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Interim
Australian/New Zealand Standard[®]

Radiofrequency fields

**Part 1: Maximum exposure
levels—3 kHz to 300 GHz**

This Interim Joint Australian/New Zealand Standard was prepared by Joint Technical Committee TE/7, Human Exposure to Electromagnetic Fields. It was approved on behalf of the Council of Standards Australia on 27 February 1998 and on behalf of the Council of Standards New Zealand on 27 February 1998. It was published on 5 March 1998.

The following interests are represented on Committee TE/7:

AirServices Australia
Australasian Faculty of Occupational Medicine
Australian Communications Authority
Australian Council of Trade Unions
Australian Electrical and Electronic Manufacturers Association
Australian Radiation Laboratory
Australian Radiation Protection Society
Australian Telecommunications Users Group
Broadcast Communications, New Zealand
Communications, Electrical Plumbing Union, Australia
Department of Communications and the Arts, Australia
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PREFACE

This Interim Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TE/7, Human Exposure to Electromagnetic Fields, to supersede, in Australia, AS 2772.1—1990 and, in New Zealand, NZS 6609.1:1990, *Radiofrequency radiation, Part 1: Maximum exposure levels—100 kHz to 300 GHz*.

This Interim Standard is based on the International Radiation Protection Association (IRPA) Specific Absorption Rate (SAR) Guidelines. This edition covers an extended frequency range down to 3 kHz.

The term ‘informative’ has been used in this Interim Standard to defined the application of the appendix to which it applies. An informative appendix is for information and guidance only.

While this document has been the subject of public comment and has met the consensus requirements for publication, given the level of public interest in this subject Standards Australia and Standards New Zealand has decided to issue this document as an Interim Standard to allow further committee review and public comment before being finalised. The particular areas the Committee will be reviewing are as follows:

- The treatment of non-thermal effects.
- The appropriateness of proposed radiation levels which are based on current World Health Organization (WHO) recommendations.
- The proposed measurement methods of time and spatial averaging.

Standards Australia and Standards New Zealand invite comment on this Interim Standard from persons and organizations concerned with this subject. The date for expiry of comment is 5 March 1999 at which (or earlier) this Interim Standard will be confirmed, withdrawn or revised in the light of comments received.

During the life of this document the Committee will monitor all comment as it is received.

Attention is drawn to the fact that this document is an Interim Australian/ New Zealand Standard and should be regarded as a development Standard liable to future alteration.

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FOREWORD

This Interim Standard provides guidance on human exposure to radiofrequency (RF) fields and sets limits intended to avoid any detrimental effects on health. It applies to the exposure of workers due to their employment and to the incidental exposure of the general public, but it does not apply to patients undergoing medical diagnosis or treatment. This Interim Standard does not address the issues of electromagnetic interference (EMI) with telecommunications, electromedical, and other electronic equipment.

This Interim Standard has been developed following a review of the relevant scientific literature and is generally in accord with the recommendations of the World Health Organization (WHO), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the International Radiation Protection Association (IRPA) and other major national reviews, guidelines and standards. As such, the whole body SAR limits of exposure to RF fields in this Interim Standard for both the general public and workers are the same as the international guidelines on exposure to RF fields published by the IRPA, ICNIRP and all major RF standards. The determination of derived exposure levels (*E*, *H* and *S* fields) is based on the ICNIRP methodology (refer Appendix A) over much of the frequency range.

At frequencies between 400 MHz and 2 GHz the ICNIRP literature gives progressively rising derived levels and thereafter a level which is constant with frequency. This Interim Standard does not, however, follow this methodology and requires a lower and constant level to be met across the entire frequency range above 400 MHz. Furthermore a lower spatial peak SAR is prescribed for all parts of the body except hands, feet, wrists and ankles. This approach was followed because of the existence of ongoing research projects by WHO and public concerns about RF radiation, particularly from cellphone systems. The higher ICNIRP derived levels in the frequency range above 400 MHz are given in this Interim Standard for information only.

The Committee responsible for this Interim Standard considered both thermal and non-thermal effects of RF exposure. The Committee found that, when established scientific literature is used, exposure limits can only be based on thermal effects at frequencies above about 10 MHz. This is consistent with the findings of organizations developing standards in all Western countries. The Committee noted that, while some researchers have found effects at body cell levels, there has been no conclusive evidence that such effects constitute a health hazard to humans.

