Australian Government
Civil Aviation Safety Authority

TEMPORARY MANAGEMENT INSTRUCTION

SORA 2.0 ground risk assessment – requirements and alternate criteria – 2024-03

October 2024

Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Inside front cover artwork: James Baban.

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Acronyms

The acronyms and abbreviations used in this Temporary Management Instruction (TMI) are listed in the table below.

Acronym	Abbreviation
ABS	Australian Bureau of Statistics
AGL	Above ground level
BVLOS	Beyond visual line of sight
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations 1998
iGRC	Intrinsic ground risk class
JARUS	Joint Authorities on Rulemaking for Unmanned Systems
NAA	National Aviation Authorities
RPA	Remotely piloted aircraft
RPAS	Remotely piloted aircraft system
SORA	Specific Operations Risk Assessment
TMI	Temporary management instruction
VLOS	Visual line of sight

Reference material

The reference material used in this TMI are listed in the table below.

Document type	Title
JARUS Document Package JAR_doc_09	JARUS SORA Package
JARUS Document JAR-DEL-WG6-D.04	JARUS guidelines on Specific Operations Risk Assessment (SORA)
Annex B to JARUS document JAR-DEL-WG6-D.04	JARUS guidelines on Specific Operations Risk Assessment (SORA) – Annex B
JARUS document JAR-DEL-SRM-SORA-F-2.5	JARUS guidelines on SORA – Annex F: Theoretical Basis for Ground Risk Classification and Mitigation
Part 101 of CASR	Unmanned aircraft and rockets

Revision history

This version of the TMI is approved by the Branch Manager, Emerging Technologies and Regulatory Change.

Revisions to this TMI are recorded below in order of most recent first.

Version number	Date	Parts and sections	Details
1.0	October 2024	All	Initial issue

Introduction

Purpose

This TMI provides alternate methods to be used by industry for SORA version 2.0 (SORA 2.0) based applications, and by CASA for application assessment, under Part 101 of CASR. This includes an alternate method to calculate the final ground risk class through an updated intrinsic ground risk class (iGRC) table, amendment to the ground risk mitigations, and an optimal grid resolution table.

This TMI does not replace the published JARUS SORA document suite; it is to be used to complement industry application and CASA assessment of RPA operations by defining population density quantitatively and qualitatively.

The alternate iGRC table better facilitates ground risk assessment for RPA operations in areas with low population density. Use of the alternate iGRC table is optional, but if used, the instruction and associated alternate M1 integrity and assurance tables in this TMI apply and must be used for the same application and assessment. If an applicant wishes to identify the applicable column for a specific RPA, they must use the associated alternated tables, and SORA Annex F, and provide justification to classify the specific RPA in another column. Use of kinetic energy calculations will not be accepted.

The TMI also details an optimal grid resolution table to help determine ground population densities. These grid resolutions should be used for any SORA application.

Feedback from CASA staff on the direction and efficiency of this TMI will be reviewed and considered, with a view to further developing the requirements related to the application of the SORA methodology in Australia.

Background

The SORA 2.0 intrinsic ground risk class table has three population bands; gathering of people, populated and sparsely populated. These population bands are qualitative terms and not quantitatively defined in the JARUS SORA 2.0 document suite.

The SORA was designed for National Aviation Authorities (NAAs) to adopt for their respective context. SORA 2.0 lacks the population granularity required for Australia's vast areas of very low population density.

Under SORA 2.0, an operator seeking to operate in an area of very low population would select and use the sparsely populated option, which is the lowest of the three available population density bands, in the existing intrinsic ground risk class table of SORA 2.0.

Due to a common acceptance and application of 'sparsely populated' to mean approximately 250 – 300 people in the area, selecting this band for RPA operations over an area with significantly less population (i.e. 10 people) can result in a skewed ground risk score that is not aligned to the actual risk and consequence for the area of operation. Correct identification of the ground risk score is essential to ensure the imposition of appropriate mitigation requirements necessary to achieve the target level of safety.

The alternate iGRC table has been developed to include two additional population bands for Australian RPA operations (seven population band densities in total) and is primarily based on the qualitative modelling utilised in the SORA 2.5 model, with necessary modification to ensure mitigation alignment with SORA 2.0.

While SORA 2.5 contains new population band density granularity better suited to the Australian environment, areas of population density in Australia remain that are below those detailed in SORA 2.5. The alternate iGRC table addresses this issue by including a population density band that is one order of magnitude less than those utilised in the SORA 2.5 iGRC table.

