Australian Government
Australian Radiation Protection and Nuclear Safety Agency

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Changes in the new ARPANSA Radiofrequency Standard

The exposure limits set in the updated ARPANSA Standard (RPS S-1, 2021) are similar to those in the 2002 standard (RPS3, 2002) with some refinements. The specific technical changes in the exposure limits are shown in Table 1. The exposure limits in RPS S-1 are based on revised guidelines by the International Commission on Non-Ionising Radiation Protection (ICNIRP, 2020) with only minor differences which are shown in Table 2. The new RPS S-1 has also updated the methods for verification of compliance with the limits of the Standard (Section 4) and updated the requirements for management of risk in occupational exposure and measures for protection of the general public (Section 5); these are shown in Table 3. A number of sections in RPS3 have been removed in the new RPS S-1 because they are no longer relevant or they are covered elsewhere; these are shown in Table 4.

Table 1. Technical changes to the exposure limits of RPS S-1

IBP = International Best Practice

Change	RPS3 (2002)	RPS S-1 (2021)	Type of Change	Reason for change
Frequency range covered by the standard	3 kHz to 300 GHz	100 kHz to 300 GHz	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Frequencies below 100 kHz are covered in the ICNIRP (2010) Low Frequency Guidelines (https://www.icnirp.org/cms/upload/publications/ICNIRPLFgdl.pdf) ARPANSA recommends the use of these ICNIRP guidelines for frequencies below 100 kHz
BASIC RESTRICTIONS				
Frequency range for whole body specific absorption rate (SAR)	100 kHz to 6 GHz	100 kHz to 300 GHz	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction	To ensure that exposures from new technologies operating above 6 GHz, such as 5G, do not lead to excessive temperature rise deep in the body

Change	RPS3 (2002)	RPS S-1 (2021)	Type of Change	Reason for change
			☐ Obsolete ☒ Align with IBP ☐ Australian specific change	
Averaging time for whole body SAR	6 min	30 min	☒ Improved accuracy ☒ New or updated method ☒ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To better match the time taken for body core temperature to rise from excessive exposure to radiofrequency electromagnetic energy
Averaging volume for local SAR	10 g of contiguous tissue in the shape of a cube	10 g (of any tissue) in the shape of a cube	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	SAR averaged over a cube (with no air pockets) provides a better correlation with temperature than 10 g of contiguous tissue in the shape of a cube.
Restrictions for local exposure above 6 GHz	Incident power density	Absorbed power density	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Better describes the measure of exposure of the body given that up to 50% of incident power density is reflected away from the body
Averaging area for local power density above 6 GHz	• $(30\text{-}2.58(f\text{-}1))^2$ cm^2 (<10 GHz) • 20 cm^2 (>10 GHz)	• 4 cm^2 (>6 GHz) • Additionally 1 cm^2 (>30 GHz)	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	The 4 cm^2 averaging area matches the face of the averaging volume (10 g) of SAR, and provides a consistent transition at 6 GHz. Above 30 GHz the additional averaging area of 1 cm^2 is set to account for highly focused beams. These changes are particularly relevant for ensuring safety with future technologies, such as 5G.

Change	RPS3 (2002)	RPS S-1 (2021)	Type of Change	Reason for change
Averaging time for local power density above 6 GHz	• 6 min (<10 GHz) • $68/f^{1.05}$ min (>10 GHz)	6 min	☒ Improved accuracy ☒ New or updated method ☒ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Reducing the averaging time with increasing frequency (for frequencies above 6 GHz) provides a poorer prediction of temperature rise than is provided by the additional 'brief exposure restriction' that has been introduced in RPS S-1 – see below
Restrictions for brief (< 6 minutes) and intense local exposure	Instantaneous (1 µs) SAR (10 MHz to 6 GHz) and power density (>6 GHz)	Specific absorption (>400 MHz to 6 GHz) and absorbed energy density (>6 GHz), both set as functions of exposure duration (>0 to <6 min)	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To ensure that transient temperature rise (occurring in less than 6 min) is not sufficient to cause pain or adversely affect tissue
Restrictions for the microwave hearing effect	Specific absorption (300 MHz to 6 GHz) over 50 µs exposure duration	Specific absorption (>400 MHz to 6 GHz) as a function of exposure duration (>0 to <6 min)	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	The new restrictions for brief local exposure in the row above will protect against RF pulses that can cause auditory biological effects
Restrictions for electrostimulation effects	Current density (3 kHz to 10 MHz)	Induced E-field (100 kHz to 10 MHz)	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To align with the ICNIRP (2010) Low Frequency Guidelines
REFERENCE LEVELS				