Below about 10 MHz, currents induced in the body by RF fields become more important than heating as the basis for setting exposure levels.

In setting limits, the lowest RF exposure level that caused adverse biological effect that could be confirmed by independent laboratory studies was used as the threshold. For exposures in the frequency range above about 10 MHz it was found to be an absorption of RF power in the body equivalent to a whole body average SAR of 4 W/kg. An example of the biological effects detected at this level is the reduced endurance to perform tasks in experimental animals when their temperature was raised by the RF exposure by at least 1°C. If the rectal temperature was raised less than 1°C, no effect was found on performance.

To derive the exposure limits from this threshold RF level, a safety factor of 10 was incorporated so that workers would not be exposed to more than 1/10th of the threshold level (i.e. 0.4 W/kg). For the general public, an additional safety factor of 5 was incorporated into the exposure limits, since they cannot be expected to take any precautions to avoid exposure. Thus the exposure limits for the general public are set at 1/50th of the threshold level (i.e. 0.08 W/kg) except at frequencies above 400 MHz, where a greater safety factor is provided.

There is no conclusive evidence of any harmful effects to people exposed to the threshold value of 4 W/kg. The derived exposure levels contained in this Interim Standard are based on not exceeding 1/10th of this threshold value for workers and 1/50th of the threshold for the general public, with further safety factors at frequencies above 400 MHz, and these levels are considered to provide large margins of safety. However, good practice suggests unnecessary exposure should be minimized.

While the basic limits (whole body average SARs) between this Interim Standard and its predecessors AS 2772.1—1990 and NZS 6609.1:1990 have not changed, there have been changes in the derived exposure levels in the frequency range around 1 MHz to bring this Interim Standard into accord with the science and recommendations of the relevant international bodies. AS 2772.1—1990 and NZS 6609.1:1990 incorporated derived field levels lower than other International Standards for frequencies above 400 MHz, and this Interim Standard has retained these. While industry should not exceed the limits in this Interim Standard, exposure to workers and to the public should be kept to the lowest levels that can be achieved consistent with best international contemporary practice and cost effective achievement of service objectives. This approach is consistent with the principle of prudent avoidance (see references in Appendix A).

SUBJECT TO THE CONDITIONS OUTLINED ABOVE, EXPOSURES SHALL BE KEPT TO A MINIMUM.

Ongoing research is being carried out in many countries into possible effects on health arising from exposure to RF radiation and in recognition of this, the Committee will continue to monitor the results of this research and, where necessary, issue amendments to this document.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Interim Australian/New Zealand Standard**Radiofrequency fields****Part 1: Maximum exposure levels 3 kHz to 300 GHz**

1 SCOPE This Interim Standard specifies SAR limits and derived field levels for exposure of all or part of the human body to RF fields in the frequency range 3 kHz to 300 GHz. This Interim Standard also identifies the rationale for the limits and provides guidance on compliance measures.

This Interim Standard provides for the following:

- (a) Whole body average and peak spatial SAR limits for occupational exposure with corresponding derived *E*, *H* and *S* levels, and body current levels as a function of frequency for the practical measurement of exposure levels.
- (b) Whole body average SAR limits for non-occupational exposure, with corresponding *E*, *H*, and *S* levels as a function of frequency for the practical measurement of exposure levels.
- (c) Equipment and usage parameters in order to readily determine compliance with this Interim Standard.

2 APPLICATION This Interim Standard is applicable wherever people may be exposed to RF fields in the course of their work and wherever the public may be exposed.

This Interim Standard is applicable to continuous wave (CW), pulsed and modulated fields.

The limits specified in this Interim Standard are intended to be used as a basis for planning work procedures, designing protective facilities, the assessment of the efficacy of protective measures and practices, and guidance on health surveillance.

This Interim Standard does not apply where persons are exposed to RF fields as part of a recognized medical procedure, but does apply to persons operating the radiating equipment and those who may be required to be in the vicinity during the procedure.

This Interim Standard does not apply to other hazards of RF fields such as the ignition of explosives or flammable gases, or interference to other electronic equipment which are the province of other Standards.

The limits specified in this Interim Standard are such as to reduce to insignificant levels any RF absorption in the body and to minimize the possibility of RF burns or shock under routine operations. Precaution may still be necessary for workers but not for members of the general public.

