



Australia's National  
Science Agency

Inyarrimanha Ilgari Bundara  
The CSIRO Murchison  
Radio-astronomy  
Observatory

# RFI Management Plan

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# Document control

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CSIRO acknowledges the Wajarri Yamaji as Traditional Owners and native title holders of Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory.

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# Definitions

ACMA	Australian Communications and Media Authority
ARQZWA	Australian Radio Quiet Zone WA
ASKAP	Australian SKA Pathfinder
CB	Citizens Band
EMC	Electromagnetic compatibility
SKA	Square Kilometre Array
SKAO	SKA Observatory
MWA	Murchison Widefield Array
RALI	Radiocommunications Assignment Licensing Instruction
REMP	Radio Emissions Management Plan
RFI	Radio Frequency Interference
RQZ	Radio quiet zone
UHF	Ultra-high frequency
WA	Western Australia

# Purpose of document

This document:

- States the standards to be applied for radio frequency interference (RFI) protection for radio telescopes on Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory (the Observatory).
- Describes the internal CSIRO procedure to be followed for proponents of infrastructure on, or to be installed on, the Observatory, and for visitors, to ensure compliance with RFI standards.
- Notes procedures for monitoring of radio quiet compliance across the Observatory.
- Replaces the earlier document *RFI Standards for Equipment to be deployed on the Observatory*.

## 1. Introduction

The Observatory has been established as a premier radio quiet site and hosts multiple radio astronomy instruments obtaining valuable science results. This location was selected on the basis of having low levels of harmful radio frequency interference.

In order to maintain the radio quiet environment a collection of Australian Government and WA State Government measures have been implemented to establish the Australian Radio Quiet Zone WA (ARQZWA) (**Appendix 1**). Additionally, in its role as Site Entity for the Observatory, CSIRO manages incidental and deliberate radio transmissions from telescope and other infrastructure on the Observatory to be within acceptable limits. This document outlines the internal Site Entity policies and procedures for managing incidental and deliberate radio transmissions from telescope and other infrastructure on the Observatory.

## 2. National regulations

Licensed transmitters that are covered by Australian regulations and policy (**Appendix 1**) need to be operated in a manner consistent with the Australian regulations and policy. This applies to radio astronomy users as well as the general community; everyone needs to comply with these national rules.

In Australia, the Australian Communications and Media Authority (ACMA) Radiocommunications Assignment Licensing Instruction MS32 (ACMA RALI MS32) specifies levels of acceptable RFI on the Observatory, based on and extrapolated from levels defined by the International Telecommunication Union for radio astronomy. These levels, presented as a table of thresholds, are given in **Appendix 2**.

## 3. CSIRO standards

As well as the national regulations governing licensed radio frequency transmitters, the Site Entity normally requires that incidental or deliberate emissions from equipment brought on to the Observatory do not exceed the levels specified in **Appendix 2** (based on ACMA RALI MS32) at the site of an existing radio astronomy receiver. **Appendix 3** lists the defined positions of existing and planned radio astronomy receiving infrastructure on the Observatory (as at 2020) to be used in determining interference levels.

In summary, equipment used on the Observatory must not exceed the levels in **Appendix 2** at the positions in **Appendix 3**.

Alternatively, in specific cases, the Site Entity and proponents may come to operational arrangements that are mutually acceptable to minimise the RFI impact to other facilities on the Observatory.

CSIRO assumes that all new telescope infrastructure will have appropriate mechanisms for dealing with self-interference.

### 3.1. Verification of compliance

Normally, for any equipment being planned to be brought to the Observatory, the proponent must be able to demonstrate to the Site Entity that the equipment will not exceed the limits described above. For substantial equipment to be deployed on the Observatory in the vicinity of existing telescopes, electromagnetic compatibility (EMC) Control Plans, or equivalent, should be provided during the planning phase (see Section 4) to ensure that the equipment satisfies the Australian and CSIRO radio quiet requirements. For smaller scale activities, assessment of compliance may be achieved through the Radio Emissions Management Plan (REMP) process (see Section 4).

As indicated above, alternatively, the Site Entity and the proponent may come to operational arrangements that are mutually acceptable to minimise the RFI impact to facilities on the Observatory.

