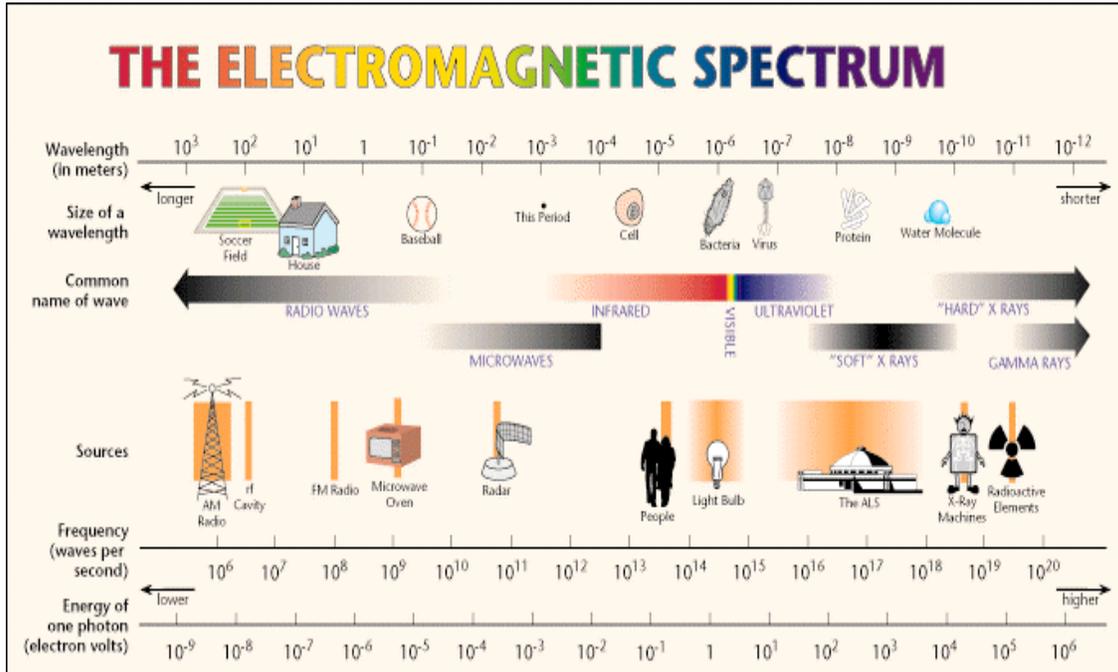
In January 2012, the Vermont Department of Health made actual measurements at active smart meters installed by Green Mountain Power in Colchester. The readings from these devices verify that they emit no more than a small fraction of the RFR emitted from a wireless phone, even at very close proximity to the meter, and are well below regulatory limits set by the Federal Communications Commission (FCC).

For example, measurements taken directly in contact with a smart meter on the exterior wall of a residence ranged from 50 to 140 $\mu\text{W}/\text{cm}^2$ compared to the FCC’s maximum permissible exposure limit of 610 $\mu\text{W}/\text{cm}^2$ for a member of the public. Measurements at distances of three feet or more away from the smart meter were at or near background. (See *Smart Meter Measurements in Vermont*, p. 4 for full discussion.)

After extensive review of the scientific literature available to date and current FCC regulatory health protection standards, we agree with the opinion of experts:

- The thermal health effects of RFR are well understood, and are the current basis for regulatory exposure limits. These limits are sufficient to prevent thermal health effects.
- Non-thermal health effects have been widely studied, but are still theoretical and have not been recognized by experts as a basis for changing regulatory exposure limits.

The Vermont Department of Health has concluded that the current regulatory standards for RFR from smart meters are sufficient to protect public health.



