THE EMF HEALTH ISSUE
1 Over the past years a large number of scientific studies have been published worldwide on biological effects from exposures to extremely low frequency (ELF) fields and radio frequency (RF) fields such as emitted by radars and telecommunication transmitters.

2 Some of these studies have demonstrated a number of hazards from electromagnetic fields (EMF) exposures, but these are generally at very high exposure levels, and international exposure guidelines have been developed to protect against them. While noting that research is still in progress, international scientific committees that have evaluated the current body of evidence, have reached the same conclusion: that there are no established health effects from EMF exposures below the international guideline limits.

MOBILE TELEPHONES AND BASE STATIONS
3 Mobile telephones, sometimes called cellular phones or hand phones, are now an integral part of modern telecommunications. In Singapore, the mobile phone penetration rate exceeds 75%. The technology of the mobile phone system necessitates the installation of a large number of antennas or base-stations in order to accommodate the large number of users, and also to provide the necessary coverage.
Many of these antennas and base-stations are installed on top of high-rise HDB blocks and apartments.

**CONCERNS FOR HEALTH**

4 Because of the large number of users, there is now considerable public concern about possible health hazards from EMF exposures from mobile phones or their base stations. This set of guidelines, which aims to address these concerns, is based on the recent reviews of the effects on human beings of exposure to RF fields. The reviews were conducted by the World Health Organization (2001), the Royal Society of Canada (1999), and a review on mobile phones and health by an expert committee in the United Kingdom (IEGMP 2000).

5 Several important considerations must be kept in mind when evaluating possible health effects of RF fields. One is the frequency of the radiation. By virtue of their frequencies, the photon energies associated with RF are insufficient to cause ionization in matter such as body tissue. Because of this, RF fields are called non-ionising, unlike X-rays and gamma radiations which can cause ionisation leading to the breakup of the molecular structure of matter.

**EXPOSURE LEVELS**

6 Mobile phone handsets and base stations present quite different exposure situations. RF exposure to a user of a mobile phone is comparatively higher than to a person living near a cellular base station. However, apart from infrequent signals used to maintain links with nearby base stations, the handset transmits RF energy only while a call is being made, whereas base stations are continuously transmitting signals.

6.1 Handsets:

- Mobile phone handsets are low-powered RF transmitters, emitting maximum powers in the range of 0.2 to 0.6 watts.
- The RF field strength (and hence RF exposure to a user) falls off rapidly with distance from the handset.
Therefore, the RF exposure to a user of a mobile phone located tens of centimetres from the head (using a "hands free" appliance) is far lower than to a user who places the headset against the head. RF exposures to nearby people are very low.

6.2 Base stations:
- Base stations transmit power levels typically from a few watts to less than 100 watts, depending on the size of the region or "cell" that they are designed to service.
- Base station antennae are typically about 20-30 cm in width and a metre in length, mounted on buildings or towers at a height of from 15 to 50 metres above ground.
- These antennae emit RF beams that are typically very narrow in the vertical direction but quite broad in the horizontal direction.
- Because of the narrow vertical spread of the beam, the RF field intensity at the ground directly below the antenna is low.
- The RF field intensity increases slightly as one moves away from the base station and then decreases at greater distances from the antenna.
- Typically within 2-5 metres of some antennae mounted on rooftops, fences or warning notices to keep people away from places where the RF fields exceed exposure limits.
- Since antennae direct their power outward, and do not radiate significant amounts of energy from their back surfaces or towards the top or bottom of the antenna, the levels of RF energy inside or to the sides of the building are normally very low.

6.3 Other RF sources in the community:
- Paging and other communications antennae such as those used by fire, police and emergency services, operate at similar power levels as cellular base stations, and often at a similar frequency. Television and radio broadcast antennae commonly transmit higher RF levels than mobile base stations.

PRESENT ASSESSMENTS OF HEALTH EFFECTS

7 RF fields penetrate exposed tissues to depths that depend on the frequency - up to a centimetre at the frequencies used by mobile phones. RF energy is absorbed in the
body and produces heat, but the body’s normal thermo-regulatory processes carry this heat away. All established health effects of RF exposure are clearly related to heating. While RF energy can interact with body tissues at levels too low to cause any significant heating, no study has shown adverse health effects at exposure levels below international guideline limits.