To ensure the alternate iGRC table is compatible with the SORA 2.0 ground risk mitigation strategies, and the correct final ground risk class is derived, this TMI includes amended M1 ground risk mitigation requirements that must be used with the alternate iGRC table. Where an applicant uses a M1 ground risk mitigation when using the alternate iGRC table, they must also use the alternate M1 integrity and assurance tables in this TMI.

This TMI also publishes a new grid resolution table for determining the intrinsic ground risk class of an operation. The publication of the grid resolution table is separate to the revised iGRC table and the amended M1 mitigation tables, and should be used for all SORA based applications.

Application

Instruction 1 of this TMI applies to all applicants and CASA Officers using any version of the SORA methodology to assess the ground risk of an RPA operation.

Instruction 2 of this TMI applies to applicants who choose to use the alternate iGRC table (Table B) and CASA Officers assessing the application.

Where an applicant uses a M1 ground risk mitigation when using the alternate iGRC table (Table B), they must use the alternate mitigating scoring table (Table R1), M1 integrity table (Table R2) and M1 assurance table (Table R3) in this TMI.

Instructions

Instruction 1 - Grid resolution for determining the iGRC

Determining the population density to calculate the iGRC in Step #2 of SORA should be done using maps with an appropriate grid size based on the operation, as detailed in Table A – Optimal Grid Resolutions.

If mapping products do not exist for the required optimal grid size, the applicant may use the closest grid size available. For example, for an operation conducted at 400 ft AGL in an area where the only available data is the ABS population grid 2022, the applicant should use the ABS 1 km x 1 km grid squares and validate this data qualitatively to ensure an accurate assessment of population.

If the closest grid size available is smaller than the required optimal grid size in Table A, the map may be smoothed to the required optimal grid size in Table A. For example, for an operation conducted at 5,000 ft AGL in an area where the only available data is the ABS population grid 2022, the applicant may use the average population density of a square, comprised of four of the 1 km x 1 km grid squares provided by the ABS.

Table A - Optimal Grid Resolutions

Max. Height (AGL)		Suggested Optimal Grid Size (metre x metre)
Feet	**Metres**	
500	152	>200 x 200
1,000	305	>400 x 400
2,500	762	>1,000 x 1,000
5,000	1,524	> 2,000 x 2,000
10,000	3,048	>4,000 x 4,000
20,000	6,096	>5,000 x 5,000
60,000	18,288	>10,000 x 10,000

Instruction 2 - Alternate iGRC table and M1

Alternate iGRC table

Applicants submitting SORA 2.0 based applications may use **Table B** – Alternate Intrinsic Ground Risk Class (GRC) Determination as an alternate to "Table 2 – Intrinsic Ground Risk Classes (GRC) Determination" contained in JARUS document “JARUS guidelines on Specific Operations Risk Assessment” (JAR-DEL-WG6-D.04).

Population density definitions

Table C - Alternate Ground Risk Class Definitions contains both qualitative and quantitative descriptors that apply to the population bands in the alternate iGRC table (Table B).

The qualitative and quantitative descriptors in Table C are intended to be used in combination with Table B to ensure the most appropriate population density band is utilised. If there is a discrepancy between the population density data and the qualitative descriptor, CASA will generally use the qualitative assessment to determine the appropriate operational scenario in Table B – Alternate Intrinsic Ground Risk Class (GRC) Determination.

RPA speed and dimension mismatch

If there is a mismatch between the maximum RPA characteristic dimension and the maximum speed:

- where the mismatch is in directly adjacent columns, applicants should select and use the higher value of either column.
- where the mismatch is not in directly adjacent columns, applicants should select and use:
  - the higher value of either column, or
  - provide substantiation for the reduced critical area and the selected column.

Note: where a critical area reduction claim is made, substantiation of the claim should generally be aligned to JARUS document SORA 2.5 Annex F[1].

GRC mitigation when using alternate iGRC table

For operations using the alternate iGRC table (Table B), the following SORA ground risk tables are replaced with the revised tables included in this TMI. The revised tables must be used if the applicant wishes to claim reductions to the iGRC:

Table R1 replaces JARUS SORA Table 3 – Mitigations for Final GRC determination[2].

Table R2 replaces JARUS SORA Table 2 – Level of Integrity Assessment Criteria for Ground Risk of Non-tethered M1 Mitigations[3].

Table R3 replaces JARUS SORA Table 3 – Level of Assurance Assessment Criteria for Ground Risk of Non-tethered M1 Mitigations[4].