SOURCE: *Lawrence Berkeley National Laboratory*

Regulation of Radio Frequency Radiation

Exposure to RFR from devices is generally regulated by the Federal Communications Commission (FCC), which licenses entities that use radio frequencies. The FCC has taken the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and the Institute of Electrical and Electronics Engineers (IEEE) to put forth maximum permissible exposure (MPE) limits for radio frequency radiation as generated by devices using the frequencies it licenses. The MPEs are based on preventing thermal effects from RFR. The NCRP guidelines and the IEEE standard are formulated with knowledge and analysis of the scientific literature regarding non-thermal effects of RFR. Neither the NCRP nor the IEEE considered the evidence from epidemiological and laboratory studies of non-thermal effects sufficient for guidance or standard-setting.

The FCC maximum permissible exposure limits are established to prevent thermal effects of RFR using units of power density. Power density is measured in units of watts per square meter (W/m^2), milliwatts per square centimeter (mW/cm^2) or microwatts per square centimeter ($\mu W/cm^2$). The MPE varies over the range of radio frequencies because the human body absorbs some radio frequencies more than others. Whatever the frequency, exposures less than the MPE will maintain the thermal energy absorption in the human body well below any hazardous level.

Basis of the Regulatory Standards

The human body is capable of absorbing a range of thermal energy changes with physiological cooling mechanisms. However, at certain rates of heating, the body cannot compensate. The MPE limits are designed to prevent heating of human tissues beyond this capacity and are derived from what are called specific absorption rates. MPE limits are set to ensure that the heating of our bodies is at a rate that our bodies can handle without risk of adverse effects. A wide safety margin is provided. In particular, the lowest specific absorption rate found in laboratory animals and human test subjects to cause adverse biological effects is 4.0 watts of heating per kilogram of tissue as averaged over the entire mass of the body. To provide a safety margin, the MPE limits for workers are based on 0.4 watts per kilogram (W/kg), which is 10 times lower than this lowest observable adverse effect level. The public MPE limit is based on a specific absorption rate of no more than 0.08 W/kg because it is assumed that members of the public may be exposed 168 hours per week rather than the 40 hours per week a worker might be maximally exposed.

The MPE limit is designed to prevent thermal effects, and scientific panels reviewed hundreds of research studies to arrive at a consensus. The MPE limit is not based on any non-thermal effects. Nevertheless, the committees making the recommendations for the MPE limits evaluated health effects and other research that focused on possible non-thermal effects. Members of NCRP Committee 53, which prepared NCRP Report 86. *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields* considered numerous laboratory studies of cells, whole animals and humans as well as numerous epidemiological studies of human populations exposed in occupational and public settings which sought to quantify an association of RFR exposure with effects that are not related to temperature change. The IEEE Standards Coordinating Committee 28 did the same for its IEEE C95.1-1999 publication *IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*.

The 1986 NCRP publication devoted significantly less attention to non-thermal effects than did the 1999 IEEE publication. Neither the NCRP nor the IEEE determined that there was sufficient evidence of harm. The NCRP stated that:

There are several thousands of reports – scientific papers, books, articles, and newspaper accounts – of widely varying scientific quality that present data or opinion on the biological response to [radio-frequency electromagnetic] radiations, no consensus has emerged regarding thresholds and mechanisms of injury at specific absorption rates (SARs) below a few watts per kilogram (W/kg).

Nevertheless, the vast majority of new research and more recent summaries on the health effects of radio frequency radiation have focused on non-thermal effects. Other issues of interest include concerns that certain people are more sensitive to RFR than others, that certain frequency modulations are uniquely harmful, and that long-term exposure to RFR can have cumulative effects.

The IEEE (1999) stated:

That no reliable scientific data exist indicating that a) certain subgroups of the population are more at risk than others; b) exposure duration at ANSI C95.1-1982 levels is a significant risk; c) damage from exposure to electromagnetic fields is cumulative; or d) nonthermal effects (other than shock) or modulation-specific sequelae of exposure may be meaningfully related to human health.

Smart Meter Measurements in Vermont

Smart meters are a part of enhancements to the electricity distribution system designed to help manage and prevent electricity demands that surpass supply throughout the day and over longer periods of time. Some smart meters relay user electricity demand information to the electricity providers using hard wire, while others use wireless devices. The wireless devices work similarly to how a mobile telephone does: a radio signal is sent from the user's meter via a small transmitter to an antenna connected to another radio transmitter, which repeats the process until the user information is collected at its final destination. This network of radio transmitter/receivers may take many shapes depending on the distribution of users and topography.