At any stage, if equipment or activities cannot be demonstrated, to the satisfaction of the Site Entity, to be acceptable from a radio quiet perspective, then Site Entity may, after consultation with the proponent and other telescope operators, require that such equipment not be placed on the Observatory, or be removed if it is already on the site, and that proposed activities not take place. Note that proponents may be required to demonstrate to the Site Entity that their activities will not unreasonably interfere with the operation of SKA-Low, including from a radio quiet perspective.

If mutually agreeable arrangements cannot be made between the Site Entity and the proponent within a reasonable timeframe, then CSIRO may raise the matter with the Australian Government.

### 3.2. SKA construction

It has been recognised in previous CSIRO RFI management plans for the Observatory that construction activities cannot all be compliant with radio quiet requirements, and exemptions to the standards above may apply to construction activities once the construction activity has been

approved to proceed. In particular, rules regarding the initial major construction activity for SKA-Low in Australia are outlined in the *SKAO MRO Science/SKA Construction Interferences Management Plan*, available from the SKA Observatory (SKAO).

Construction activity by other telescope proponents on site will need to be approved by the Site Entity before they can proceed and proponents may need to demonstrate to the Site Entity that the activity will not unreasonably interfere with the operation of SKA-Low, including from a radio quiet perspective.

### 3.3. Communications on site

Radio communications are required on site, both for safety and to enable essential maintenance to be carried out efficiently. During ASKAP and MWA construction and operations, the default radio communications system has been UHF Citizens Band (CB) radio and standard RFI management requirements for activities on the Observatory have governed their use (see Section 6).

However, recent information indicates that a change may be required in the future once SKA-Low is operational, because:

- The range of legal UHF radio transceivers is limited to approximately 10-15 km, so the system does not provide coverage across the Observatory
- The use of UHF radio communications may be problematic for existing telescopes on the Observatory and for SKA-Low due to:
  - The SKA-Low receivers lose sensitivity slowly as frequency increases above the designated observing range of frequencies. There is, therefore, a significant risk of UHF radio communications signals interfering with astronomy observations and damaging receivers if the UHF radios are too close.
  - Harmonics from the fundamental 477 MHz bands used by UHF CB radios that fall within the ASKAP observing band can interfere with ASKAP observations depending on location.

Further studies during SKA-Low construction on the potential impact of different communications systems on the science potential of the telescopes on site should be conducted and information provided to the Site Entity as required.

To facilitate alternative short-range communications being trialled during SKA-Low construction, WiFi at 2.4 GHz and 5.2/5.8 GHz will be allowed to be used:

- on the Observatory, including at SKA-Low construction sites, during SKA-Low construction hours (7am to 5pm) and
- in the SKA Construction Camp and the Boolardy Accommodation Facility at all times.

After five years, or upon completion of SKA-Low construction activities, at the discretion of the Site Entity the use of WiFi will be reviewed. If, after appropriate consultation, WiFi is found to cause unacceptable interference, and/or is otherwise found to be unacceptable, the Site Entity will request that WiFi not be used and that alternative communications systems be used. The Site Entity will then update this plan accordingly.

## 4. Procedure for applying for RFI assessment and approval of proposed activities and equipment

This section provides information on the process for the radio quiet compliance assessment by the Site Entity of new projects and activities (or modifications to existing projects) proposed for the Observatory. The purpose of the required assessment is to determine if the proposed activity is acceptable from the perspective of radio quiet compliance. This document only describes the approvals required from a radio quiet compliance perspective. The full approvals process, and the application form, is detailed in the *MRO Management Plan (MROSE 03)*.

It is recommended that proponents consult the Site Entity early in their planning process for further information on what approval processes may be required. No on-site activity can commence until written approval from the Site Entity has been received. Approval to conduct the proposed activity should not be assumed.

Proponents may be required to demonstrate to the Site Entity that their activities will not unreasonably interfere with the operation of SKA-Low, including from a radio quiet perspective.

