

Australian/New Zealand Standard™

Radiofrequency fields

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



AS/NZS 2772.2:2016

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 31 May 2016 and by the New Zealand Standards Approval Board on 2 June 2016.
This Standard was published on 24 June 2016.

The following are represented on Committee TE-007:

Australian Centre for Radiofrequency Bioeffects Research
Australian Communications and Media Authority
Australian Industry Group
Australian Mobile Telecommunications Association
Australian Radiation Protection and Nuclear Safety Agency
Communications, Electrical and Plumbing Union—Electrical Trades Division
Department of Defence (Australian Government)
Electrical Compliance Testing Association
Electricity Engineers Association of New Zealand
Local Government New Zealand
Ministry of Health, New Zealand
National Measurement Institute
National Radiation Laboratory, New Zealand
New Zealand Telecommunications Forum
Victoria University of Wellington, New Zealand
Wireless Institute of Australia

Additional Interests:

Telstra Corporation

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 Standards may also be withdrawn.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 or Standards New Zealand web site at www.standards.govt.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 Standards Australia or the New Zealand Standards Executive at the address shown on the back cover.

This Standard was issued in draft form for comment as DR AS/NZS 2772.2:2015.

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.
This edition AS/NZS 2772.2:2016.
Reissued incorporating Amendment No. 1 (September 2018).

COPYRIGHT

© Standards Australia Limited

© The Crown in right of New Zealand, administered by the New Zealand Standards Executive

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, PO Box 1473, 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/NZS 2772.2:2011.

This Standard incorporates Amendment No. 1 (September 2018). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of the Standard is to specify commonly accepted processes for assessing compliance with the exposure limits of radiofrequency (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 electromagnetic fields by measurement or computation, which form part of any compliance assessment.

Significant changes incorporated in this edition include the following:

- (a) Calculation, reporting and application of uncertainty in RF exposure assessments.
- (b) Guidance on spatial averaging provided along with instrumentation selection and calibration for new technologies, such as 4G.
- (c) A review of the harmonization with other international standards, and new case studies relating to Wi-Fi and smart meters.

A1 | Amendment 1 to this Standard incorporates SAR assessment methods for radiocommunication base stations.

The term 'informative' has been used in this Standard to define the application of the appendices 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	16
SECTION 2 SUMMARY OF PROVISIONS	
SECTION 3 GENERAL ASSESSMENT PROCESSES	
3.1 GENERAL.....	19
3.2 ASSESSOR COMPETENCY	19
3.3 ASSESSMENT PROCESS OVERVIEW	20
3.4 DEFINITION OF ASSESSMENT TASK.....	20
3.5 DETERMINATION OF SOURCE AND PHYSICAL ENVIRONMENTAL CHARACTERISTICS	21
3.6 DETERMINATION OF APPLICABLE EXPOSURE LIMITS	22
3.7 PRELIMINARY ASSESSMENT	22
3.8 CHOICE OF ASSESSMENT METHOD (MEASUREMENT OR COMPUTATION).....	23
3.9 ASSESSMENT BY MEASUREMENT	23
3.10 ASSESSMENT BY COMPUTATION	25
3.11 REPORTING OF RESULTS	26
SECTION 4 POST-PROCESSING	
4.1 GENERAL.....	28
4.2 SPATIAL AVERAGING FOR DEMONSTRATING COMPLIANCE.....	28
4.3 SIMULTANEOUS EXPOSURE TO MULTIPLE FREQUENCY FIELDS.....	29
4.4 EXTRAPOLATION	29
SECTION 5 CALIBRATION AND VALIDATION	
5.1 GENERAL.....	31
5.2 RADIOFREQUENCY TEST INSTRUMENT CALIBRATION REQUIREMENTS.....	31
5.3 CALIBRATION LABORATORY REQUIREMENTS	31
5.4 RECOMMENDED INTERVALS OF CALIBRATION.....	32
5.5 PERIODIC CHECKING OF INSTRUMENTATION.....	32
5.6 VALIDATION OF COMPUTATIONAL TOOLS.....	32
5.7 CHECKING AND REVERIFICATION OF COMPUTATIONAL TOOLS	33
SECTION 6 UNCERTAINTY ESTIMATION	
6.1 REQUIREMENT FOR UNCERTAINTY ANALYSIS.....	34
6.2 REPORTING OF ASSESSMENT RESULTS AND UNCERTAINTY ANALYSES	34
6.3 THE ROLE OF UNCERTAINTY IN COMPLIANCE ASSESSMENTS	34

APPENDICES

A	RADIOFREQUENCY MEASUREMENT INSTRUMENTATION AND DESIRABLE PERFORMANCE CHARACTERISTICS	36
B	FIELD REGIONS	45
C	MEASUREMENT	46
D	UNCERTAINTY ESTIMATES	58
E	RADIOFREQUENCY COMPUTATIONAL TOOLS	83
F	FACTORS INFLUENCING MEASUREMENT ACCURACY	97
G	OTHER HAZARDS AND SAFETY CONSIDERATIONS	101
H	EXAMPLE RF MEASUREMENT OF AN RF WELDER	104
I	EXAMPLE MOBILE TELEPHONE BASE STATION ASSESSMENT	107
J	EXAMPLE REPORT MAXIMUM EXPOSURES FROM A HOME WI-FI ROUTER	120
K	EXAMPLE—AMI METER ELECTROMAGNETIC FIELD SURVEY	124
L	SAR ASSESSMENT OF RADIOCOMMUNICATION BASE STATIONS	134

FOREWORD

The reliable evaluation of radiofrequency (RF) electric and magnetic field exposures and the subsequent assessment of compliance with relevant RF safety exposure standards are complex and specialized tasks. 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 standards 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 radiofrequency (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.

A1 | This Standard also sets out processes for calculating the basic restrictions' quantities (such as specific absorption rate (SAR) and induced current density) in the relevant standards and addresses SAR measurement.

This Standard provides appropriate methodologies for measurement techniques and instrumentation selection, computational techniques and the determination of the uncertainty of exposure assessments 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.

A1 | This Standard is applicable to the compliance assessment of RF exposures from most kinds of RF sources including—

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

Advice and examples describing approaches to the assessment of reference level/basic restriction quantities are presented in Appendices H through to L.