Some wireless smart meters operate at the frequency range of 902 to 928 megahertz (MHz). Other frequencies used include 2.4 gigahertz (GHz) and, to a lesser extent, 150-222, 450-470 and 950 MHz. These are frequencies also previously or currently used by mobile telephones. The radio signal from smart meter transmitters is measured in watts (W). The typical smart meter has a power level of 0.250 W or less, although some may have a power level of 1.0 W. By comparison, a mobile telephone might have a power level of 3.0 W. A cordless telephone might use 0.25 W and a wireless router used to connect computer components might use about 1.0 W.

Gatekeeper Meter Measurements

A "gatekeeper" meter is mounted on the roof of the Green Mountain Power facility in Colchester where it communicates with a nearby neighborhood where the electric meters have been replaced with smart meters. Its radio signal is more powerful than that of the smart meters as it communicates with many simultaneously. On January 11, 2012, the Vermont Department of Health obtained measurements of RFR from its antenna located at the top of the gatekeeper case.

This site is restricted from public use. The maximum permissible exposure limit for occupational exposures from this site is **3,050 $\mu\text{W}/\text{cm}^2$** .

- RFR emissions from the unit ranged from 2,100 to 2,888 microwatts per square centimeter ($\mu\text{W}/\text{cm}^2$) on contact with the transmitting antenna.
- Emissions measured 120 $\mu\text{W}/\text{cm}^2$ at 12 inches from the transmitter. RFR levels were measured at background levels at distances of three feet or more from the transmitter.

Residential Smart Meter Measurements

Also on January 11, 2012, the Health Department obtained RFR measurements from an operating smart meter on the exterior wall of a residence in Colchester, when it was instructed to download data to the gatekeeper. Measurements were taken with a Narda Model 8712 RFR Survey Meter. The surveyor has been specifically trained by Narda to obtain these readings.

This smart meter is in a residential neighborhood. The maximum permissible exposure limit for a member of the general public for RFR from this smart meter is **610 $\mu\text{W}/\text{cm}^2$** .

- Measurements of RFR during transmission ranged from 50 to 140 $\mu\text{W}/\text{cm}^2$ on contact with the smart meter in the vicinity of its transmitting antenna.
- Measurements at 12 inches from the smart meter during transmission ranged between 10 and 50 $\mu\text{W}/\text{cm}^2$. Measurements at distances of three feet or more away from the smart meter were at or near the background level.
- A separate set of measurements were made within the residence in the room on the opposite side of the wall in the photograph above. No measurements of RFR above background were recorded during multiple instructions from the gatekeeper for the smart meter to transmit.
- A separate set of measurements were made in this neighborhood for the simultaneous transmission of all smart meters. No RFR could be distinguished above background during multiple tests.
- Another smart meter at a different residence was tested to see if RFR levels would differ during a remote connection and remote disconnection of the smart meter from the network. During multiple tests of this process, RFR was measured in the range of 50 to 90 $\mu\text{W}/\text{cm}^2$ on contact with the smart meter.
- RFR was indistinguishable from background more than three feet from the smart meter during normal transmissions.

A mobile telephone was used to test the Narda RFR Survey Meter in between measurements to verify satisfactory operations. The transmission of RFR from this mobile telephone at the time of measurement was 490 $\mu\text{W}/\text{cm}^2$.

Studies of Health Effects Specific to Smart Meters

There are not yet any research studies on health effects using smart meters as the source. The devices are very similar to mobile telephones in both radio frequency and radio power. As such, looking at the health effects research where mobile telephones are the source of RFR exposure makes sense.

One important difference between exposure from smart meters and mobile telephones is that of the physical arrangements of exposure. While a mobile telephone exposes the user's eyes, skull and brain with a transmitting antenna in close proximity, smart meters are fixed sources attached to the outside of buildings. This should make comparisons to the health effects research findings from mobile telephones a "worst case scenario."