The level of approval required from a radio quiet compliance perspective depends on the size, nature and potential impacts of the proposed project or activity. For activities ranging from guest tours/visits by VIPs etc to minor projects or modifications to existing projects, the Site Entity Lead, or their delegate, will be responsible for making decisions on whether projects/ activities are approved or not, usually using a REMP, as described below. For major projects (e.g., a new telescope), approval at a more senior level within CSIRO may be required and other government and regulatory approvals are likely to be required. Note that requests to conduct overflights of the Observatory (eg by drones or planes) will not usually be approved by the Site Entity.

Note that the Site Entity will require adequate time to initially assess applications for new activities for radio quiet compliance. The amount of time required for assessment may vary, at the discretion of the Site Entity, from 10-15 business days for straightforward site tours/visits, the conduct of radio astronomy projects using existing equipment, or operational or maintenance activities where the expected RFI impact is acceptably low, to at least eight weeks for major activities, and many months for major new facilities. Applicants should consult early with the Site Entity regarding the likely timescale for the RFI assessment of their proposal. If there is uncertainty about the RFI impact, contact the Site Entity for advice.

No on-site activity can commence until written approval from the Site Entity has been received. Approval to conduct the proposed activity should not be assumed.

### 4.1. Radio quiet compliance assessment procedure

The required procedure to have proposals for new projects or activities assessed for radio quiet compliance is as follows:

1. An applicant first undertakes preliminary consultation with the Site Entity for the project to be sited on the Observatory and provides the determined necessary information for an initial



assessment of the suitability of the project to be made. Further information is provided in the *MRO Management Plan* (MROSE-03).

2. Following Step 1, and subject to the outcome of Step 1 being to proceed with the application, the applicant submits a REMP application form (see **Appendix 4**), and/or EMC Control Plans, as appropriate and as advised by the Site Entity. Depending on the scale of a particular proposal it is possible that an ongoing communication mechanism will be established between the proponent and the Site Entity to ensure there is continuous interaction for planning and to track outstanding questions and actions. The communication mechanism may be through the Observatory Coordination Committee, managed by the Site Entity, or a separate mutually agreed mechanism may be established.
3. Application is reviewed by the Site Entity, and a decision is reached regarding approval from an RFI perspective for the activity, subject to all other requirements being satisfied (see below).
4. Applicant is notified in writing whether the proposal has approval from an RFI perspective subject to other required approvals (see below) being met. The Site Entity will advise on what other approval steps are likely to be required.
5. It is strongly recommended that applicants seek guidance early from the Site Entity on what approvals will be required for their project/activity and how to obtain these. All approvals required (Heritage, HSE, ILUA guidelines, environmental, site license or permits, etc.) must be obtained and evidence provided to CSIRO that all requirements have been met before projects can commence on the Observatory site.
6. Applicants will be notified in writing by the Site Entity, once all approvals are in place, that their project can proceed. No project activity is permitted to take place before written notification is received from the Site Entity that the project/activity is formally approved. Written communication can be via email.
7. The proponent can then proceed to make necessary arrangements for their activities, including necessary RFI inductions and ensuring that any personnel involved in visiting site are aware of the code of conduct rules for the site, including regarding radio quiet compliance.

The process described above is not required for activities to address emergency situations involving preservation of life or potential damage to property or the environment, or urgent repairs to prevent major equipment damage. Communication to the Site Entity of what occurred as soon as practicable is essential, and a summary of such activity will be required after the fact to document any impact.

## 5. Monitoring RFI compliance on the Observatory

RFI monitoring equipment will be installed on the Observatory and information obtained from the telescopes about RFI detected in observations. If a proponent's equipment is found to be emitting at above the required levels defined by the CSIRO standards above at the site of another telescope receiver, then proponents may be required to modify or remove their equipment from the Observatory.

## 6. Default RFI management operational arrangements for activities on the Observatory

The Site Entity has developed default operational arrangements for the day-to-day behaviour of staff and visitors on the Observatory to ensure that acceptable RFI standards are met, while allowing day-to-day activity to continue.

These default requirements are listed below. **Alternative operational arrangements may be agreed between proponents and the Site Entity as part of any approval process (eg via a REMP approval) for an activity to proceed. In the absence of any specific alternative arrangement approved by the Site Entity the default requirements below apply.**

Please contact the Site Entity if there are any questions about these requirements.

