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 | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  Align with IBP[ ]  Australian specific change | 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 |
| Averaging time for whole body SAR | 6 min | 30 min | [x]  Improved accuracy[x]  New or updated method[x]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | * (30-2.58(f-1))2 cm2 (<10 GHz)
* 20 cm2 (>10 GHz)
 | * 4 cm2 (>6 GHz)
* Additionally 1 cm2 (>30 GHz)
 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  Align with IBP[ ]  Australian specific change | The 4 cm2 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 cm2 is set to account for highly focused beams. These changes are particularly relevant for ensuring safety with future technologies, such as 5G. |
| Averaging time for local power density above 6 GHz | * 6 min (<10 GHz)
* 68/f1.05 min (>10 GHz)
 | 6 min | [x]  Improved accuracy[x]  New or updated method[x]  Improved prediction[ ]  Obsolete[x]  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) | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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) | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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) | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  Align with IBP[ ]  Australian specific change | To align with the ICNIRP (2010) Low Frequency Guidelines  |
| **REFERENCE LEVELS** |
| 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[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[ ]  New or updated method[x]  Improved prediction[ ]  Obsolete[x]  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  | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 × 104/f1.05 min
 | 30 minutes | [x]  Improved accuracy[x]  New or updated method[x]  Improved prediction[ ]  Obsolete[x]  Align with IBP[ ]  Australian specific change | To better match the time taken for body core temperature to rise |
| 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[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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)
 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 understand contact currents, the potential hazards, and how to mitigate such hazards | [ ]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[x]  Obsolete[x]  Align with IBP[ ]  Australian specific change | 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 |
| 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) | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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*M0.7* Public

(0.1– 6.27 MHz):1.375*f*M0.5 | No reference levelsat these frequencies  | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[ ]  Align with IBP[x]  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*M0.7* Public

(0.1– 10 MHz):671/*f*M0.7 | No reference levelsat these frequencies | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[ ]  Align with IBP[x]  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 levelsat these frequencies | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[ ]  Align with IBP[x]  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 4Updated 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[x]  New or updated method[x]  Improved prediction[ ]  Obsolete[x]  Align with IBP[ ]  Australian specific change |
| Section 5Updated 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 publicExtending 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[x]  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 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 TransmittingEquipment (100 kHz To 6 GHz) | [ ]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[x]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  Align with IBP[ ]  Australian specific change | Provided in Appendix A of the ICNIRP guidelines (2020) |
| Annex 3. Epidemiological Studies of Exposure to RF Fields and Human Health | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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 | [x]  Improved accuracy[ ]  New or updated method[ ]  Improved prediction[ ]  Obsolete[x]  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[x]  Obsolete[ ]  Align with IBP[x]  Australian specific change | Details on the assessment of RF fields is described in other technical standards e.g. AS/NZS 2772.2 (2016) |