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Licensing and coordination procedures for area-wide apparatus licensed services in the 26/28 GHz bands

RALI: MS 46

DATE OF EFFECT: 28 JULY 2022

Amendment history

Date	Comments
August 2020	Initial draft covering arrangement for area-wide apparatus licences in the 26 GHz and 28 GHz bands
October 2020	Release of first version of RALI
November 2020	Minor updates including: • Removing provisions that are now replicated in the Radiocommunications Advisory Guidelines (Managing interference to Spectrum Licensed Receivers – 26 GHz band) 2020. • Clarifying the application of the area-boundary limit for dual polarised systems • Alignment of the site coordinates for the SRS earth receive stations with their applicable apparatus licences and requiring the most current version of ITU-R Recommendation SA.509 to be used. • Correction of an error in the y-axis label in Figures 2 and 3 (reference bandwidth changed from 1 MHz to 200 MHz). • Minor editorial corrections
July 2022	Updates include: • Inclusion of coordination requirements around Mingenew, WA. • Additional information on coexistence arrangements for overlapping AWLs. • Consolidation of arrangements in RALI MS38 and Embargo 79 into this RALI. • Permitting the area-boundary conditions to be exceeded when there is an active agreement with the affected licensee(s). • Permitting the use of FDR when coordinating with fixed links. • Requirement for fixed outdoor transmitters that are exempt from registration to be coordinated using RALI MS32 before operation. • Removal of surplus information that is contained in other documents and general changes to improve the understanding of the AWL technical framework and the provisions in this RALI.

Suggestions for improvements to Radiocommunications Assignment and Licensing Instruction MS 46 may be addressed to:

The Manager, Spectrum Planning Section
Australian Communications and Media Authority
PO Box 78
Belconnen ACT 2616

or by email to: freqplan@acma.gov.au.

Please notify the ACMA of any inaccuracy or ambiguity found in this RALI, so that it can be investigated and appropriate action taken.

Contents

1 Introduction 1

1.1 Purpose 1

1.2 Background 1

1.3 Scope 3

1.3.1 Definitions 3

1.3.2 Basic principles 4

1.4 Operation of technical framework 5

1.5 RALI contents and structure 7

2 Licensing 9

2.1 Overview of Licensing 9

2.2 Licence conditions 9

2.3 AWL issue process 9

2.3.1 Issuing instructions 10

2.3.2 Channel raster 11

2.3.3 Assignment priority 11

2.3.4 FSS-only licence condition 12

2.4 Coexistence arrangements and advisory notes 13

2.4.1 Coexistence with existing earth stations 13

2.4.2 Coexistence with existing apparatus licensed services 13

2.4.3 Coexistence between earth stations and receivers operating in sole-primary frequency and areas 14

2.4.4 Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs) 14

2.4.5 Coexistence with class licensed devices 15

2.4.6 Notional receiver and compatibility requirement 16

3 Coordination procedures and pre-registration requirements 18

3.1 Coexistence with AWL and spectrum licensed receivers 18

3.2 Registration of FSS earth stations 20

3.2.1 Earth station antennas 21

3.3 Coordination at the geographic boundary 22

3.3.1 Coordination at the AWL boundary 22
3.3.2 Coordination at the boundary of a 26 GHz band spectrum licence 25
3.4 Coordination requirements with space research service (SRS) earth receive stations 26
3.4.1 Coordination requirements 26
3.5 Coexistence with passive EESS 27
3.5.1 Density limits 28
3.6 Coordination with legacy point-to-point fixed links 28
3.6.1 Coordination process 29
3.6.2 Determination of co-channel or adjacent-channel configuration for earth stations 31
3.6.3 Earth station transmit power 31
3.6.4 Earth station antenna gain 32
3.7 Coordination with the Mingenew earth station protection zone 32
3.7.1 Coordination requirements for AWL transmitters near Mingenew 32
3.8 Requirements contained in other RALIs and business operating procedures (BOPs) 33

4 Exceptions 35

5 RALI Authorisation 36

Appendix A: Fallback synchronisation uplink-downlink configuration 37

Appendix B: Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs) 38

Appendix C: Examples of compliance at the geographic boundary 43

Appendix D: Protection criteria for fixed link receivers 46
D.1 Protection from AWL-authorised transmitters other than earth stations 46
D.2 Protection from AWL-authorised transmitting earth stations 48
D.3 Protection ratio correction factors 49