### 6.1. Standard requirements for RFI management

All activities on the Observatory must adhere to the following restrictions (except in the case of an emergency). The points below relate to equipment that is essential to the core activity of building, operating and maintaining radio telescopes. The use of non-essential equipment is not allowed without approval of the Site Entity.

- Use of radiocommunication equipment for communication between people on the Observatory at frequencies in the ARQZWA frequency range (70 MHz to 25.25 GHz) will be kept to an absolute minimum. This includes CB/UHF radios, and satellite phones. Whenever possible, work plans will be co-ordinated in person rather than by radio communication. After hours (5pm to 7am) and on weekends, radio use is allowed only in an emergency situation.
- All radio communication systems should be switched off (including after hours, 5pm to 7am) unless required for safety reasons or essential coordination of activities where other means are not feasible.
- Except within the approved boundaries of SKA Construction Camp and Boolardy Accommodation Facility, all equipment not part of essential telescope operations at the time should be turned off after hours (5pm to 7am).
- Mobile phones and iPads, or similar devices that have a cell/mobile phone connection, shall be switched off or left in flight mode when within the Inner 70 km zone of the ARQZWA and remain switched off, or in flight mode, at all times while within this zone. New electrical equipment that incorporates Bluetooth, WiFi or similar sub-systems should not be brought to the Observatory without approval from the Site Entity. Note that personal fitness trackers or smart watches typically include Bluetooth, and/or WiFi. Please avoid bringing such items to site, or ensure they are completely switched off.
- Permanent radio transmitting/receiving equipment should not be brought to the Observatory without approval from the Site Entity, including wireless data transport, wireless monitoring systems and remote-controlled equipment.
- Operation and/or installation of radio receiving equipment requires permission from the Site Entity. This includes, but is not limited to, satellite TV, televisions and radios.

- Arc welders, earth moving equipment, aircraft and drones are not to be used without approval from the Site Entity.
- Routine activities may use vehicles, hand-held power tools and domestic appliances intermittently as required. Within about one kilometre of telescope receivers, vehicles may cause unacceptable interference so such traffic should be kept to a minimum.
- Overflights of the Observatory (eg by planes or by drones) are not permitted without specific approval from the Observatory.
- All equipment to be used on the Observatory will comply with the Australian testing authority EMC standards. Commercially available equipment is assumed to comply with these standards unless it has been modified. Note this a minimum requirement and does not ensure that such equipment will not interfere with radio astronomy observations.

## Appendix 1 - Summary of Australian radio quiet legislation and policy

The Australian Radio Quiet Zone (WA) is implemented via a number of Australian Government and WA Government measures. The ones directly relevant to radiocommunications use are implemented under the *Radiocommunications Act 1992* (Cwlth) and are as follows:

- ACMA Radiocommunications Assignment Licensing Instruction (RALI) MS 32
  - Within the Inner restricted zone of 70 km radius from the MRO Regulatory Centre, no new licences would normally be issued.
  - In outer coordination zone up to 260 km radius, coordination with CSIRO is required to develop solutions to minimise radio frequency interference to acceptable levels.
- Radiocommunications (Mid-West Radio Quiet Zone) Frequency Band Plan 2011
  - Provides legislative framework for RALI MS32
  - Radio astronomy is primary user of spectrum within the 70 km radius zone
  - Radio astronomy is a co-primary user of spectrum within 150 km radius
  - Requires that licence applicants consult with the Site Entity (currently CSIRO) before applying for a licence.
- Spectrum licence restrictions
  - Spectrum licensed installations (eg mobile phone towers) are not permitted within a defined region of the ARQZWA.
  - Progressively introduced as licences are issued or renewed
  - Implementation varies (for historical or legal reasons) but in most cases is identical to RALI MS 32 process
- Class licence restrictions (eg consumer radio devices: WiFi, remote controls, CB radio, satellite phones, etc)
  - Conditions for class licences contain a general obligation to not cause interference to other authorised radiocommunications services (including radio astronomy).
  - Three class licences include specific reference to the radio astronomy service in the Mid-West, applying to devices within 70 km of the MRO Regulatory Centre.

As a package, these measures impose restrictions on all radio transmitters within 70 km of the MRO Regulatory Centre.