This Interim Standard applies where RF fields are produced or radiated, either deliberately or incidentally, by the operation of equipment or devices. It is the responsibility of the manufacturer/supplier, installer, employer/service provider and user to ensure that all devices and installations are operated in such a way as to achieve compliance with the requirements of this Interim Standard. Clause 7 of this Interim Standard sets out the procedures to be followed in the verification of compliance. Clause 7.4 permits 'type-testing of RF sources or RF site evaluation' for RF installations in order to demonstrate compliance without actual measurement of each source or site. In recognition that certain classes of low-powered devices are incapable of producing exposures in excess of the guidelines, Clause 7.7 sets out parameters for equipment operated by occupationally exposed persons, aware users and others, adherence to which ensures compliance with the SAR limits of this Interim Standard without the need for further measurements.

3 REFERENCED DOCUMENTS The following documents are referred to in this Interim Standard:

AS	
1000	The International System of Units (SI) and its application
1319	Safety signs for the occupational environment
AS/NZS	
1852	International Electrotechnical Vocabulary (all Parts)
2772	Radiofrequency radiation
2772.2	Part 2: Principles and methods of measurement—300 kHz to 100 GHz
4346	Guide to the installation in vehicles of mobile communication equipment intended for connection to a cellular mobile telecommunication service (CMTS)
IEC 215	Safety requirements for radio transmitting equipment
IRPA	Guidelines on limits of exposure to radiofrequency electromagnetic fields in the frequency range from 100 kHz to 300 GHz. Health Phys., 54: 115-123 (1988a)
WHO	Environmental health criteria 137: Electromagnetic Fields 300 Hz to 300 GHz. Geneva, World Health Organization (1993)
ICNIRP	Health issues related to the use of hand-held radiotelephones and base transmitters. Statement of the International Commission on Non-Ionizing Radiation Protection. Health Physics 70(4):587-593 (1996)

4 DEFINITIONS AND UNITS For the purpose of this Interim Standard, the definitions given in AS/NZS 1852 and those below apply. Units are selected from AS 1000.

4.1 Averaging time—the interval of time during which measurement of power flux density, the root mean square of the electric field strength or the root mean square of the magnetic field strength, is made to allow the average value during that interval to be established.

4.2 Aware users—users whose involvement with use of RF radiation is coincidental to their work and who, by virtue of their training, either through their work or other means, are aware of the potential risk of exposure to RF fields. This category includes emergency service operators and amateur radio licensees.

4.3 Continuous wave (CW)—an unmodulated electromagnetic wave.

4.4 Duty factor—the ratio of pulse duration to the pulse period of a periodic pulse train. A duty factor of 1.0 corresponds to continuous wave operation.

4.5 Electric field strength—the RMS magnitude of the electric field vector, (E) defined as equal to the force (F) on a unit electric charge (q) at the field point expressed in volts per metre (V/m), i.e.

$$E = \frac{F}{q}$$

4.6 Exposure—that which occurs whenever a person is exposed to an RF field or a contact current.

4.7 Exposure, partial-body—exposure which occurs when RF fields are substantially non-uniform over the body. Fields that are non-uniform over volumes comparable to the human body may occur due to highly directional sources, standing-waves, re-radiating sources or in the near-field.

4.8 Hertz (Hz)—the unit for expressing frequency, (f). One hertz equals one cycle per second. 1 kHz = 1000 Hz, 1 MHz = 1000 kHz, 1 GHz = 1000 MHz.

4.9 Magnetic field strength—the RMS magnitude of the magnetic field vector (H) expressed in amperes per metre (A/m).

4.10 Modulated field—an RF field, the amplitude, phase or frequency of which varies with time.

4.11 Non-occupational exposure—exposure of persons, other than in the course of or intrinsic to their work. This category includes persons of all ages and health status who will be generally unaware that exposure is taking place. It includes pregnant workers who would normally be occupationally exposed but who have informed their employer of their pregnancy.

4.12 Occupational exposure—exposure under controlled conditions, in the course of and intrinsic to the nature of their work, of a population consisting of adults who are trained or informed to be aware of potential risks and to take appropriate precautions. The duration of occupational exposure is limited to the duration of the working day or duty shift per 24 hours and the duration of the working lifetime. This category excludes pregnant workers, who must not be exposed at levels in excess of the non-occupational limit.

4.13 Radiofrequency (RF)—electromagnetic energy with frequencies in the range 3 kHz to 300 GHz.

4.14 RF field—a physical field which specifies the electric and magnetic states of a medium or free space, quantified by vectors representing the electric field strength and the magnetic field strength.