[1] Annex F (Theoretical Basis for Ground Risk Classification and Mitigation) to JARUS guidelines on SORA (JAR-DEL-SRM-SORA-F-2.5)
[2] Contained in JARUS document JARUS guidelines on Specific Operations Risk Assessment (JAR-DEL-WG6-D.04)
[3] Contained in Annex B to JARUS document JARUS guidelines on Specific Operations Risk Assessment (JAR-DEL-WG6-D.04)
[4] Contained in Annex B to JARUS document JARUS guidelines on Specific Operations Risk Assessment (JAR-DEL-WG6-D.04)

Table B - Alternate Intrinsic Ground Risk Class (iGRC) Determination

Intrinsic RPA Ground Risk Class					
Max RPA characteristics dimension[1]	**1 m / approx. 3 ft**	**3 m / approx. 10 ft**	**8 m / approx. 25 ft**	**20 m / approx. 65 ft**	**40 m / approx. 130 ft**
Maximum speed[2]	25 m/s	35 m/s	75 m/s	120 m/s	200 m/s
Operational scenarios					
BVLOS/ VLOS over a controlled ground area	1	1	2	3	4
VLOS over isolated environment	1	1	2	3	4
BVLOS over isolated environment	1	2	3	4	5
VLOS in scarcely populated environment	1	2	3	4	5
BVLOS in scarcely populated environment	2	3	4	5	6
VLOS in lightly populated	2	3	4	5	6
BVLOS in lightly populated environment	3	4	5	6	7
VLOS in sparsely populated environment	3	4	5	6	7
BVLOS in sparsely populated environment	4	5	6	7	8
VLOS in suburban / low density metropolitan	4	5	6	7	8
BVLOS in suburban / low density metropolitan	5	6	7	8	9
VLOS in high density metropolitan	5	6	7	8	9
BVLOS in high density metropolitan	6	7	8	9	10
VLOS over assemblies of people	7	Not part of SORA			
BVLOS over assemblies of people	8				

[1] The maximum RPA characteristic dimension should be calculated as follows:

- wingspan for fixed wing,
- blade diameter for rotorcraft,
- maximum distance between blade tips for multi-copters.

[2] The maximum speed is the maximum possible commanded airspeed of the RPA, as defined by the designer. This is not the mission specific maximum commanded airspeed of the RPA.

Note: for operations in low population density environments (including within controlled ground areas) where there is a significant disparity between the iGRC and the iGRC of the adjacent ground area, SORA step 9(c) high containment[5] will generally be required.

[5] See page 29 of JARUS document JARUS guidelines on Specific Operations Risk Assessment (JAR-DEL-WG6-D.04)

Table C - Alternate Ground Risk Class Definitions

Qualitative descriptors	Quantitative Population Value (persons per km^2)	Area Description
Controlled ground area	N/A	Areas where the only people present are active participants (if any). Active participants are persons under the full control of the remote pilot who are fully aware of the risks involved with the RPAS operation and have accepted these risks. Active participants are informed on and able to follow relevant effective emergency procedures and/or contingency plans.
Isolated environment	< 0.5	Areas such as mountains, remote deserts, and large bodies of water, which generally contain few, if any, habitable dwellings, and where it is reasonably expected that people will rarely be present.
Scarcely populated environment	< 5	Areas such as forests, deserts, and large farm parcels, with limited habitable dwellings (approximately 1 small building every square kilometre).
Lightly populated environment	< 50	Areas of small farms and residential areas with very large lot sizes (approximately 4 acres or larger).
Sparsely populated environment	< 500	Areas of homes and small businesses, with large lot sizes (approximately 1 acre or larger).
Suburban / low density metropolitan environment	< 5,000	Areas of single-family homes on small lots, low-rise apartment complexes, and low-rise commercial buildings.
High density metropolitan environment	< 50,000	Areas of mostly large multistorey buildings, generally the downtown areas of larger cities.
Assemblies of people	> 50,000	Areas where there is a large gathering of people such as professional sporting events, large concerts, etc.

Table R1 - Revised Ground Mitigation Scoring Table (replaces SORA Table 3 – Mitigations for Final GRC determination)

		Robustness		
Mitigation Sequence	**Mitigations for ground risk**	**Low/None**	**Medium**	**High**
1	M1 - Strategic mitigations for ground risk	0: None -1: Low	-2	-3
2	M2 - Effects of ground impact are reduced	0	-1	-2
3	M3 - An Emergency Response Plan (ERP) is in place, operator validated and effective	1	0	-1

Table R2 - Revised M1 Integrity Table (replaces SORA Table 2 – Level of Integrity Assessment Criteria for Ground Risk of Non-tethered M1 Mitigations)