In addition, there are measures relating to mining activity, including Section 19 zones and the Radio Telescope Mineral Resource Entity Area, both under the *Mining Act 1978* (WA).

## Appendix 2 - Observatory RFI thresholds (from ACMA RALI MS 32)

FREQUENCY RANGE (MHz) <sup>1</sup>	PSD THRESHOLD (dBm/Hz)
70-100	-211
100-230	-214
230-400	-222
400-520	-224
520-694	-224
694-1000	-228
1000-2300	-230
2300-6000	-232
6000-10000	-232
10000-25250	-236

<sup>1</sup> Lower limit exclusive, upper limit inclusive.

## Appendix 3 - Positions of existing telescope receiver infrastructure

A digital file containing the positions of existing telescope receiver infrastructure is available from [research.csiro.au/mro](https://research.csiro.au/mro).

## Appendix 4 - Radio Emissions Management Plan (REMP) application form

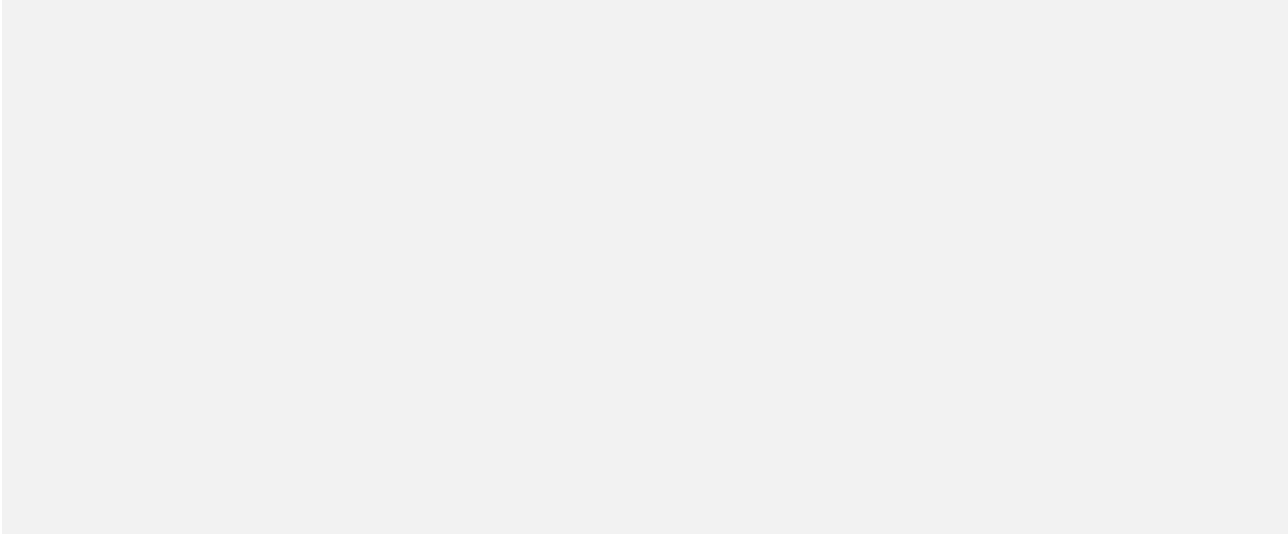
This form must be submitted as a Word document at least three weeks prior to the proposed commencement date of the activity. The Word version is available from [research.csiro.au/mro](https://research.csiro.au/mro).