Appendix E: Calculating antenna off-axis angle in two dimensions 50

Appendix F: Calculating antenna off-axis angle in three dimensions 53

Appendix G: On-tune rejection 54

Appendix H: Coexistence with space-receive stations 55

1 Introduction

1.1 Purpose

The purpose of this Radiocommunications Assignment and Licensing Instruction (RALI) is to

> Outline the apparatus licence types that are permitted to be issued in the 24.7-30 GHz range

> provide information about, and describe the necessary steps for:

  > administratively issuing area-wide apparatus licences (AWLs) in the 26 GHz (24.7-27.5 GHz) and 28 GHz (27.5-30 GHz) bands (referred to collectively as the 26/28 GHz bands), and

  > the coordination of devices operated under these licences.

The information in this document reflects the ACMA's statement of current policy in relation to devices authorised under an AWL in the 26/28 GHz bands. In making decisions, accredited frequency assigners and the ACMA's officers should take all relevant factors into account and decide each case on its merits. Issues relating to this document that appear to fall outside the enunciated policy should be referred to:

The Manager, Spectrum Planning Section
Australian Communications and Media Authority
PO Box 78
Belconnen ACT 2616

or by email to: freqplan@acma.gov.au.

Some parts of this RALI are incorporated by reference into legislative instruments. The ACMA will undertake public consultation prior to making any changes to those parts.

1.2 Background

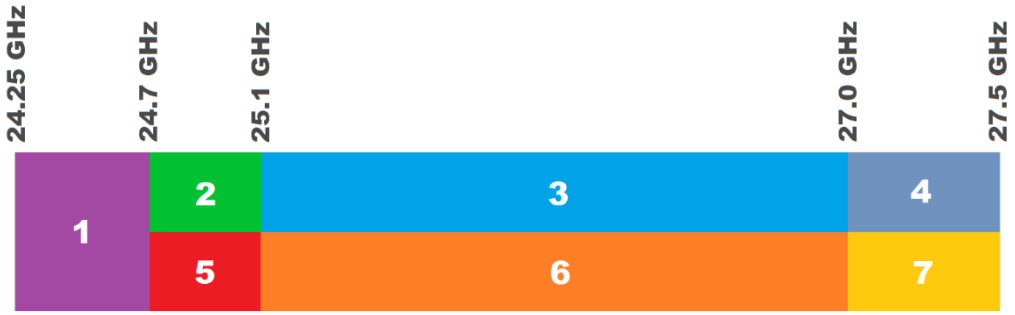
In April 2019, the ACMA released the Future use of the 26 GHz band—Planning decisions and preliminary views paper which:

> Identified the frequency range 25.1–27.5 GHz (the 26 GHz band) for spectrum licensing in 34 specified cities and regional centres.

> Identified a range of apparatus and class licensing measures to facilitate a broad range of wireless broadband use cases in the 26 GHz band.

These arrangements in the 26 GHz band are illustrated in Figure 1.

Figure 1 Licensing arrangements in 24.25-27.5 GHz



1. Class-licensing for indoor use (Australia-wide).
2. Class-licensing for indoor and outdoor use (Australia-wide).
3. Spectrum licensing in defined areas.[1]
4. Spectrum licensing with additional fixed satellite service (FSS) coexistence conditions within certain areas.
5. Area-wide apparatus licensing (AWL) - Australia-wide.
6. Area-wide apparatus licensing (AWL) - Australia-wide, except defined areas.
7. Area-wide apparatus licensing (AWL) with additional conditions to protect FSS uplinks (Australia-wide except defined areas). New FSS earth stations will also be permitted, on a first-in-time coordinated basis with apparatus licensed wireless broadband services.

