

Australian/New Zealand Standard™

## Radiofrequency fields

**Part 2: Principles and methods of  
measurement and computation—3 kHz  
to 300 GHz**



## **AS/NZS 2772.2:2011**

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee TE-007, Human Exposure to Electromagnetic Fields. It was approved on behalf of the Council of Standards Australia on 2 May 2011 and on behalf of the Council of Standards New Zealand on 19 April 2011. This Standard was published on 23 May 2011.

---

The following are represented on Committee TE-007:

Australian Centre for Radiofrequency Bioeffects Research  
Australian Mobile Telecommunications Association  
Australian Radiation protection and Nuclear Safety Agency  
Department of Defence (Australia)  
EMC Technologies  
Engineers Australia  
Kordia Solutions  
Kordia (New Zealand)  
Local Government New Zealand  
Ministry of Economic Development (New Zealand)  
National Measurement Institute  
National Radiation Laboratory New Zealand  
New Zealand Institute of Occupational and Environmental Medicine  
Office of the Australian Safety and Compensation Council  
Swinburne University of Technology  
Telecom New Zealand  
Telstra Corporation  
Wireless Institute Australia

---

### **Keeping Standards up-to-date**

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at [www.saiglobal.com.au](http://www.saiglobal.com.au) or Standards New Zealand web site at [www.standards.co.nz](http://www.standards.co.nz) and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

---

*This Standard was issued in draft form for comment as DR AS/NZS 2772.2.*

---

# Australian/New Zealand Standard™

## Radiofrequency fields

### Part 2: Principles and methods of measurement and computation—3 kHz to 300 GHz

Originated in Australia as AS 2772.2—1988.  
Jointly revised and designated as AS/NZS 2772.2:2011.

#### **COPYRIGHT**

© Standards Australia Limited/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140

## PREFACE

This Standard was prepared by the joint Standards Australia/Standards New Zealand Committee TE-007, Human Exposure to Electromagnetic Fields, to supersede AS 2772.2—1988, *Radiofrequency radiation, Part 2: Principles and methods of measurement—300 kHz to 100 GHz*.

The objective of the Standard is to specify commonly accepted processes for assessing compliance with the exposure limits of RF safety standards such as ARPANSA Standard RPS3 and New Zealand Standard NZS 2772.1. It includes methodologies for reliably assessing human exposures to radiofrequency (RF) electromagnetic fields by measurement or computation, which form part of any compliance assessment.

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

.

## CONTENTS

	<i>Page</i>
FOREWORD.....	5
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE .....	6
1.2 REFERENCED DOCUMENTS .....	7
1.3 DEFINITIONS .....	8
1.4 ACRONYMS AND SYMBOLS.....	15
SECTION 2 SUMMARY OF PROVISIONS.....	16
SECTION 3 GENERAL ASSESSMENT PROCESSES	
3.1 GENERAL .....	17
3.2 ASSESSOR COMPETENCY .....	17
3.3 ASSESSMENT PROCESS OVERVIEW .....	18
3.4 DEFINITION OF ASSESSMENT TASK.....	18
3.5 DETERMINATION OF SOURCE AND PHYSICAL ENVIRONMENT CHARACTERISTICS .....	19
3.6 DETERMINATION OF APPLICABLE EXPOSURE LIMITS .....	19
3.7 PRELIMINARY ASSESSMENT .....	20
3.8 CHOICE OF ASSESSMENT METHOD (MEASUREMENT OR COMPUTATION).....	21
3.9 ASSESSMENT BY MEASUREMENT.....	21
3.10 ASSESSMENT BY COMPUTATION .....	23
3.11 REPORTING OF RESULTS .....	24
SECTION 4 POST-PROCESSING	
4.1 GENERAL .....	26
4.2 SPATIAL AVERAGING.....	26
4.3 SIMULTANEOUS EXPOSURE TO MULTIPLE FREQUENCY FIELDS.....	26
4.4 EXTRAPOLATION .....	26
SECTION 5 CALIBRATION AND VALIDATION	
5.1 GENERAL .....	28
5.2 TEST INSTRUMENT CALIBRATION REQUIREMENTS .....	28
5.3 CALIBRATION LABORATORY REQUIREMENTS.....	28
5.4 RECOMMENDED INTERVALS OF CALIBRATION .....	29
5.5 PERIODIC CHECKING OF INSTRUMENTATION.....	29
5.6 VALIDATION OF COMPUTATIONAL TOOLS.....	29
5.7 CHECKING AND REVERIFICATION OF COMPUTATIONAL TOOLS .....	30
SECTION 6 UNCERTAINTY ESTIMATION	
6.1 REQUIREMENT FOR UNCERTAINTY ANALYSIS.....	31
6.2 REPORTING OF ASSESSMENT RESULTS AND UNCERTAINTY ANALYSES .....	31
6.3 THE ROLE OF UNCERTAINTY IN COMPLIANCE ASSESSMENTS .....	31

