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REPORT OF STUDY ON ELECTROMAGNETIC RADIATION SAFETY OF MOBILE TELECOMMUNICATIONS BASE STATIONS IN MACAO

Summary

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1. INTRODUCTION AND BACKGROUND

The mobile communication is one of the important economic components of Macao Special Administrative Region ("MSAR"), accounting for over 200 percentage users' increase in the past five years and over 635,000 users registered in 2006. The mobile communication evolved from GSM 900 in 1995 to GSM 1800 and CDMA in 1999 and 2006 respectively. This rapid development has also brought the persistent public concerns about the possible adverse health effects of electromagnetic emissions from digital cellular telephone base stations. It is thus necessary to carry out the electromagnetic compatibility assessment to identify whether the level of emission due to the base stations represents a risk for human health from the thermal point of view. Against this background, Wireless Communication Laboratory (WCL) of Faculty of Science and Technology of University of Macau was retained by the Bureau of Telecommunications Regulation (DSRT) to undertake a research on mobile communication base stations' electromagnetic radiation in Macao. This study was conducted during the fourth quarter of 2006. The purpose of this study was mainly to perform *in-situ* electromagnetic field strength measurement of base stations in Macao in order to provide DSRT with the needed tools of evaluation of radiation safety compliance for GSM 900, GSM 1800 and CDMA mobile communication base stations.

2. MOBILE COMMUNICATIONS IN MACAO AND ELECTROMAGNETIC RADIATION EXPOSURE STANDARDS

2.1. Mobile Communications in Macao

There are totally four public digital cellular communication operators in Macao and they are CTM, Hutchison, SmarTone and Unicom. The first three operators are offering the service of GSM 900 and GSM 1800 whilst the Unicom only provides CDMA. The spectrum allocated for the above services ranges from 825 MHz to 960 MHz and 1730 MHz to 1880 MHz respectively. Each operator uses around 150 base stations to cover Macao peninsula, Taipa and Coloane. The base station is generally emitting the RF power of 42 dBm and 38 dBm for GSM 900/1800 and CDMA respectively. In order to extend the indoor coverage, operators install some antenna in some areas like shopping mall, public car park and so forth. The power emitted from this type of indoor antenna is around 30 dBm. According to MSAR regulation, the above base station installations are approved and monitored by DSRT.

2.2. Electromagnetic Radiation Exposure Standards

Some international radiation exposure standards are defined from the thermal point of view and they provide information on radiation exposure limits and assessment methods. Nowadays, the standards from the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and Institute of Electrical and Electronics Engineers (IEEE) are regarded as the most popular ones in the world. Most European countries employ the former; in particular, some countries and metropolis in Asia adopt this standard like Japan, Singapore and Hong Kong. On the other hand, the IEEE standard is being used in America. To assess the radiation safety in the frequency range of Macao's mobile communication, as shown in Fig. 1, the safety reference levels for E-field strength as stated in both ICNIRP and IEEE standards are ranged from 38.8 V/m to 59.8 V/m deriving from the basic restriction value – Specific Absorption Rate (SAR). SAR represents the rate at which electromagnetic energy is absorbed by unit of tissue mass. Based on WCL experience and judgment, we believe either ICNIRP or IEEE is applicable to Macao considering no harmonized standard defined yet.

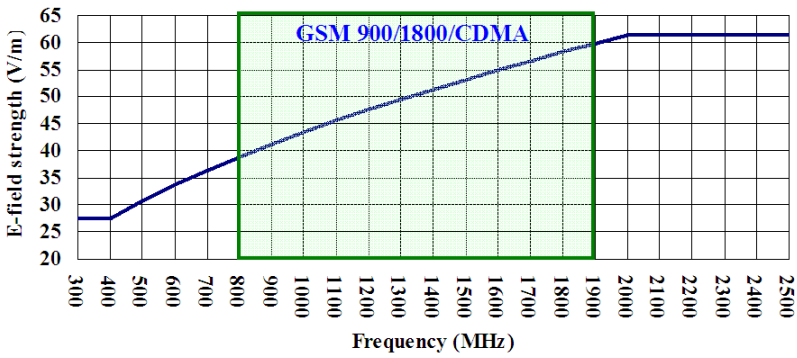

Fig. 1 Safety reference levels for E-field strength.

3. Electromagnetic Assessment On Human Safety of Mobile Communication Base Stations in Macao

There were 181 locations chosen to perform *in-situ* electromagnetic field strength measurement of base stations. Amongst them, 146 measurements were taken in public areas and the rest were at rooftops of some residential or commercial buildings. As the concern of this study was about the radiation generated by mobile communication, the field strength of frequency band of 800 MHz and 1900 MHz was monitored in reference to the standards of ICNIRP and IEEE. A typical E-field measurement result of a base station in Macao is shown in Fig. 2, using a 2.5-GHz dipole antenna with conically shaped radiation elements.