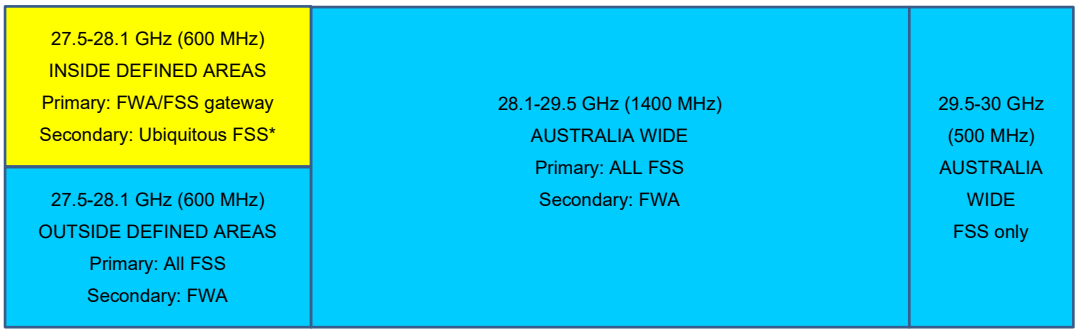
The ACMA also finalised its arrangements for area-wide apparatus licensing in the 26/28 GHz bands in October 2020, such that apparatus licences may be issued for:

- fixed and mobile wireless broadband (IMT-2020/5G) in the following frequency ranges:
  - 24.7-25.1 GHz Australia-wide,
  - 25.1-27.5 GHz outside of defined areas,
- fixed wireless access (FWA) in the following frequency ranges:
  - 27.5-28.1 GHz co-primary with coordinated FSS earth stations in the defined areas, but secondary to all FSS outside these areas,
  - 28.1-29.5 GHz on secondary basis to FSS.

Arrangements in the 28 GHz band are illustrated in Figure 2.

[1] Refer to the definition of a defined area in section 1.3.1.

Figure 2 Licensing and service arrangements in 27.5-30 MHz



*Operation of ubiquitous FSS earth stations is subject to the conditions in the Radiocommunications (Communication with Space Object) Class Licence 2015, as in force from time to time

1.3 Scope

The scope of the RALI covers the administrative allocation and coordination arrangements for AWLs in the 26/28 GHz bands. Additional information regarding the licence application process is available on the ACMA website.

Technical arrangements detailed in this RALI have been developed using information from the 26/28 GHz apparatus licence Technical Liaison Group (TLG) – TLG papers are available on the ACMA website.

1.3.1 Definitions

The following definitions apply for the purposes of this RALI:

- 'AWL receiver' means a radiocommunications receiver which is:
  - used for the reception of radio emissions from area-wide stations;
  - does not require an area-wide receive licence; and
  - is located within the area authorised by the licence under which the area-wide station is operating (therefore does not include space receive stations).
- Co-primary frequency/area means:
  - 24.7-27.5 GHz Australia wide; and
  - 27.5-28.1 GHz inside a defined area
- Sole-primary frequency/area means:
  - 27.5-28.1 GHz outside a defined area; and
  - 28.1-29.5 GHz Australia wide
- 26/28 GHz bands means the frequency range 24.7-30 GHz
- A defined area means an area specified in the relevant tables for HCIS area descriptions set out in RALI MS 26 that apply to the 25.1 to 27.5 GHz frequency range. These areas are identical to the areas subject to the *Radiocommunications (Spectrum Re-allocation—26 GHz band) Declaration 2019*.

1.3.2 Basic principles

The basic principles for issuing and operating devices under an AWL in the 26/28 GHz bands are:

- An AWL provides service-flexible and technology-flexible access to a frequency range and geographic area (its 'licence area') specified on the licence. Conditions applicable to all AWLs in the 26/28 GHz band are detailed in the Radiocommunications Licence Conditions (Area-Wide Licence) Determination 2020 (the AWL LCD),[2] as in force from time to time.
- Consistent with the Radiocommunications (Interpretation) Determination 2015, an AWL may be used to operate an area-wide service that consists of one or more area-wide stations (radiocommunications transmitters), and which may also consist of one or more area-wide receive stations (also see definition of 'AWL receiver' in section 1.3.1).
- The technical arrangements for AWLs in the 26/28 GHz bands have been designed to accommodate wireless broadband and FSS earth stations (referred to as 'earth stations' for the purposes of this RALI) – although other services may be deployed as long as devices comply with the applicable licence conditions.[3]
- For the purposes of this RALI, two types of AWLs are available for issue:
  - *Standard-AWL*: used to authorise any radiocommunications device (including both wireless broadband devices and earth stations). A defining feature of a standard-AWL is the inclusion of the advisory notes detained in section 2.4.
  - *FSS-only AWL*: used to only authorise earth stations (no other type of station is permitted). A defining feature of an FSS-only AWL is the inclusion of the 'FSS-only licence condition' detailed in section 2.3.4.
- Earth stations operated under an 26/28 GHz band AWL have primacy over AWL receivers operating in 'sole-primary frequencies/areas' (refer to definition in section 1.3.1). This arrangement operationalises the planning outcomes for the 28 GHz band as detailed in section 1.2.
- An overview of how the AWL technical framework operates is provided in section 1.4.
- An AWL is issued prior to device coordination (if required). An AWL will generally only be issued if it complies with the licensing arrangements detailed in Chapter 2 of this RALI.
- In general, a new AWL will not be issued if it would overlap with an existing AWL in both frequency and area. The exception is when the new AWL, or the existing AWL(s), is an FSS-only AWL. Arrangements for coexistence between devices operating under overlapping AWLs are detailed in Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs).
- A transmitter must not be operated under an AWL unless it complies with the AWL LCD and conditions included on individual licences, including any applicable parts of this RALI (see paragraph 5 of schedule 1 of the AWL

[2] The AWL LCD and all other legislative instruments referred to in this RALI may be accessed, free of charge, on the Federal Register of Legislation at www.legislation.gov.au.

[3] Noting that licence conditions will preclude the operation of some services in segments of the 26/28 GHz bands.

LCD), and if registration is required, is registered on the Register of Radiocommunications Licences (RRL).

> Where applicable, any necessary device coordination is to be undertaken prior to including applicable devices in the RRL – see Chapter 3.

1.4 Operation of technical framework

The technical framework for AWLs in the 26/28 GHz bands sets out the conditions and planning arrangements that allow coexistence with other services operating in and adjacent to the 26/28 GHz bands. The conditions or arrangements are contained in:

> Conditions included on individual licences

> the Radiocommunications Licence Conditions (Area-Wide Licence) Determination 2020 (AWL LCD)

> in the Radiocommunications Licence Conditions (Apparatus Licence) Determination 2015, which contains conditions for all apparatus licences

> in the policy document Radiocommunications Assignment and Licensing Instruction MS46 (RALI MS46).

The technical framework operates using the 3 steps described below:

Step 1: Determine your needs, then apply for a licence

Define the area and frequency range first:

> Unlike most other types of apparatus licences, AWLs are issued *before* device coordination. You will need to identify the area and frequency range you wish to operate in before applying for an AWL.

> Go to the ACMA's Register of Radiocommunications Licences to check if your desired geographical area(s) and frequency range(s) are available (see licence issue instructions in section 2.3.1).

> Additional spectrum and/or area may be required so that operation complies with all requirements at the frequency and area boundaries of the licence (detailed in the AWL LCD and section 3.3 of this RALI). This will make sure that enough 'spectrum space' (geographic area and bandwidth) is licensed.

Apply to the ACMA:

> Chapter 2 of this RALI contains the basic arrangements for issuing AWLs in the 26/28 GHz bands.

> See the ACMA website for further information about how to apply for an AWL.

> You should engage an Accredited Person to assist with your application.

After you apply:

> After we receive your application, we will send you an invoice for the application fee.

> After we approve your licence, we will send you an invoice for the apparatus licence tax. The licence will only be issued once the apparatus licence tax is paid.
> You may only operate a transmitter once your licence is issued (and all applicable conditions below are met).

Step 2: Coordinate and register the device

Before registration, meet the requirements in Chapter 3 of this RALI. These include:

> Coordinating with existing services – see sections 3.1, 3.4, 3.6 and 3.7 of this RALI.
> Implementing operational limitations to facilitate coexistence with other services (for example, meeting the power flux density limit at the geographic boundary of the licence, where applicable) – see sections 3.3 and 3.5 of this RALI.
> Complying with arrangements detailed in other documents to be met prior to registration – see sections 3.2 and 3.8 of this RALI.