## APPENDICES

A	RF MEASUREMENT INSTRUMENTATION AND DESIRABLE PERFORMANCE CHARACTERISTICS.....	33
B	FIELD REGIONS.....	42
C	MEASUREMENT .....	43
D	UNCERTAINTY ESTIMATES.....	55
E	RF COMPUTATIONAL TOOLS .....	75
F	FACTORS INFLUENCING MEASUREMENT ACCURACY .....	88
G	OTHER HAZARDS AND SAFETY CONSIDERATIONS.....	92
H	EXAMPLE RF MEASUREMENT OF AN RF WELDER.....	95
I	EXAMPLE MOBILE TELEPHONE BASE STATION ASSESSMENT .....	98

## FOREWORD

The reliable evaluation of radiofrequency (RF) electric and magnetic field exposures and the subsequent assessment of compliance with relevant RF safety exposure standards is a complex and specialised task. Users of this Standard should be aware that a full understanding of its content requires a well-developed knowledge of RF field theory and practice, and the potential hazards associated with exposure to RF fields. It also requires knowledge of the limitations of the measurement techniques, instrumentation and computational methods used. For safety compliance assessments, the assessor should be aware of the exposure limits set out in the relevant RF safety Standard such as ARPANSA Standard RPS3 or New Zealand Standard NZS 2772.1, and be in possession of appropriate skills, knowledge and understanding. Notwithstanding these requirements, this standard will also be of use to anyone wishing to better inform themselves in this area.

## STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

---

**Australian/New Zealand Standard**  
**Radiofrequency fields**

---

**Part 2: Principles and methods of measurement and computation—3 kHz to 300 GHz**

---

## SECTION 1 SCOPE AND GENERAL

**1.1 SCOPE**

This Standard specifies requirements for, and provides guidance on, assessing compliance with the exposure limits of radio frequency (RF) safety standards such as ARPANSA Standard RPS3 or New Zealand Standard NZS 2772.1. This includes methodologies for making an assessment (by measurement or computation) of human exposure to ambient RF fields and induced body currents in the frequency range of 3 kHz to 300 GHz.

This Standard also sets out processes for calculating the basic restrictions quantities (such as specific absorption rate and induced current density) in the relevant standards, but does not address their *measurement*.

This Standard may also be used as a guide for making low-level environmental exposure assessments in areas around RF sources, or for other purposes.

This Standard provides appropriate methodologies, including measurement techniques and instrumentation selection, computational techniques and the determination of assessment uncertainty and its use in assessing compliance with applicable exposure limits.

The assessment methodologies provided in this Standard may be applied for all types of RF exposure situations including exposure to—

- (a) leakage fields;
- (b) radiated fields; and
- (c) reactive fields.

NOTE: Leakage fields generally imply unintentional leakage of energy, whereas radiated fields are considered primarily to be intentionally radiated RF fields. Reactive fields are present in the immediate vicinity of all sources or re-radiating objects.

This Standard is applicable to the compliance assessment of RF exposures from most kinds of RF sources including—

- (i) broadcast installations;
- (ii) cellular base stations;
- (iii) radio-communications facilities;
- (iv) radar installations;
- (v) medical applications such as diathermy machines;
- (vi) industrial applications, including RF welders, heaters and induction heaters; and
- (vii) scientific applications.