AS 2772.2—1988

Australian Standard®

Radiofrequency radiation

Part 2: Principles and methods of measurement—300 kHz to 100 GHz

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- Australian Electronic Industry Association
- Australian Radiation Protection Association
- Confederation of Australian Industry
- Consumer Electronics Suppliers Association
- CSIRO Division of Applied Physics
- Department of Community Services and Health
- Department of Transport and Communications
- Department of Defence
- Department of Industrial Relations and Employment, N.S.W.
- Institution of Radio and Electronic Engineers Australia
- International Radiation Protection Association
- Queensland Department of Health
- Telecom Australia
- The Royal Melbourne Hospital
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PREFACE

This draft Standard was prepared by the Association's Committee on Hazards of Non-ionizing Radiation. The techniques discussed apply to radiofrequency (RF) electromagnetic radiation in the frequency range 300 kHz to 100 GHz. In preparing this draft attention was paid to ANSI C95.3 and ANSI C95.5,* for which acknowledgement is due for the assistance received therefrom.

Except for light, electromagnetic radiation is not visible and its presence must be measured by instruments or approximated by theoretical calculations. This draft specifies techniques and instrumentation for the measurement of potentially hazardous electromagnetic fields as defined in Part 1 of this Standard. The techniques apply to both the near-field and the far-field of the source of the electromagnetic radiation. No single measurement technique or instrumentation configuration is suitable for such a wide frequency range. Furthermore, most older instruments are not designed specifically for hazardous purposes and are incapable of performing the accurate near-field measurements required to evaluate hazardous situations, e.g. below 300 MHz field-strength measurements are often required within one wavelength of the source.

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* ANSI C95.3 Techniques and instrumentation for the measurement of potentially hazardous electromagnetic radiation.

ANSI C95.5 Recommended practice for the measurement of hazardous RF electromagnetic fields.

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FOREWORD

The evaluation of potentially hazardous fields is not a subject for persons who are unaware of the dangers of the situation in which they may find themselves. It is also a task which should be performed only by the technically competent, if the correct assessment is to be made. This may seem strange given the ready availability of instrumentation claimed to be simple to use, robust and accurate, but is nevertheless true. The measuring or survey instruments may well be all these things but they are, however, deceptively simple and the situations that are required to be surveyed may be anything but simple when actually attempted.

This is not to say that simple instruments cannot be used to give warning of a hazardous situation. It means however, that reliance must not be placed on such instruments to evaluate situations for which they are not intended. Survey instruments must be selected to match the operating conditions of the equipment to be measured. Measurement techniques as explained in this Standard must be carefully followed. Survey instruments must be regularly calibrated, and checked against known signals to ensure that their calibration is still accurate before undertaking a survey.

The surveyor should take care to observe the occupational limits set in AS 2772, being especially careful not to disregard the time limits for limited period exposure in fields with levels of the recommended maximum exposure limits.

The surveyor should estimate the expected field strength and, selecting the appropriate instrument, proceed with the survey using a high-power probe to avoid inadvertent probe burnout. The instrument should be set on the most sensitive setting to avoid possible over-exposure of the surveyor.

For accurate measurements in the near field, where many surveys must be performed, an electrically small sensor is required since large gradients in field components exist and spatial resolution is critical. Unless the polarization of the field is known, or can be deduced, then the use of an isotropic probe is recommended. A probe with a single axis requires measurement in all three directions to ensure that all components have been measured. If this latter approach is used the field must also be time-invariant.

Accessible positions as well as those normally occupied by any personnel must be surveyed. All objects likely to reflect energy, including the operator, should be in their normal positions. Only if all these factors are carefully observed is the survey likely to be meaningful.

A flowchart to explain the measurement system of this Standard is given in Figure 1.