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">Level of integrity</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td rowspan="3">M1 – Strategic Mitigations for Ground Risk</td><td>Criterion #1 (Definition of the ground risk buffer)</td><td>A ground risk buffer with at least a 1 to 1 rule[1].</td><td>Ground risk buffer takes into consideration:
Improbable[2] single malfunctions or failures (including the projection of high energy parts such as rotors and propellers) which would lead to an operation outside of the operational volume,
Meteorological conditions (e.g. wind),
RPAS latencies (e.g. latencies that affect the timely manoeuvrability of the RPA),
RPA behaviour when activating a technical containment measure,
RPA performance.</td><td>Same as Medium[3]</td></tr>
<tr><td>Comments</td><td>[1] If the RPA is planned to operate at an altitude of 150m, the ground risk buffer should be a minimum of 150m.</td><td colspan="2">[2] For the purpose of this assessment, the term “improbable” should be interpreted in a qualitative way as,
“Unlikely to occur in each RPAS during its total life but which may occur several times when considering the total operational life of a number of RPAS of this type”.
[3]The distinction between a medium and a high level of robustness for this criterion is achieved through the level of assurance.</td></tr>
<tr><td>Criterion #2 (Reduction of population at risk)</td><td>The applicant claims that the at-risk population is lowered by at least 1 iGRC population band (~90%) due to:
persons not being present at the time of the operations[4], and/or
persons in the area being adequately sheltered[5] from the RPA[6] at the time of the operations.</td><td>The applicant claims that the at-risk population is lowered by at least 2 iGRC population bands (~99%) due to:
persons not being present at the time of the operations[4], and/or
persons in the area being adequately sheltered[5] from the RPA[6] at the time of the operations.</td><td>The applicant claims that the at-risk population is lowered by at least 3 iGRC population bands (~99.9%) due to:
persons not being present at the time of the operations[4], and/or
persons in the area being adequately sheltered[5] from the RPA[6] at the time of the operations.</td></tr>
</table>

		Level of integrity		
		Low	**Medium**	**High**
	Comments	*[4] This can be done by means of:* • *An analysis or appraisal of characteristics of the location (land use that relate to the presence of people, e.g., industrial area, urban park or shopping centres) and time of day or day of the week that would influence the presence of people, e.g., weekend for industrial plants, night-time, time after opening hours of shops. of operation, AND/OR* • *Use of temporal density data (e.g., data from a supplemental data service provider) relevant for the proposed area. For higher integrity levels real time data will generally be required.* *[5] In general, it can be expected that RPA weighing less than 25 kg are not able to penetrate into buildings except in rare cases where the RPA speed or building materials are unusual (tents, glass roofs, etc). In cases where a RPA is still able to penetrate a structure, sheltering may not be fully effective, but can still offer a partial mitigation* *[6] The effectiveness of sheltering will vary based on local conditions. The applicant should demonstrate that it is reasonable to consider that the claimed percentage of non-active participants will be located within a suitable structure during the time of the operations.*		

Table R3 - Revised M1 Assurance Table (replaces SORA Table 3 – Level of Assurance Assessment Criteria for Ground Risk of Non-tethered M1 Mitigations)

		Level of Assurance		
		Low	**Medium**	**High**
M1 – Strategic Mitigations for Ground Risk	Criterion #1 (Definition of the ground risk buffer)	The applicant declares that the required level of integrity is achieved[1].	The applicant has supporting evidence to claim the required level of integrity has been achieved. This is typically done by means of testing, analysis, simulation[2], inspection, design review or through operational experience.	The claimed level of integrity is validated by a competent third party.
	Comments	*[1] Supporting evidence may or may not be available*	*[2] When simulation is used, the validity of the targeted environment used in the simulation needs to be justified.*	*N/A*
	Criterion #2 (Evaluation of people at risk)	The applicant declares that the required level of population density reduction is achieved for the time of the operations. Where sheltering is claimed: • For RPA with a maximum gross weight not greater than 25 kg, the applicant declares that the RPA is unlikely to penetrate the structures. • For RPA with maximum gross weight greater than 25 kg, the applicant provides evidence to support the claim. This is typically done by means of testing, analysis, simulation, inspection, design review or through operational experience.	The applicant has supporting evidence that the required level of population density reduction is achieved for the time of the operations. All mapping products, data sources and processes used to claim lowering the density of population at risk are accepted by the competent authority. Where sheltering is claimed to contribute to not more than 90% of the population reduction and the RPA has a maximum gross weight not greater than 25 kg, the applicant declares that the RPA is unlikely to penetrate the structure. Where sheltering is claimed to contribute to more than 90% of the population reduction, or for RPA with a maximum gross weight greater than 25 kg, the applicant provides evidence that the RPA is unlikely to penetrate the structures in the operating area. This is typically done by means of testing, analysis, simulation, inspection, design review or through operational experience.	Same as Medium