Vermont is not the first state to investigate the health impacts of smart meters. Both Maine and California have previously published their assessment of smart meters for public health impacts. The following are summaries from recent efforts to characterize health risk from smart meter RFR conducted by the Maine Center for Disease Control, the California Council on Science and Technology and the Monterey County, California Health Department.

Maine Center for Disease Control

The Maine Center for Disease Control assembled a panel of state government leaders to review the scientific literature on smart meter and mobile phone RFRs, and published a summary opinion:

Our review of these national and international government or government-affiliated assessments indicate a broad consensus that studies to date give no consistent or convincing evidence of a causal relation between RF exposure in the range of frequencies and power used by smart meters and adverse health effects.

We found little information in these assessments that spoke directly about the safety of RF exposure from smart meters. There is, however, much discussion about the safety of mobile phones. Mobile phone use represents an RF exposure qualitatively similar to smart meters in range of frequency, but because the power is higher and typical use results in exposure closer to the body, the resulting exposure to RF appears to be quantitatively much greater than that from smart meters. Thus, it appears to us that the lack of any consistent and convincing evidence of a causal relation between RF exposure from mobile phones and adverse health effects would indicate even less concern for potential health effects from use of smart meters.

The full report is available at: <http://www.maine.gov/dhhs/mecdc/environmental-health/documents/smart-meters-maine-cdc-executive-summary-11-08-10.pdf>

Maine CDC also published a summary of the specific documents reviewed about smart meters and RFR: <http://www.maine.gov/dhhs/mecdc/environmental-health/smart-meters.shtml>

California Council on Science and Technology

The California Council on Science and Technology made a comprehensive review of the costs and benefits of smart metering, including a comparison of RFR emissions from various technologies and the real and perceived risks of RFR exposure from smart meters. The full report is available at:

<http://www.ccst.us/publications/2011/2011/smartA.pdf>

Monterey County Health Department

Like the Maine CDC, the Monterey County Health Department published its summary of a literature review. The full report is available at:

http://publicagendas.co.monterey.ca.us/MG97205/AS97224/AS97230/AI99413/DO99416/DO_99416.pdf

Health Effect Studies from a Regulatory Perspective

In the U.S., the FCC has long used the guidance of the National Council for Radiation Protection and Measurements. Before the FCC established its role (primarily due to the evolution of wireless technologies), industry standards of the Institute of Electrical and Electronics Engineers were used to establish RFR safety in the workplace and for the general public. The FCC is part of a federal Interagency Working Group. Other members include the Food and Drug Administration, the Occupational Safety and Health Administration and the Environmental Protection Agency.

In many parts of the rest of the world, regulations are adopted from standards recommended by the World Health Organization (WHO). The WHO relies on the work of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) for science-based guidance in establishing regulatory recommendations.

National Council for Radiation Protection and Measurements (NCRP)

NCRP Report Number 86, *Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields*, provides the basis of current regulations for protecting workers and the general public as adopted by the FCC. This 1986 report is a comprehensive review of the thousands of research studies conducted up to that date. The research covered most areas of physical harm possible from RFR.

The NCRP guidance resolved on preventing thermal effects from what they called radiofrequency electromagnetic (RFEM) radiations, as measured by specific absorption rates (SAR) measured in watts of energy absorbed per kilogram (W/kg) of human tissue. The research at that time led them to conclude thermal effects were the only reproducible effects, and their SAR limits of 0.4 W/kg for workers and 0.08 W/kg for the general public remain the norm today, both in the U.S. and around the world.

With regard to the growing interest in non-thermal effects, the NCRP stated:

Although there are several thousands of reports – scientific papers, books, articles, and newspaper accounts – of widely varying scientific quality that

present data or opinion on the biological response to RFEM radiations, no consensus has emerged regarding thresholds and mechanisms of injury at specific absorption rates (SARs) below a few watts per kilogram (W/kg).