REMP NUMBER (TO BE ASSIGNED BY RQZ TEAM):		
Date of submission of this REMP		
Title of proposed activity		
Name and details of PRIMARY contact responsible for proposed activity		
Name of CSIRO staff member responsible for coordination	Name: email:	Phone:
<u>Specific</u> location of proposed activity <sup>1</sup>		
Period of proposed activity	Start date:	End date:
Daily <u>weekday</u> timeframe (attach schedule if necessary)	Start time:	End time:
Daily weekend timeframe (if necessary, attach a schedule or provide details in the work description below)	Start time:	End time:
Answer Yes or No to the following questions - if Yes, please specify in the activity description field below		
1. Will any electrical equipment be permanently installed?		
2. Does this activity require access to the area circled in Figure 1 (above)?		
3. Will aircraft be used to fly in to, out of, or over the Observatory?		
4. Will welding equipment be used? (Provide details of specific days/times)		
5. Will radio equipment be used (e.g. CB/two-way radios, sat phones, remote control units, wireless devices, WiFi or Bluetooth etc.)?		
<p>Provide a brief description of the proposed activity to allow an assessment of the radio frequency interference impact. Include details in relation to questions answered 'yes' above.</p> <p>Specify all:</p> <ul style="list-style-type: none"> <li>• electrical, electronic, battery operated or communication equipment/devices</li> <li>• vehicle type</li> <li>• aircraft and drones.</li> </ul> <p>It is not necessary to explain why the activity is required or to provide other non-technical information For advice on what to include please contact: <a href="mailto:mro.emc@csiro.au">mro.emc@csiro.au</a>.</p>		

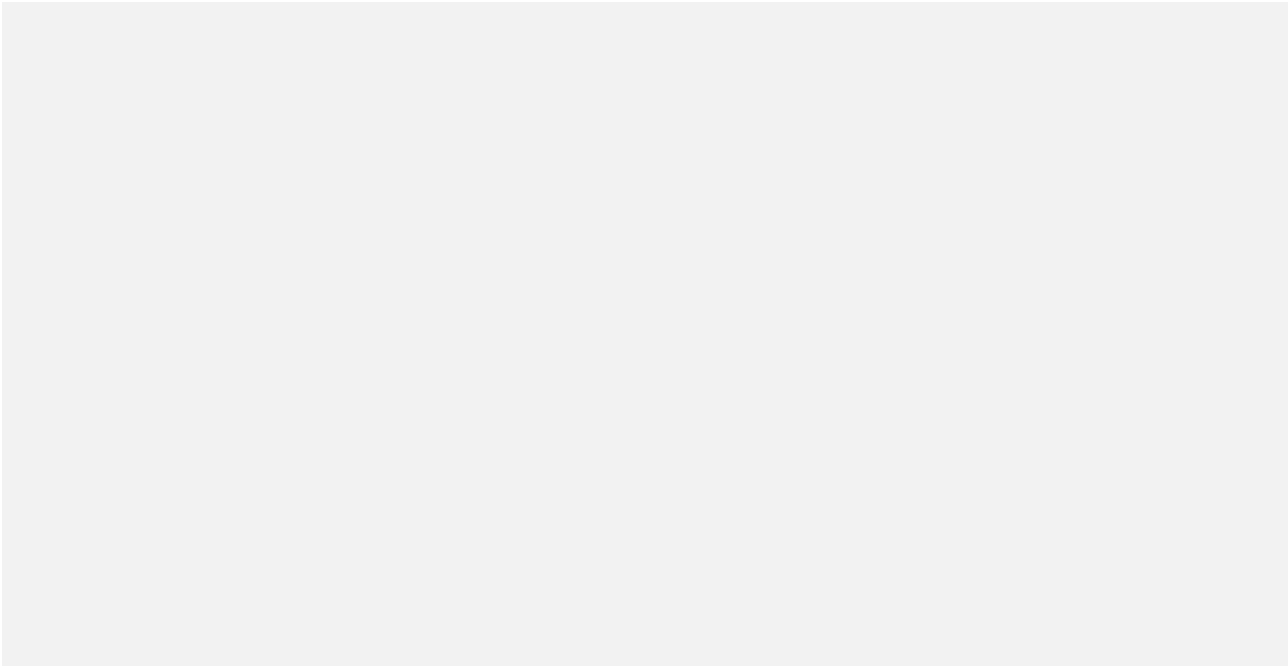
<sup>1</sup> This should either be an obvious, well-known landmark (such as the ASKAP Control Building, ASKAP Antenna 10, or Boolardy Airstrip), GPS coordinates, or a map showing the exact location in relation to the circled area or Boolardy Homestead. Vague descriptions such as 'the turkey nest' or 'Jagged tree' are not acceptable landmarks.


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**Conclusions** (including input from science teams on the impact and the RFI team assessment)



**Recommendations** (including further constraints for this work)





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