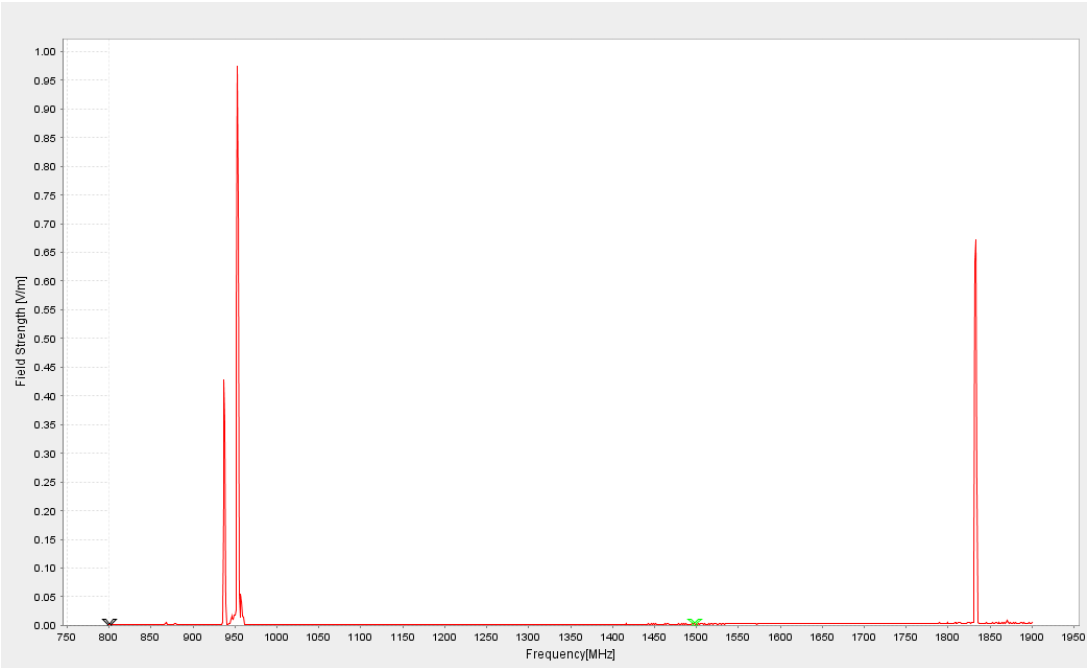

Fig. 2 A typical E-field measurement result.

The measured strengths were then compared with the safety reference levels of both European (ICNIRP) and American (IEEE) standards. The ICNIRP measurement results were compared and summarized in Fig. 3. In these 181 measurements, no measurement points were found against the safety reference level, and only 8.3% of the measurements reached the highest field strength ranged from 2.8 V/m to 9.9 V/m. 34.8%

of the locations reported field strength from 0.8 V/m to 2.8 V/m whilst 45.9% were for the range of 0.3 V/m to 0.8 V/m. The rest was lower than 0.3 V/m. Similar observation was recorded if IEEE safety compliance evaluation was used.

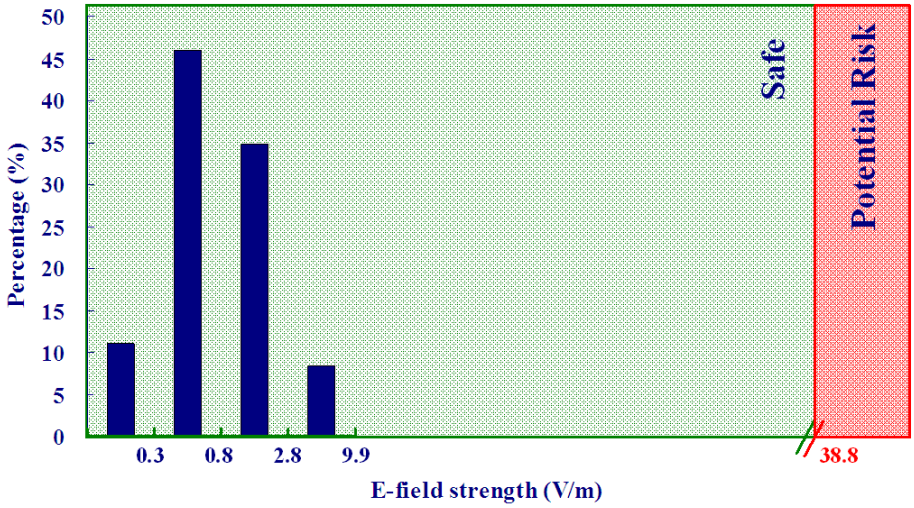

Fig. 3 Field strength measurement result distribution.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Concluding Remarks

The electromagnetic radiations from mobile communication base stations have been measured *in-situ*. As observed, the majority of measured field strength levels were ranged from 0.3 V/m to 0.8 V/m. These measurements are well below the restricted reference level for human safety according to ICNIRP and IEEE standards, it is thus concluded that the base stations in Macao are safe.

4.2. Recommendations

The following recommendations are made based on the above findings:

- In the near term, for Macao residents' interests and environmental protection, the most appropriate action would be to retain the regular monitoring mechanism of the radiation emitted from the base stations;
- Longer term, MSAR should also concern the public distribution and awareness of the radiation safety.