

Australian Standard[®]

**Radio transmitters and similar
equipment—Safe practices**

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equipment—Safe practices**

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PREFACE

This Standard was prepared by the Standards Australia Committee on Radiocommunication to encompass recent technical developments in safety practices when working with radio transmitters and similar equipment.

It is a revision of AS 1188—1972 *Rules for safe practice in the operation and maintenance of electronic equipment* (known as the *SAA Code for Safety of Electronic Equipment*), which was based on the International Electrotechnical Commission (IEC) Publication 284 and, for completeness, includes extracts from AS 2243—*Safety in laboratories*, IEC Publication 479*, NHMR Code of practice for disposal of radioactive waste and the Fire protection handbook of the National Fire Protection Association.

The title of this Standard was changed to give a better indication of the content.

Section 3 contains extracts from IEC 479* which is being considered for adoption as the revision of MP30*, these extracts being guidance only for applications within this Standard's Scope.

Attention is drawn to possible statutory regulations covering some of the subject matter of this Standard.

Clause 3.8—Live parts and current limits, does not apply to equipment operating on the Telecom network at Telecom network voltages (TNV), for which reference to Austel and Telecom regulations should be made.

* Report on the effects of current passing through the human body.

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FOREWORD

This Standard should be read in conjunction with AS 1470, Health and safety at work—Principles and practices, which should be known and implemented by the employer and employees involved in this field.

Basic safety factors, such as proper training and supervision by properly qualified personnel, correctly installed equipment, proper access to all equipment, the availability of the correct tools and the knowledge of how to use them, are not considered part of this Standard which concerns itself only with those safety practices peculiar to the field of electronics engineering.

To ensure the safety of personnel working in the field of electronics, a full appreciation of the various hazards involved is required.

The factors which contribute to safety are too numerous to be stated in entirety but those covered, with respect to personnel, include:

- (a) The precautions to be taken when using voltages exceeding 30 V r.m.s. (42.4 V peak) or 60 V d.c.
- (b) Special precautions to be taken when using voltages exceeding 1000 V peak.
- (c) The special precautions to be taken when using radiofrequency (r.f.) energy, where very high induced voltages may be present.
- (d) The effects of r.f. fields existing in the vicinity of antennas and antenna transmission lines which may introduce fire hazards, danger of electrical shock and burns.
- (e) Explosion hazards where flammable gases, vapours or materials are present.
- (f) The risk of falls and coming into contact with live conductors whilst working on structures or buildings.
- (g) Ionizing (X-ray) and non-ionizing radiation hazards.

Adequate safety measures, such as the use of enclosures and protective interlocking systems, are required to guard against the effects of these hazards.

Specifications for the installation of electronic equipment may also require similar or additional protective measures, such as the provision of protective coverings (insulating matting) in areas—

- (a) which may be frequented by personnel engaged in operating and servicing equipment;
- (b) where voltages over 30 V r.m.s. or 60 V d.c. are used; and
- (c) at the front and rear of power and lighting switchboards.

Notwithstanding the provision of safety devices, safety depends on the user being continuously aware of the possible hazards and how to avoid these hazards.

Removing a unit or part of a unit from its normal location within an assembly and energizing this part while outside its normal enclosure, may nullify the protection envisaged by built-in protective measures, such as safety switches, earthing switches, isolating switches and the interlocking of these components. Since the normal safety measures may then no longer exist, the person authorizing the operation should ensure that suitable personnel safety precautions are taken and normal equipment safety conditions are maintained.

All circuit diagrams and other published information which set out the nature and form of the equipment should be complete, accurate and available to the employee involved prior to the commencement of the work. Equipment diagrams should be marked to indicate hazardous components. Permanent markings should be correct and clearly legible. Temporary markings should be correct, clearly legible and, where necessary, made permanent within the shortest possible time.

Further dangers may arise from various types of radiation and from toxic materials.

STANDARDS AUSTRALIA

Australian Standard

Radio transmitters and similar equipment—Safe practices

1 SCOPE AND APPLICATION

1.1 Scope This Standard specifies safe working practices to be adopted by personnel directly concerned with the operation or maintenance of commercial electronic equipment, radio communications equipment and associated electrical equipment.

This Standard applies generally to all types of commercial electronic equipment, radiocommunication equipment and equipment employing similar techniques e.g. radio and television transmitters, 400 Hz aircraft equipment, power tools, electric welders, electrotherapy equipment, switch mode power supplies, radiofrequency heating equipment, etc ...

This Standard excludes equipment operating at Telecom network voltages (TNV) for which reference to Austel and Telecom regulations should be made.

1.2 Application The purpose of this Standard is to provide a general basis for drafting specific safety procedures to ensure that personnel working on electronic equipment are not exposed to danger. The general practices, as listed, shall form the basis for the preparation of more specific instructions. Where they exist, specific safety standards on particular items or types of equipment, or particular safety regulations of the relevant authority, will override the requirements of these practices. State regulations may contain additional requirements.