8 The World Health Organisation (WHO) has identified that further research is needed for long-term health risk assessments and has promoted the research to participating agencies. Briefly, at present time, current research indicates the following:

- **Cancer**: Current scientific evidence indicates that exposure to RF fields, such as those emitted by mobile phones and their base stations, is unlikely to induce or promote cancers. Several studies of animals exposed to RF fields similar to those emitted by mobile phones found no evidence that RF causes or promotes brain cancer. Epidemiological studies found no convincing evidence of increase in risk of cancer or any other disease with use of mobile phones.

- **Other health risks**: Scientists have reported other effects of using mobile phones including changes in brain activity, reaction times, and sleep patterns. These effects are small and have no apparent health significance. More studies are in progress to confirm these findings.

- **Driving**: Research has clearly shown an increased risk of traffic accidents when mobile phones (either handheld or with a "hands-free" kit) are used while driving.

- **Electromagnetic Interference**: When mobile phones are used close to some medical devices (including pacemakers, implantable defibrillators, and certain hearing aids) there is the possibility of causing interference. There is also the potential of interference between mobile phones and aircraft electronics.
EMF GUIDELINES

9  International guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are based on a careful analysis of all scientific literature (both thermal and non-thermal effects) and offer protection against all identified hazards of RF energy with large safety margins. Both measurements and calculations show that RF signal levels in areas of public access from base stations are far below international guidelines, typically by a factor of 100 or more. RF exposure levels to a user from mobile handsets are higher but below international guidelines.

WHO INTERNATIONAL EMF PROJECT

10  In response to public concerns, WHO established the International Electromagnetic Fields (EMF) Project to assess the scientific evidence of possible health effects of EMF. Singapore is participating in this Project and is a member of its International Advisory Committee. The project has established a formal mechanism for reviewing the research results and conducting risk assessments of RF exposure. It is also developing public information materials, and bringing together standards groups worldwide in an attempt to harmonise international exposure standards.

11  WHO is also conducting RF research. A large epidemiological study is being coordinated in over 10 countries by the International Agency for Research on Cancer (IARC) - a specialised cancer research agency of WHO - to identify if there are links between use of mobile phones and head and neck cancers. The study is anticipated to be completed in 2003.

CONCLUSIONS AND RECOMMENDATIONS

12  None of the recent reviews have concluded that exposure to the RF fields from mobile phones or their base stations causes any adverse health consequence. However, further research on long-term health risk assessment is in progress.

13  It will take about 3 to 4 years for the RF research to be completed, evaluated and to publish the final results of any health risks.
In response to the increasing public concern expressed through the media on health risks associated with radiation from mobile phones and base stations, the Health Sciences Authority recommends the following:

For Individuals:

- **Individuals**: Present scientific information does not indicate the need for any special precautions for use of mobile phones. If individuals are concerned, they could choose to reduce RF exposure to themselves or their children by limiting the length of calls, or using "hands-free" devices to keep mobile phones away from the head and body.

- **Obey restrictions on mobile phone use to avoid EMF interference**: Mobile phones may interfere with certain electro-medical devices, such as cardiac pacemakers and hearing aids. In hospital intensive care departments, mobile phone use can be a danger to patients and should not be used in these areas. Similarly mobile phones should not be used in aircraft as they may interfere with its navigation systems.

For all Telecommunication Service Providers, including importers and manufacturers:

- **Adherence to the ICNIRP safety standards**: The present Radiation Protection Act 1991 defines radiation under control to include EMF as well as ionising radiation. Specifics of control of EMF are incorporated into the Radiation Protection (Non-ionising Radiation) Regulations 1991. Currently, only devices emitting a limited range of frequencies such as microwave ovens and lasers are under control. The HSA is currently working towards the incorporation of the health-based EMF exposure limits which are in line with the ICNIRP standards into the Regulations. Such standards, based on current knowledge, are developed to protect the population, including users of
mobile phones, those working near or live around base stations, as well as people who do not use mobile phones.

- **Simple protective measures**: Fences or barriers or warning notices or other protective measures are needed for some base stations (principally, those located on building rooftops) to preclude unauthorised access to areas where exposure limits may be exceeded.

**HEALTH SCIENCES AUTHORITY**  
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**References:**
1. WHO Fact Sheet No. 193 Revised June 2000