Register the transmitter:

> Meet the requirements in Chapter 3 of this RALI before you register the transmitter.
> Engage an Accredited Person to register the device in the Register of Radiocommunications Licences.
> You must register your transmitter *before* operation, unless it is exempt. Schedule 1 Paragraph 4 of the AWL LCD shows the types of transmitters that are exempt from registration – registration-exempt transmitters still must comply with other applicable licence conditions (see Step 3).

Receivers are not required to be registered; however only registered receivers will be afforded protection. Coordination requirements before a receiver can be registered (or references to those requirements) are contained in this RALI – see Chapter 3.

Step 3: Follow the operating conditions

> **Conditions are in the AWL LCD, on the licence and in this RALI.**
> **All transmitters (including transmitters exempt from registration) must comply with conditions where applicable**, including:
    > Maximum power levels (within the licensed frequency range and in adjacent frequencies) – see paragraphs 1 and 15 of Schedule 1 of the AWL LCD.
    > Limitations of emissions above the horizon and antenna-pointing requirements in certain frequency ranges and geographic areas – see paragraph 10 of Schedule 1 of the AWL LCD.
    > Limitations of transmitters operating in certain geographic areas, and the operation of certain types of transmitters – see paragraphs 2, 3 and 11 of Schedule 1 of the AWL LCD.
    > Earth station transmitters may only be operated after ITU regulatory status checks have been completed and where minimum antenna requirements are met – see section 3.2 of this RALI.

- Some transmitters that are exempt from registration are required to be coordinated before operation see – sections 3.4 and 3.8 of this RALI.
- Obligations for licensees to help manage and resolve interference – see paragraphs 6, 7, 8, 9 and 12 of Schedule 1 of the AWL LCD.

1.5 RALI contents and structure

This RALI is structured as follows:

- Chapter 2 – details the rules when assigning a new AWL in the 26/28 GHz bands.
- Chapter 3 – details the requirements and procedures to be undertaken before a radiocommunications transmitter or receiver can be registered in the RRL.
- Appendices – contain additional supporting information.

Table 1 further expands on the rules and requirements set out in Chapters 2 and 3, and the topics contained in the appendices.

Table 1 Contents and structure of RALI MS 46

	Topic	Reference
Licence issue rules	Licence issue instructions	2.3.1
	Channel raster	2.3.2
	Assignment priority	2.3.3
	FSS-only licence condition	2.3.4
	Advisory notes on standard-AWLs	2.4
Pre-registration requirement	Coexistence with existing AWL or 26 GHz band spectrum licensed receivers	3.1
	Additional requirements before FSS earth stations can be registered	3.2
	Geographic boundary coordination	3.3
	Coordination with SRS earth stations	3.4
	Coexistence with passive EESS in 23.6-24 GHz	3.5
	Coordination with legacy point-to-point links	3.6
	Coordination with Mingenew	3.7
	Requirements in other RALIs and business operating procedures (BOPs)	3.8
Supporting appendices	Fallback-synchronisation configuration	Appendix A: Fallback synchronisation uplink-downlink configuration
	Arrangements for AWLs overlapping in both area and frequency	Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs)
	Examples of compliance at the geographic boundary	Appendix C: Examples of compliance at the geographic boundary
	Protection criteria for fixed link receivers (including supporting information)	Appendix D: Protection criteria for fixed link receivers, Appendix E: Calculating antenna off-axis angle in two dimensions, Appendix F: Calculating antenna off-axis angle in three dimensions and Appendix G: On-tune rejection
	Summary of arrangements to safeguard coexistence with space receive stations	Appendix H: Coexistence with space-receive stations

2 Licensing

This chapter provides an overview of the apparatus licensing arrangements in the 26/28 GHz band and sets out the rules for issuing AWLs. Additional information regarding the licence application process is available on the ACMA website.

2.1 Overview of Licensing

An AWL authorises the operation of radiocommunications devices within a frequency range and geographic area specified on the licence.

Only AWLs and space receive apparatus licences are to be issued in the frequency range in 25.1-27.5 GHz outside defined areas[4] or in 24.7-25.1 GHz and 27.5-30 GHz Australia wide[5]. All existing apparatus licences are permitted to continue to operate and be renewed.

Any applications for case-by-case exemptions are to be referred to the Manager, Spectrum Planning Section, ACMA for consideration.