A PROCEDURE TO MEASURE RADIO FREQUENCY RADIATION

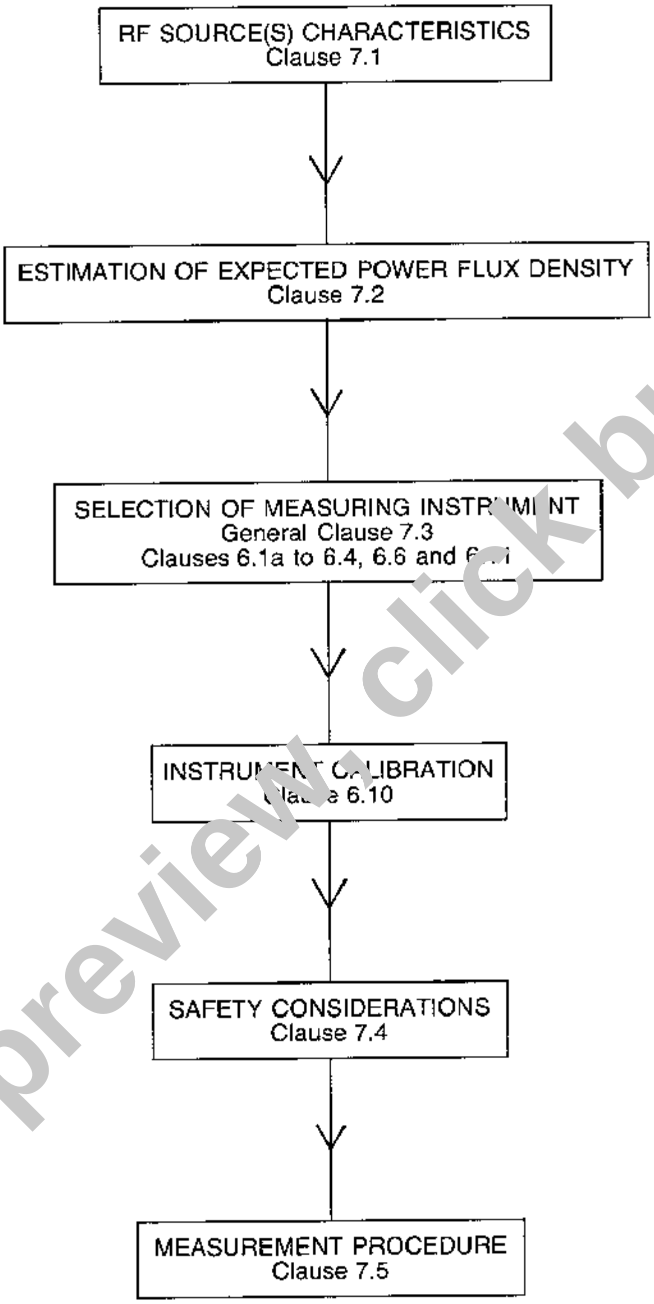

FIGURE 1. FLOWCHART

STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard
RADIOFREQUENCY RADIATION

Part 2—PRINCIPLES AND METHODS OF MEASUREMENT 300 kHz to 100 GHz

1 SCOPE. This Standard specifies techniques and instrumentation for the measurement of potentially hazardous electromagnetic fields in both the near field and far field of electromagnetic sources, in the frequency range 300 kHz to 100 GHz.

To ensure accuracy of measurement, techniques have been included to estimate or avoid multipath interference, caused by scattering or reflection of energy from other objects or surfaces. Also discussed are the spurious effects experienced with instrumentation for measurement.

2 APPLICATION. The Standard applies to measurements of fields which have the potential to be hazardous to persons, either directly, or indirectly by radiofrequency (RF) shock or burns but does not apply to the initiation of explosives or ignition of flammable liquids, although the recommended method may be appropriate.

The Standard applies to the frequency range of 300 kHz to 100 GHz, under both near-field and far-field conditions. However, no single technique or instrumentation configuration is suitable over the entire frequency range specified. Furthermore, most older instruments are not designed specifically for hazards purposes and are incapable of performing accurate near-field measurements. Below 300 MHz field-strength measurements within one wavelength of the source are commonly required.

The Standard applies to measurement of potentially hazardous fields, by measurement of one or more components of the electric field (*E*) or the magnetic field (*H*), or both. Measuring equipment is not available to measure power flux density directly. Measurement techniques usually provide values of $|E^2|$ and $|H^2|$, which in these circumstances can be considered more meaningful quantities (Ref. 1). However the equivalent plane-wave power flux density can be calculated from the far-field, plane-wave relationship for $|E^2|$ and $|H^2|$ as given in AS 2772.1.

The Standard applies to near-field and far-field situations typical of—

(a) leakage fields;

(b) radiated fields; and

(c) reactive fields.

Leakage fields generally imply unintentional leakage of energy, whereas radiated fields are considered to involve intentionally radiated electromagnetic fields. Reactive fields are present in the immediate vicinity of all sources.

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

AS
- 1000 The international system of units (SI) and its application
- 2772 Radiofrequency radiation
  Part 1—Maximum exposure levels—300 kHz to 300 GHz (AS 2772.1)

IEC
- 215 Safety requirements for radio transmitting equipment

BS
- 6656 Prevention of inadvertent ignition of flammable atmospheres by RF radiation
- 6657 Prevention of inadvertent initiation of electro-explosive devices by RF radiation
- 79 EHD-30 Recommended safety procedures for the installation and use of radiofrequency and microwave devices in the frequency range 10 MHz–300 GHz (Dept. of Health and Welfare, Canada)

ANSI/IEEE
- 100 Standard dictionary of the electrical and electronics terms

TPH
- 1834 Radio frequency site measurement for exposure control—Telecom Australia

See also the Appendix C for sources of information referred to in the text, i.e. Ref. 1. to Ref. 50

4 DEFINITIONS. For the purpose of this Standard definitions given in ANSI/IEEE 100 and those below apply.

4.1 Antenna field regions. It is convenient to distinguish between the regions of small radiators (one wavelength or less) and large radiators (larger than one wavelength) as follows:

(a) Small radiators—field regions of small radiators (current elements and small linear radiators) are the electrostatic field region, the induction field region, and the radiation field region.

(b) Large radiators—field regions of large radiators or aperture antennas are the reactive near-field region, the radiating near-field region, and the far-field region.

NOTE: The term ‘induction field’ as defined for small antennas is not meaningful, but important vector field terms decaying inversely as higher powers of distance than the first are usually called near-field terms.

4.2 Bolometer—device capable of absorbing radiant energy and of using the heat so developed to change its electrical resistance, thus indicating the amount of energy absorbed.