The rapid growth of the cellular subscriber base (about 800 million as of June 2011) has resulted in the deployment of an increasing number of base transceiver stations (BTSs). Currently, over 250,000 mobile towers are spread across the country. Considering that India is expected to have over 1 billion mobile subscribers by 2015, an addition of 250,000 more towers is required by that year.

Countries across the world have set their own standards for acceptable exposure to electromagnetic fields (EMFs). The US standard for radiation exposure from mobile towers is 580-1,000 microwatts per square centimetre (mW/cm2), among the least protective in the world, while European countries have set standards that are 100 to 1,000 times lower than the US. The Telecom Engineering Centre (TEC) is responsible for checking Indian radiation levels, which are nominal.

EMF radiation

Mobile communication technologies use EMF for radio frequencies to transmit information. There is a growing concern over health risks due to EMF radiation. Although concerns have been constantly increasing in India too, the issue is not as severe as compared to other parts of the world.

Regulator's take

The Indian government is working on the implementation of stringent norms proposed by TEC. The Cellular Operators Association of India and operators are working with various non-governmental organisations and the government to address this issue. The Telecom Regulatory Authority of India (TRAI), along with other central agencies, has proposed that radiation exposure be limited to 9.2 W per square metre in India, though experts say this needs to be widely debated and analysed before implementation. The union government has taken a strong stance on the potential health hazards resulting from mobile tower radiation and started random testing of towers from November 2010, imposing a huge penalty in case of non-compliance with norms. Electromagnetic emissions of mobile towers in India are governed by guidelines drawn from the recommendations of the International Commission on

Non-Ionizing Radiation Protection (ICNIRP). The government has made it mandatory for service providers to adhere to internationally accepted limits for mobile tower radiation. However, developed countries like Canada, Australia, New Zealand, Switzerland and Russia have adopted stricter guidelines. The Department of Telecommunications (DoT) has also fixed a penalty of Rs 0.5 million for each mobile phone tower that does not follow these guidelines.

Complying with radiation standards

To provide adequate network coverage and capacity for network traffic, rooftops are often utilised as cell site locations. In some cases, cell sites are located in close proximity to residential areas, schools, hospitals and businesses. In order to safeguard the public against the possible undesired effects of electromagnetic radiations, TEC has introduced guidelines for controlling the same. It has issued test procedures for EMF, according to which all existing BTSs should comply with ICNIRP guidelines.

Standardising EMF radiation

To measure EMF radiations at a particular point, a test engineer ideally needs to employ an isotropic antenna along with a broadband spectrum analyser. In addition to this, EMF analyser software helps calculate the E field, H field and the power density of the BTS, besides automating the overall process. The guidelines specify the permissible values of radio frequency (RF) field strength or power density as averaged over six minutes, which can be maintained perfectly by using automated EMF analyser software.

A test engineer should distinguish the exposure situation before starting the measurement process or attempting to determine the frequency and maximum power of the RF source, in addition to other nearby sources. Ideally, test engineers need to specify an area for measuring EMF radiation where other important radiation sources are available and which can have a considerable impact on the total EMF strength of the specified area. For example, if a person stands in a particular area where multiple mobile towers exist, the person will experience a cumulative radiation effect. In a theoretical radiation calculation, this scenario will not be reflected accurately.

According to the ICNIRP guidelines, in many situations, there may be several RF sources and different types of cellular BTS antennas present at rooftop sites. In such situations, the use of both broadband and narrowband instrumentation helps in completely characterising the electromagnetic environment. Broadband instrumentation, on the other hand, can be used to determine the overall field levels, while narrowband instrumentation can determine the relative contribution of each signal to the total field.

An edge over theoretical approach

In complex environmental conditions that have high wave propagation mechanisms, theoretical calculations are not adequate due to the existence of three variable and fundamental physical properties of electromagnetic waves – reflection, absorption and interference.

The scattering of the radio signal towards different directions by rain droplets is known as rain scattering. Rain scattering is a function of the wavelength of the radio wave and the size of the scattered particle. Rain plays a significant role in the undesired absorption of radio waves in the lower atmosphere. Otherwise, the large number of buildings, obstacles, trees, etc. that are present near a BTS tower have a major impact on EMF.

The wave phenomenon

Electromagnetic waves travel on a “multi-path”, wherein the wave gets modified by its propagation through the environment, before arriving at the receiver. These multi-path waves arrive from many angles and directions, causing them to merge with various magnitudes and phases at the receiving point. As a result, the composite wave at the receiver can be either greater than or less than what would be produced by the direct wave alone. This means that some waves add to the direct signal and some subtract from it. In the practical measurement of EMF, an isotropic antenna is used to capture EM radiations from all directions. Based on several practical measurements and report analysis, it can be concluded that the radiation levels recorded at sites are influenced by a number of factors. The key factors include the height of the transmitting antenna above the ground level, proximity to other cell sites, output power of transmitting antennas and orientation of antennas.

The inaccuracies related to proximity to other cell sites that are generally found in theoretical calculations are rectified during practical real-life measurements. The two most prominent factors that affect the measurement of the radiation level during real-life measurements are: the height of transmitting antennas in relation to the height of the receiving antenna where the surveyor takes measurement, and the proximity of other cell sites to the one of interest. It has been observed that the height of transmitting antennas above the surveyor is inversely proportional to radiation levels.

In case there are two cell sites at a location, the contribution of the RF fields of the adjacent site would increase the radiation level of the site of interest. The radiation level at a cell site is determined by the power density, that is, the electromagnetic power received per unit square area. Therefore, higher power radiation from transmitting antennas will result in higher EM radiation levels.

Conclusion

Predicting the behaviour of a transmitted wave using theoretical methods is difficult, as the wave follows multiple paths before arriving at the receiver. Moreover, at any given point near a BTS tower, there are several RF sources that emit EM radiations besides the radiation coming from the tower itself; and electromagnetic waves are altered as they propagate. Therefore, it is recommended to undertake practical measurements in order to evaluate the actual electromagnetic radiation.