2.2 Licence conditions

The operation of radiocommunications devices authorised by an AWL in the 26/28 GHz bands is subject to:

> Conditions specified in the *Radiocommunications Act 1992* (the Act), including an obligation to comply with the Act;

> Conditions specified in the Radiocommunications Licence Conditions (Apparatus Licence) Determination 2015 (as is force from time to time), the Radiocommunications Licence Conditions (Area-Wide Licence) Determination 2020 (as in force from time to time), and any other applicable determinations made by the ACMA under section 107(1)(f) of the Act;

> Conditions specified in the licence; and

> Conditions specified in this RALI.

2.3 AWL issue process

This section outlines the rules for administratively issuing an AWL in the 26/28 GHz bands. An AWL in the 26/28 GHz bands can be issued, subject to the rules in this section, prior to device coordination requirements detailed in Chapter 3.

[4] Refer to the definition of a defined area in section 1.3.1.

[5] In this context, 'Australia-wide' means areas that are part of the Australian Spectrum Map Grid (ASMG) – available on the ACMA website.

2.3.1 Issuing instructions

The ACMA's standard operational practice is to consider an application for the issue of an AWL in the 26/28 GHz bands in accordance with the following instructions:

- An AWL can be issued to authorise access:
  - In any area within the ranges 24.7-25.1 GHz and 27.5-30 GHz[6]
  - In the range 25.1-27.5 GHz outside of a defined area.
- Standard-AWLs may only be issued in the frequency range 24.7-29.5 GHz
- FSS-only AWLs may only be issued in the frequency range 27-30 GHz.
- The upper and lower frequency limits authorised by the licence must align with the channel raster in section 2.3.2, except for FSS-only AWLs which will authorise operation only in sole-primary frequencies/areas or in 29.5-30 GHz.
- An AWL cannot be issued if its frequency range would overlap with the frequency range authorised by an existing AWL in the same HCIS[7] cell, except when either:
  - the proposed licence is an FSS-only AWL, or
  - the proposed licence overlaps existing AWL(s) which are all FSS-only AWLs.

  Sections 2.3.4 and 2.4.3 contain provisions related to overlapping AWLs which are included on issued AWLs. Further information about overlapping AWLs is contained in Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs).
- The geographic area authorised by an AWL will consist of only whole HCIS cells. The smallest geographic area authorised by an AWL is a single HCIS level 00 cell comprising an area of 20x15 seconds (approximately 500m x 500m).
- An AWL will not be issued if it would include frequencies in the range 25.5-27 GHz and it:
  - Contains either of the following HCIS: MW4H6 or BV2A3, or
  - Only contains one or more of the HCIS listed in Table 2.
- The allocation must comply with any Spectrum Embargo issued by the ACMA[8]

Table 2 Exclusion zones around SRS earth receive stations

[6] Only earth stations are permitted to operate in 29.5-30 GHz – see the AWL LCD.

[7] HCIS is a naming convention developed by the ACMA that applies unique 'names' to each of the cells that make up the Australian Spectrum Map Grid (ASMG) – more information is on the ACMA website.

[8] Spectrum embargos are detailed on the ACMA website.

Area name	HCIS
New Norcia	BU7K, BU7L, BU7O, BU7P, BU8E, BU8F, BU8G, BU8I, BU8J, BU8K, BU8L, BU8M, BU8N, BU8O, BU8P, BV2A, BV2B
Tidbinbilla	MW4H1, MW4H2, MW4H4, MW4H5, MW4H6, MW4H7, MW4H8, MW4D7, MW4L2

2.3.2 Channel raster

Channelling arrangements in 26/28 GHz bands provide for a total of 96 x 50 MHz channels across the frequency range 24.7-29.5 GHz. The upper and lower frequency limits of the 50 MHz channels are calculated using the following formula:

Lower frequency limit = [24.65 + n(0.05)] MHz

Upper frequency limit = [24.7 + n(0.05)] MHz

Where:

n = channel number (integer range is between 1 to 96).

A licence can be issued which authorises operation over multiple aggregated 50 MHz channels.