Change	RPS3 (2002)	RPS S-1 (2021)	Type of Change	Reason for change
Reference levels for whole body exposure	Equivalent plane wave E-field, H-field and power density	• Incident E-field, H-field and power density • Equivalent plane wave power density (only in the far-field)	☐ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Equivalent plane wave parameters are no longer applied in the near-field zone to prevent possible over-exposure.
Frequency range for whole body E-field and H-field reference levels	100 kHz to 300 GHz	100 kHz to 2 GHz	☒ Improved accuracy ☐ New or updated method ☒ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	E-field and H-field levels do not always provide a good estimate of the basic restrictions above approximately 2 GHz
Whole body E-field and H-field levels below 30 MHz	See Table 7, RPS3	Higher values	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	E-field and H-field reference levels in RPS3 were overly conservative based on limited research. RPS S-1 has updated these reference levels to incorporate improved knowledge on the levels required to reach the basic restrictions
Frequency range for whole body power density	• >1 MHz for occupational • >10 MHz for public	>30 MHz	☐ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Updated application of the far-field zone
Averaging time for whole body reference levels	• 100 kHZ-10 GHz: 6 min • >10 GHz: $9.6 \times 104/f^{1.05}$ min	30 minutes	☒ Improved accuracy ☒ New or updated method ☒ Improved prediction ☐ Obsolete	To better match the time taken for body core temperature to rise

Change	RPS3 (2002)	RPS S-1 (2021)	Type of Change	Reason for change
			☒ Align with IBP ☐ Australian specific change	
Reference levels for local (time-averaged) exposure	None	Incident E-field, H-field (100 kHz to 2 GHz) and power density (>30 MHz), all averaged over 6 min	☐ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To demonstrate compliance of local exposure basic restrictions
Reference levels for brief and intense exposure	Instantaneous E-Field and H-field (3 kHz to 300 GHz), and instantaneous power density (1 MHz to 300 GHz)	• Instantaneous E-Field and H-field (100 kHz to 10 MHz) • Incident energy density (>400 MHz) set as a function of exposure duration (>0 to <6 min)	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To demonstrate compliance of local exposure basic restrictions for: • Electrostimulation effects • Transient temperature rise
Application of the (whole body, local and brief exposure) reference levels in the far- and near-field zones	None	New rules on the application of reference levels in the far- and near-field zones	☐ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To ensure that exposures within the near-field zone will not result in over-exposure.
Reference levels for contact currents	See Table 9, RPS3	No reference levels. Guidance provided to assist those responsible for transmitting high-power RF fields to	☐ Improved accuracy ☐ New or updated method ☐ Improved prediction ☒ Obsolete ☒ Align with IBP	Contact current exposure is unpredictable, due to both behavioural factors (e.g. grasping versus touch contact) and environmental conditions (e.g. configuration of conductive objects) it is therefore not possible to provide accurate reference levels

Change	RPS3 (2002)	RPS S-1 (2021)	Type of Change	Reason for change
		understand contact currents, the potential hazards, and how to mitigate such hazards	☐ Australian specific change	
Simultaneous exposure to multiple frequency fields	See Section 3, RPS3	Various changes to the calculations of exposures from multiple frequency fields; see Section 3, RPS S-1 (2021)	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	To correspond to changes in the basic restrictions and reference levels

Table 2. Technical differences between ICNIRP (2020) and RPS S-1 (2021)