1.3 Referenced Documents The documents below are referred to in this Standard:

STANDARDS

AS

- 1104 Informative symbols for use on electrical and electronic equipment
- 1318 SAA Industrial Safety Colour Code
- 1319 Safety signs for the occupational environment
- 1336 Recommended practices for eye protection in the industrial environment
- 1337 Eye protectors for industrial applications
- 1668 SAA Mechanical Ventilation and Airconditioning Code
- 1768 Lightning protection
- 1846 Portable fire extinguishers—Powder type
- 1847 Portable fire extinguishers—Carbon dioxide type
- 1848 Portable fire extinguishers—Halon type
- 2243 Safety in laboratories
- 2243.1 Part 1: General
- 2243.7 Part 7: Electrical aspects
- 2676 Installation and maintenance of batteries in buildings
- 2772 Radiofrequency radiation
- 2772.1 Part 1: Maximum exposure levels—100 kHz to 300 GHz
- 2772.2 Part 2: Principles and methods of measurement—300 kHz to 100 GHz
- 3100 Approval and Test Specification—Definitions and general requirements for electrical materials and equipment
- 3250 Approval and Test Specification—Mains operated electronic and related equipment for household and similar general use
- MP30 Report on effects of current passing through the human body

IEC

- 479 Effects of current passing through the human body
- 479-1 Part 1: General aspects
- 479-1-1 Chapter 1: Electrical impedance of the human body
- 479-1-2 Chapter 2: Effects of alternating current in the range of 15 Hz to 100 Hz
- 479-1-3 Chapter 3: Effects of direct current
- 479-2 Part 2: Special aspects
- 479-2-4 Chapter 4: Effects of alternating current with frequencies above 100 Hz
- 479-2-5 Chapter 5: Effects of special waveforms of current

479-2-6 Chapter 6: Effects of unidirectional single impulse currents of short duration

IRCP

15 International Commission for Radiological Protection Publication 15:
Protection against ionizing radiation from external sources

NHMRC Code of practice for the disposal of radioactive waste by the user

2 DEFINITIONS

2.1 Definitions—general where the terms ‘voltage’ and ‘current’ are used, they imply r.m.s. values, unless otherwise specified.

2.2 Danger—denotes a hazard to health, life or limb, from shock, burn or fire.

2.3 Skilled personnel—denotes persons considered to be skilled if they have the necessary technical training and practical experience of electrical and radio engineering to appreciate the various hazards that can arise from working on a particular equipment and, to take appropriate precautions to minimize the danger to themselves and ensure the safety of other personnel.

2.4 Radiation worker denotes a person who is required to work in electromagnetic fields the radiation levels of which exceed those specified for non-occupational exposure.

3 DANGEROUS VOLTAGES AND CURRENTS

3.1 General Care is to be taken not to contact live parts (see Clause 3.8) because the voltages encountered in electronic equipment may be dangerous and may be higher than the power supply voltage or than indicated by meters. The values of the voltages should be given in the equipment technical manual. Care is to be taken to avoid capacitor or inductor discharges, while inductor discharge only occurs at the switch-off instant, capacitor charge may be retained long after equipment is switched off.

Fundamentally, current, rather than voltage, is the criterion of shock intensity. The passage of even a very small current through the human heart can cause death. The voltage necessary to produce this fatal current must be present during the vulnerable period of the cardiac cycle and is dependent on body resistance, contact conditions and current path through the body also on the frequency and waveform of the current.

The following details are based on investigations made by IEC TC 64* and published in IEC Report 479. This information is given as guidance for applications within the Scope of this Standard (see Preface).

3.2 Effects of current When a 50 Hz alternating current is passed through a person from hand to hand or from hand to foot and the current is gradually increased from zero, it will cause the following effects:

- (a) At about 0.5 mA the shock is perceptible.
- (b) At about 10 mA the shock is of sufficient intensity to prevent voluntary control of the muscles and a person may be unable to let-go and free himself.
- (c) At about 40 mA the shock, if it lasts for 1 s or longer, is likely to be fatal due to ventricular fibrillation (rapid irregular uncoordinated contractions of the heart’s ventricular muscles, which prevent the heart pumping blood).
- (d) Increasing the current further or extending its duration may produce effects such as cardiac (heart) arrest, breathing arrest and heavy burns.

Atrial (atrial muscles of the heart) fibrillation and transient cardiac arrest may occur without ventricular fibrillation. Such effects are non-lethal and usually reversible.

With currents of several amperes, heavy burns resulting in serious injury and even death are likely to occur.