Institute of Electrical and Electronics Engineers (IEEE)

The IEEE has deliberated on the scientific literature of RFR exposure and effects since the 1950s. It has provided recommendations primarily to industry for protecting workers and the general public. Lacking other guidance, the IEEE standards served as the best available guidance for entities outside of industry until the NCRP published its recommendations in 1986. The IEEE health protection recommendations are similar to those of the NCRP and the International Commission for Non-Ionizing Radiation Protection (ICNIRP). The IEEE exposure limits are very similar to those adopted by the FCC and WHO.

From a 2005 publication by the IEEE's Committee on Man and Radiation:

The IEEE and other RF/microwave exposure limit standards are based principally on laboratory studies of animals using short exposure durations (hours at most). The limiting effect for whole body exposures (behavioral disruption) is clearly a thermal phenomenon. Some investigators have reported effects at much lower exposure levels, which are sometimes called "nonthermal" effects. Each version of the IEEE standard has acknowledged the existence of such reports, while at the same time indicating that they were insufficient to be considered a health hazard or to be used as a basis to develop exposure guidelines. For example, the 1991 standard states that "research on the effects of chronic exposure and speculations on the biological significance of nonthermal interactions have not yet resulted in any meaningful basis for alteration of the standard. It remains to be seen what future research may produce for consideration at the time of the next revision of this standard". Other organizations have independently reached this same conclusion.

The full publication is available at: <http://ewh.ieee.org/soc/embs/comar/standardsTIS.pdf>

Federal Communications Commission (FCC)

In the U.S., the FCC is the regulatory agency that has jurisdiction for health and safety relative to RFR from wireless technologies, including smart meters and mobile telephones. The FCC has promulgated limits for RFR exposure for workers and the general public. It also licenses organizations that use frequencies under its regulatory authority. Its perspective on RFR health protection is summarized in this document <http://transition.fcc.gov/oet/rfsafety/rf-faqs.html#Q5>:

Biological effects can result from exposure to RF energy. Biological effects that result from heating of tissue by RF energy are often referred to as "thermal"

effects. It has been known for many years that exposure to very high levels of RF radiation can be harmful due to the ability of RF energy to heat biological tissue rapidly. This is the principle by which microwave ovens cook food. Exposure to very high RF intensities can result in heating of biological tissue and an increase in body temperature. Tissue damage in humans could occur during exposure to high RF levels because of the body's inability to cope with or dissipate the excessive heat that could be generated. Two areas of the body, the eyes and the testes, are particularly vulnerable to RF heating because of the relative lack of available blood flow to dissipate the excess heat load.

At relatively low levels of exposure to RF radiation, i.e., levels lower than those that would produce significant heating; the evidence for production of harmful biological effects is ambiguous and unproven. Such effects, if they exist, have been referred to as "non-thermal" effects. A number of reports have appeared in the scientific literature describing the observation of a range of biological effects resulting from exposure to low-levels of RF energy. However, in most cases, further experimental research has been unable to reproduce these effects. Furthermore, since much of the research is not done on whole bodies (in vivo), there has been no determination that such effects constitute a human health hazard. It is generally agreed that further research is needed to determine the generality of such effects and their possible relevance, if any, to human health. In the meantime, standards-setting organizations and government agencies continue to monitor the latest experimental findings to confirm their validity and determine whether changes in safety limits are needed to protect human health.

A more detailed report is available from the FCC Office of Engineering and Technology. OET Bulletin 56, fourth edition, published in 1999 is available at:
http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet56/oet56e4.pdf.

Food and Drug Administration (FDA)

The FDA is a part of the Interagency Working Group, which also includes the National Institute for Occupational Safety and Health, the Environmental Protection Agency, the Federal Communications Commission, the Occupational Safety and Health Administration and the National Telecommunications and Information Administration. The FDA will also investigate any mobile telephone that is suspected of emitting RFR in excess of FCC regulatory limits for device emissions. On its website, the FDA defines its perspective on mobile telephone RFR:

Cell phones emit low levels of radiofrequency energy (RF). Over the past 15 years, scientists have conducted hundreds of studies looking at the biological effects of the radiofrequency energy emitted by cell phones. While some researchers have reported biological changes associated with RF energy, these studies have failed to be replicated. The majority of studies published have failed to show an association between exposure to radiofrequency from a cell phone and health problems.