2.3.3 Assignment priority

The ACMA's standard operating practice will be to assign a frequency range to a licence so that the range either:

> aligns with any existing 26/28 GHz band licences held by the licensee (either apparatus or spectrum) in a directly or near-adjacent geographic area, if that frequency range is available; or

> if the licensee does not already hold licences in the 26/28 GHz bands, is the first frequency range available in the desired geographic area following the assignment priority in Table 3. Where possible, this should avoid the 25.1-27.5 GHz range unless alternative spectrum is either unavailable or unsuitable.[9]

Other than the specific measures set out in the above dot points, the frequency ranges in Table 3 have equal priority (that is, a licence may be assigned in the frequency segment of the licensee preference).

The assignment priority in Table 3 does not apply for FSS-only AWLs which authorise operation in the frequency range 27-27.5 GHz.

Table 3 Assignment priority

[9] Examples of 'unsuitable' spectrum may include spectrum in a sole-primary frequency/area or spectrum that is subject to an existing co-area AWL (which could be overlapped as detailed in section 2.3.1) that does not meet the proposed licensees required level of utility.

Frequency range (GHz)	Channel assignment direction
24.7-25.1	Descending order
25.1-27.5	Ascending order
27.5-30 (operation in 29.5-30 GHz limited to earth stations only)	Ascending order for standard-AWLs
	Descending order for FSS-only AWLs

2.3.4 FSS-only licence condition

FSS-only AWLs will contain the 'FSS-only licence condition' detailed below. FSS-only AWLs will be able to overlap, or be overlapped, in frequency and area by other AWLs (also see section 2.3.1 and Appendix B). This condition is included on all FSS-only AWLs in the 26/28 GHz bands at licence issue/renewal.[10]

(1) The licensee must not operate a radiocommunications device under this licence that is not an earth station.

(2) The licensee must not cause harmful interference to an existing or future radiocommunications receiver communicating with a transmitter operated under another area-wide licence (the other licence) which was first issued before this licence and authorises operation in a frequency range and geographic area which is also authorised by this licence, if that receiver is located within an area authorised by the other licence and is operating in the frequency range:

- *24.7-27.5 GHz; or*
- *27.5-28.1 inside an area subject to the Radiocommunications (Spectrum Re-allocation—26 GHz band) Declaration 2019.*

(3) For the purposes of (2), interference means interference from:

a. An earth station transmitter located inside the overlapped area to:
   i. a co-channel receiver located inside or outside the overlapped area; or.
   ii. an adjacent-channel receiver located inside the overlapped area.

b. An earth station transmitter located outside the overlapped area to a co-channel receiver located inside the overlapped area.

(4) 'Overlapped' area means the geographic area in which both this licence and the other licence authorise the operation of transmitters in the same frequency range.

[10] The wording of the FSS-only condition included on AWLs issued/renewed prior to the latest version of this RALI may be slightly different.

2.4 Coexistence arrangements and advisory notes

Advisory notes are used to codify the coexistence arrangements between devices in particular scenarios. This section outlines these coexistence arrangements and describes the relevant advisory notes. All advisory notes detailed in this section are included on all standard-AWLs in the 26/28 GHz bands at licence issue.[11]

2.4.1 Coexistence with existing earth stations

The potential for interference from earth stations to AWL receivers will depend on a number of factors, in particular the earth station transmit power and unwanted emission limits, geographical separation between the earth station and AWL receivers and any antenna discrimination.

Given that apparatus licensed earth stations operate at known (registered) locations, and that the interference potential will likely be limited to only short distances from the site, the onus is on other AWL licensees to ensure their devices do not receive harmful interference from existing registered earth stations. No protection will be afforded to AWL receivers from interference caused by an existing FSS earth station licensed under an AWL or a fixed earth apparatus licence (that is, where an earth station which was licensed and had its device details recorded in the RRL before the AWL receiver had its details recorded in the RRL) – the exception is when AWLs are overlapping in frequency and area, see Appendix B. Where an earth station was originally authorised using a fixed earth licence but was subsequently authorised using an AWL, the date that the earth station was first licensed would apply.

AWL licensees should take account of these arrangements and plan their services accordingly.

The following advisory note is included on standard-AWLs issued in the 26/28 GHz bands:

Coexistence with existing earth stations
A radiocommunications receiver, that is:

a) *receiving radio emissions from a radiocommunications transmitter that is operated under this licence; and*
b) *located within an area authorised by this licence;*

is not afforded protection from interference caused by an earth station operated under an apparatus licence if the details of the earth station were included in the Register of Radiocommunications Licences (RRL) before details of the receiver were included in the RRL.