Change	ICNIRP (2020)	RPS S-1 (2021)	Type of Change	Reason for change
Whole body E- field strength at low frequencies	• Occupational (0.1-6.943 MHz): $660/f_M^{0.7}$ • Public (0.1– 6.27 MHz): $1.375f_M^{0.5}$	No reference levels at these frequencies	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☐ Align with IBP ☒ Australian specific change	No reference levels are available at these frequencies, as they would be greater than the reference levels for peak instantaneous field strengths based on electrostimulation effects shown in Table 7 of RPS S-1
Local E- field strength at low frequencies	• Occupational (0.1-10 MHz): $1504/f_M^{0.7}$ • Public (0.1– 10 MHz): $671/f_M^{0.7}$	No reference levels at these frequencies	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☐ Align with IBP ☒ Australian specific change	No reference levels are available at these frequencies, as they would be greater than the reference levels for peak instantaneous field strengths based on electrostimulation effects shown in Table 7 of RPS S-1
Local H- field strength at low frequencies	• Occupational (0.1-0.135 MHz): $10.8/f_M$ • Public (0.1-0.233 MHz): $4.9/f_M$	No reference levels at these frequencies	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☐ Align with IBP ☒ Australian specific change	No reference levels are available at these frequencies, as they would be greater than the reference levels for peak instantaneous field strengths based on electrostimulation effects shown in Table 7 of RPS S-1

Table 3. Other updates to RPS S-1

Change	Type of Change
Section 4 Updated methods for verification of compliance with the limits of the Standard including referencing updated measurement standards. This provides suppliers of RF-transmitting equipment with the latest methods for verifying the compliance of equipment that is being rolled-out in the community.	☐ Improved accuracy ☒ New or updated method ☒ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change
Section 5 Updated requirements for management of risk in occupational exposure and measures for protection of the general public (Section 5) including: Clear classification of different groups who may be either occupationally exposed or treated as members of the general public Extending the management of over-exposure incidents to include both workers and the general public	☐ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☐ Align with IBP ☒ Australian specific change

Table 4. Sections in RPS3 that have been removed in RPS S-1

Removed	Type of Change	Reason for removal
Schedule 1. Rationale	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	A description of the derivation of the exposure limits in RPS S-1 is provided in the ICNIRP guidelines (2020) (https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf)
Schedule 4. Equivalent Power Flux Density	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	RPS S-1 provides new rules on the application of power density in the far- and near-field zones (See Section 2)
Schedule 5. Compliance of Mobile or Portable Transmitting Equipment (100 kHz To 6 GHz)	☐ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Specific rules on the compliance of mobile or portable transmitting equipment are no longer within the scope of RPS S-1. Supplementary guidance on how this is determined is now provided in the RPS S-1 Advisory Note: Compliance of mobile or portable transmitting equipment (100 kHz to 6 GHz).
Annex 2. Coupling Mechanisms between RF Fields and the Body	☒ Improved accuracy ☒ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	Provided in Appendix A of the ICNIRP guidelines (2020)

Removed	Type of Change	Reason for removal
Annex 3. Epidemiological Studies of Exposure to RF Fields and Human Health	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	A summary of the latest epidemiological research on RF and health is provided in Appendix B of ICNIRP (2020). ARPANSA will continue to assess new research in this area
Annex 4. Research into RF Bio-Effects at Low Levels of Exposure	☒ Improved accuracy ☐ New or updated method ☐ Improved prediction ☐ Obsolete ☒ Align with IBP ☐ Australian specific change	A summary of the latest research into RF bioeffects at low levels is provided in Appendix B of ICNIRP (2020). ARPANSA will continue to assess new research in this area
Annex 5. Assessment of RF Exposure Levels	☐ Improved accuracy ☐ New or updated method ☐ Improved prediction ☒ Obsolete ☐ Align with IBP ☒ Australian specific change	Details on the assessment of RF fields is described in other technical standards e.g. AS/NZS 2772.2 (2016)