The low levels of RF cell phones emit while in use are in the microwave frequency range. They also emit RF at substantially reduced time intervals when in the stand-by mode. Whereas high levels of RF can produce health effects (by heating tissue), exposure to low level RF that does not produce heating effects causes no known adverse health effects.

This and other information from the FDA is available at: <http://www.fda.gov/radiation-emittingproducts/radiationemittingproductsandprocedures/homebusinessandentertainment/cellphones/default.htm>.

International Commission on Non-Ionizing Radiation Protection (ICNIRP)

ICNIRP is relied upon by the World Health Organization (WHO) for guidance on RFR and other non-ionizing radiation from low frequency electromagnetic fields from power lines to ultraviolet radiation. Numerous countries rely on WHO and ICNIRP guidance as they may not have the infrastructure to conduct their own science-based health protection research.

ICNIRP has updated its guidance most recently in 2009 in ICNIRP 16, *Exposure to High Frequency Electromagnetic Fields, Biological Effects and Health Consequences (100 kHz-300 GHz)*. This guidance reflects consideration of a great deal of evidence available since the NCRP published its Report 86, which serves as the basis of U.S. health protection regulations. This includes 15 years of laboratory and epidemiologic study of mobile telephone use, where the primary public health concern was cancer of the head and neck. It concludes:

In the last few years the epidemiologic evidence on mobile phone use and risk of brain and other tumors of the head has grown considerably. In our opinion, overall the studies published to date do not demonstrate a raised risk within approximately ten years of use for any tumor of the brain or any other head tumor. However, some key methodological problems remain - for example, selective non-response and exposure misclassification. Despite these methodologic shortcomings and the still limited data on long latency and long-term use, the available data do not suggest a causal association between mobile phone use and fast-growing tumors such as malignant glioma in adults, at least those tumors with short induction periods. For slow-growing tumors such as meningioma and acoustic neuroma, as well as for glioma among long-term users, the absence of associations reported thus far is less conclusive because the current observation period is still too short. Currently data are completely lacking on the potential carcinogenic effect of exposures in childhood and adolescence.

Electromagnetic Hypersensitivity

The WHO provides numerous guidance documents based upon ICNIRP research and deliberation, including on electromagnetic field (EMF) hypersensitivity or EHS. See <http://www.who.int/mediacentre/factsheets/fs296/en/index.html>.

The WHO concluded:

A number of studies have been conducted where EHS individuals were exposed to EMF similar to those that they attributed to the cause of their symptoms. The aim was to elicit symptoms under controlled laboratory conditions.

The majority of studies indicate that EHS individuals cannot detect EMF exposure any more accurately than non-EHS individuals. Well controlled and conducted double-blind studies have shown that symptoms were not correlated with EMF exposure.

It has been suggested that symptoms experienced by some EHS individuals might arise from environmental factors unrelated to EMF. Examples may include “flicker” from fluorescent lights, glare and other visual problems with VDUs, and poor ergonomic design of computer workstations. Other factors that may play a role include poor indoor air quality or stress in the workplace or living environment.

There are also some indications that these symptoms may be due to pre-existing psychiatric conditions as well as stress reactions as a result of worrying about EMF health effects, rather than the EMF exposure itself.

EHS is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem

Earlier Research on Mobile Phones

There is only a limited amount of scientific research about the RFR from smart meters. However, the frequency of RFR from smart meters and the radiated power of transmitters employed in smart meters are the same as used in mobile telephones. This makes comparison to the scientific research on RFR from mobile telephones relevant. There is one very important difference between smart meter and mobile telephone RFR. Mobile telephone RFR is experienced by users often with the transmitting antenna very close to the body, including the skull, brain and eyes as compared to smart meters, which operate in fixed positions on the outside wall of a house or business.