3.3 Alternating and direct current The threshold of perception for alternating current is about 0.5 mA while that for direct current is about 2 mA. Direct current is generally not as dangerous as the same alternating current, the threshold of let-go current† being about 10 mA for alternating current and substantially higher for direct current. Unlike alternating current there is no definable threshold of let-go for direct current magnitudes below approximately 300 mA. Above approximately 300 mA d.c., let-go may be impossible or only possible after several seconds or minutes of shock duration.

The making and breaking of direct current leads to painful and cramp-like contractions of the muscles.

* International Electrotechnical Commission Technical Committee No. 64: Electrical installations of buildings.

† See SAA MP 30, for definition of let-go current.

3.4 Effects of voltage The effects of voltage are approximate because of the varying impedance of the human body.

The value of the impedance of the skin depends on the voltage, frequency, duration of the current flow, surface area of contact, temperature, pressure of contact and the degree of moisture of the skin.

For voltages up to approximately 50 V, the value of the impedance of the skin varies widely with surface area of contact, temperature, respiration, etc., even for one person.

For higher voltages in the order of approximately 50 V to 100 V the skin impedance decreases considerably and becomes negligible when the skin breaks down.

A voltage limit of 30 V r.m.s. or 60 V d.c. is considered safe but when the skin is punctured the internal body impedance can be as low as 500 ohms so fatal currents can occur at these low voltages.

3.5 Results of short contact The possible results of a short contact with 50 Hz alternating current are as follows:

- (a) For contact of less than 0.1 s with currents just greater than 0.5 A, ventricular fibrillation may occur only if the shock is in the vulnerable period of the cardiac cycle.
- (b) For contact of less than 0.1 s with currents of several amperes, ventricular fibrillation is likely if the shock is in the vulnerable period of the cardiac cycle.
- (c) For contact of greater than 0.8 s (approximately 1 cardiac cycle) with currents just greater than 0.5 A, cardiac arrest (reversible) may occur.
- (d) For contact of greater than 0.8 s with currents of several amperes, burns and death are likely.

3.6 Effect of alternating current at frequencies greater than 100 Hz Electric energy using higher frequencies than 50 Hz is increasingly used in modern electrical equipment, for example aircraft (400 Hz), power tools and electric welding (up to 450 Hz), electrotherapy (4 kHz to 5 kHz), switch-mode power supplies (20 kHz to 1 MHz), radiofrequency heating and radio transmitters.

For potentials of tens of volts the impedance of the skin decreases as the frequency increases, skin contact resistance being approximately inversely proportional to frequency, so that at 500 Hz skin contact impedance is only about 1/10 that at 50 Hz. At higher frequencies the whole body impedance is equal to the internal body impedance, about 500 ohms.

The threshold of perception increases as the frequency increases. From 10 kHz to 100 kHz, the threshold of perception rises from approximately 10 mA to 100 mA.

For frequencies above 100 kHz the tingling sensation, characteristic for the perception at lower frequencies, changes into a sensation of warmth for current intensities in the order of some hundred milliamperes.

For frequencies above 100 kHz there is neither experimental data nor reported incidents concerning the threshold of let-go or the threshold of ventricular fibrillation.

At frequencies above 100 kHz with current magnitudes in the order of amperes, burns may occur depending on the duration of the current flow.

3.7 Effect of waveshape Contact with voltages from phase controls or multicycle controls (e.g. light dimmers or speed controls) usually cause effects between those of alternating current and direct current sources.

3.8 Live parts For alternating and direct current, conductive parts that may be touched with a standard test finger are not considered to be live if from each other part or contact, the current measured through a non-inductive resistance of 50 k Ω does not exceed 0.7 mA peak a.c. or 2 mA d.c.

NOTE: The maximum current of 0.7 mA peak a.c., while safe, is within the perception range of some people. Under some conditions, particularly in tropical regions where a comfort limit is desired, a value of 0.3 mA peak a.c. should be used.

For voltages between 34 V peak and 450 V peak the part is not considered to be live if the source capacitance does not exceed 0.1 μ F. With 0.1 μ F, if the voltage exceeds 34 V peak a.c. or 100 V d.c., the source impedance must be such that a current greater than 0.7 mA peak a.c. or 2 mA d.c. cannot be drawn through a resistance of 50 k Ω .

For frequencies above 1 kHz, the limit of 0.7 mA peak is multiplied by the value of the frequency in kilohertz, but shall not exceed 70 mA peak, see Table 1. The current is measured in a non-inductive resistor of 2 k Ω connected between the part concerned and earth or any other accessible part.

TABLE 1
CURRENT LIMITS WITH FREQUENCY

Frequency	Current limit
d.c.	2 mA
< 1 kHz	0.7 mA peak
1 kHz to 100 kHz	(0.7f*) mA peak
> 100 kHz	70 mA peak

* f = frequency in kilohertz.