The Royal Society of Canada (RSC) for Health Canada

In 1999, the Royal Society of Canada published *A Review of the Potential Health Risks of Radiofrequency Fields from Wireless Telecommunication Devices*.

This report provided a comprehensive review of the scientific literature available up to 1999 as part of Health Canada's routine activities for periodic review and revision of its safety codes. This report also concluded:

Scientific studies performed to date suggest that exposure to low intensity non-thermal RF fields do not impair health of humans or animals. However, the existing scientific evidence is incomplete, and inadequate to rule out the possibility that these non-thermal biological effects could lead to adverse health effects. Moreover, without an understanding of how low energy RF fields cause these biological effects, it is difficult to establish safety limits for non-thermal exposures.

The NRPB sponsored Independent Expert Group on Mobile Phones

In 2000, the National Radiological Protection Board of the United Kingdom, now a part of the UK's Health Protection Agency, sponsored its own comprehensive review of the scientific literature, *Mobile Phones and Health*. The report may be read in full at: <http://www.iegmp.org.uk/report/text.htm>.

Its findings were similar to those published a year earlier by the Royal Society of Canada:

Despite public concern about the safety of mobile phones and base stations, rather little research specifically relevant to these emissions has been published in the peer-reviewed scientific literature. This presumably reflects the fact that it is only recently that mobile phones have been widely used by the public and as yet there has been little opportunity for any health effects to become manifest. There is, however, some peer-reviewed literature from human and animal studies, and an extensive non-peer-reviewed information base, relating to potential health effects caused by exposure to RF radiation from mobile phone technology.

The balance of evidence to date suggests that exposures to RF radiation below NRPB and ICNIRP guidelines do not cause adverse health effects to the general population.

There is now scientific evidence, however, which suggests that there may be biological effects occurring at exposures below these guidelines. This does not necessarily mean that these effects lead to disease or injury, but it is potentially important information and we consider the implications below.

There are additional factors that need to be taken into account in assessing any possible health effects. Populations as a whole are not genetically homogeneous and people can vary in their susceptibility to environmental hazards. There are well-established examples in the literature of the genetic predisposition of some

groups, which could influence sensitivity to disease. There could also be a dependence on age. We conclude therefore that it is not possible at present to say that exposure to RF radiation, even at levels below national guidelines, is totally without potential adverse health effects, and that the gaps in knowledge are sufficient to justify a precautionary approach.

In the light of the above considerations we recommend that a precautionary approach to the use of mobile phone technologies be adopted until much more detailed and scientifically robust information on any health effects becomes available.

We note that a precautionary approach, in itself, is not without cost but we consider it to be an essential approach at this early stage in our understanding of mobile phone technology and its potential to impact on biological systems and on human health.

In addition to these general considerations, there are concerns about the use of mobile phones in vehicles. Their use may offer significant advantages – for example, following accidents when they allow emergency assistance to be rapidly summoned. Nevertheless, the use of mobile phones whilst driving is a major issue of concern and experimental evidence demonstrates that it has a detrimental effect on drivers' responsiveness. Epidemiological evidence indicates that this effect translates into a substantially increased risk of an accident. Perhaps surprisingly, current evidence suggests that the negative effects of phone use while driving are similar whether the phone is hand-held or hands-free. Overall we conclude that the detrimental effects of hands-free operation are sufficiently large that drivers should be dissuaded from using either hand-held or hands-free phones whilst on the move.

Recent Scientific Findings: The Interphone Study

Much of the RFR health-related guidance of the 1990s concluded there was need for more research, especially for long-term users of mobile phones. The May 2010 publication of the results of the largest epidemiological study to date, the Interphone Study, provided it. Soon after the results were published in *Lancet*, the British medical journal, the International Agency for Research on Cancer (IARC) classified RFR from mobile telephones as a possible (Group 2B) carcinogen. This classification of RFR from mobile telephones as a possible carcinogen by IARC is explained in the press release issued at publication of the study:

Dr Christopher Wild, Director of IARC said: "An increased risk of brain cancer is not established from the data from Interphone. However, observations at the highest level of cumulative call time and the changing patterns of mobile phone use since the period studied by Interphone, particularly in young people, mean that further investigation of mobile phone use and brain cancer risk is merited.

The WHO, which includes IARC, provided more detail as to why RFR was classified as a Group 2B carcinogen:

The international pooled analysis of data gathered from 13 participating countries found no increased risk of glioma or meningioma with mobile phone use of more than 10 years. There are some indications of an increased risk of glioma for those who reported the highest 10% of cumulative hours of cell phone use, although there was no consistent trend of increasing risk with greater duration of use. The researchers concluded that biases and errors limit the strength of these conclusions and prevent a causal interpretation. Based largely on these data, IARC has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), a category used when a causal association is considered credible, but when chance, bias or confounding cannot be ruled out with reasonable confidence.

Numerous other organizations have reflected on the Interphone Study. ICNIRP provided a comprehensive review of a study titled *Mobile Phones, Brain Tumours and the Interphone Study: Where Are We Now?* published in the journal *Environmental Health Perspectives*. The objective of the study was to review the evidence on whether mobile phone use raises risk of the main types of brain tumour, glioma and meningioma, with a particular focus on the 13-country Interphone Study. It concluded that, although there remains some uncertainty, the trend in the accumulating evidence is increasingly against the hypothesis that mobile phone use can cause brain tumors in adults.

The full report is available at: <http://www.icnirp.org/documents/SCIreview2011.pdf>.

Food and Drug Administration

The FDA is part of the U.S. Interagency Working Group for mobile telephone safety, and will investigate reports of excessive RFR from mobile telephones. FDA responded to the Interphone Study:

The study reported little or no risk of brain tumors for most long-term users of cell phones. “There are still questions on the effect of long-term exposure to radio frequency energy that are not fully answered by Interphone,” says Abiy Desta, network leader for science at FDA’s Center for Devices and Radiological Health. “However, this study provides information that will be of great value in assessing the safety of cell phone use.”

The full response is available at:

<http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM212306.pdf>

This FDA consumer update cites a National Cancer Institute study that found no evidence of causality in an analysis of brain cancer incidence rates over the years 1992 to 2006, a period of rapidly growing mobile telephone use. NCI’s fact sheet on cell telephones expresses its own perspective on the most recent mobile telephone epidemiological studies at <http://www.cancer.gov/cancertopics/factsheet/Risk/cellphones>:

Studies thus far have not shown a consistent link between cell phone use and cancers of the brain, nerves, or other tissues of the head or neck. More research is needed because cell phone technology and how people use cell phones have been changing rapidly.

The Health Physics Society (HPS)

The HPS is a professional organization of radiation protection professionals. HPS publishes fact sheets for public outreach, and one on mobile telephone RFR starts with:

To date, no adverse health effects have been established for mobile phone use. However, epidemiology data regarding long-term (more than 10 years) use of mobile phones (also known as “wireless” or “cell” phones) are sparse and unreliable and do not permit conclusions to be drawn about possible risks from long-term use of mobile phones.

The fact sheet provides also includes other recent expert assessments, such as from the European Commission Scientific Committee on Emerging and Newly Identified Health Risks, which stated in 2007:

No health effect has been consistently demonstrated at exposure levels below the ICNIRP limits established in 1998. The data for this evaluation is limited, especially for long-term, low-level exposure.

It also cites the Swedish Radiation Protection Authority for its 2008 opinion:

Short-term use of mobile phones does not appear to be associated with brain or head and neck cancer risks in adults.” It also cites ICNIRP 16, Exposure to High Frequency Electromagnetic Fields, Biological Effects and Health Consequences (100 kHz-300 GHz) where the Commission stated “results of epidemiological studies to date give no consistent or convincing evidence of a causal relation between RF exposure and any adverse health effect.

The full fact sheet may be available at:

http://hps.org/documents/Mobile_Telephone_Fact_Sheet_update_May_2010.pdf