2.4.2 Coexistence with existing apparatus licensed services

AWL receivers are not afforded protection from interference caused by existing apparatus-licensed transmitters. AWL licensees should take account of these arrangements and plan their services accordingly.

[11] The wording of some of the advisory notes included on AWLs issued prior to the latest version of this RALI may be slightly different.

The following advisory note is included on standard-AWLs issued in the 26/28 GHz bands:

Coexistence with existing apparatus licensed services
A radiocommunications receiver, that is:

a) *receiving radio emissions from a radiocommunications transmitter that is operated under this licence; and*
b) *located within an area authorised by this licence;*

is not afforded protection from interference caused by a radiocommunications transmitter operated under an apparatus licence which was first issued before the commencement for this licence. This provision does not apply if the transmitter is operated under an area-wide licence.

In planning deployments under this licence, the licensee should take account of existing apparatus licensed services and plan their services accordingly.

2.4.3 Coexistence between earth stations and receivers operating in sole-primary frequency and areas

AWL receivers in sole-primary frequencies/areas are secondary in relation to FSS services and will not be afforded protection from existing or future earth stations operated under either an apparatus or class licence[12]. AWL licensees should take account of this arrangement and plan their services accordingly.

The following advisory note is included on all standard-AWLs issued in the 26/28 GHz bands:

Coexistence between earth stations and receivers operating in sole-primary frequencies and areas
A radiocommunications receiver that is:

a) *receiving radio emissions from a radiocommunications transmitter that is operated under this licence; and*
b) *operating in the range 27.5-28.1 GHz and located outside the areas subject to the Radiocommunications (Spectrum Re-allocation—26 GHz band) Declaration 2019, or in the range 28.1-29.5 GHz;*

is not afforded protection from interference caused by an earth station operated under an apparatus licence or under the Radiocommunications (Communication with Space Object) Class Licence 2015, as in force from time to time.

2.4.4 Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs)

The following advisory note, included on all standard-AWLs, codifies the coexistence arrangements when a standard-AWL overlaps with an existing FSS-only AWL (also see section 2.3.1 and Appendix B).

Coexistence with transmitters operating under another AWL authorising operation in the same frequency and area

[12] The Radiocommunications (Communication with Space Object) Class Licence 2015 authorises the operation of ubiquitous FSS earth stations.

(1) A radiocommunications receiver, that is:

a) receiving radio emissions from radiocommunications transmitters that are operated under this licence; and

b) located within an area authorised by this licence;

will not be afforded protection from interference from an existing or future transmitter which is operating in the same frequency range authorised by this licence, if that transmitter is operating under another area-wide licence (the other licence) which was first issued before this licence and authorises operation in a frequency range and geographic area authorised by this licence.

(2) For the purposes of (1), interference means interference to:

- *a. A receiver located inside the overlapped area from:*
  - *a co-channel transmitter located inside or outside the overlapped area; or.*
  - *an adjacent-channel transmitter located inside the overlapped area.*
- *b. A receiver located outside the overlapped area from a co-channel transmitter located inside the overlapped area.*

(3) For the purposes of (2), 'overlapped area' means the geographic area in which both this licence and the other licence authorise the operation of transmitters in the same frequency range.

2.4.5 Coexistence with class licensed devices

Various class licensed devices currently operate in the 24.25-29.5 GHz range, including:

> Aviation security body scanning devices operating in the frequency range 24.25-30 GHz, authorised under the Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018

> Devices authorised under the Radiocommunications (Low Interference Potential Devices) Class Licence 2015 (the LIPD class licence) including:

  > Data communications transmitters operating in the frequency range 24.25-25.1 GHz

  > Radiofrequency identification transmitters operated in the frequency range 24.1-26.5 GHz

  > Radiodetermination transmitters operating in the frequency range 24.05-26.5 GHz

  > Ultra-wideband short-range vehicle radar systems operating in the range 22-26.5 GHz

The risk of interference between AWL services and class licensed systems is low; however, in the unlikely event there is interference between these services the following arrangements apply:

> LIPD class licensed devices operate on a no-interference, no-protection basis with respect to other radiocommunications devices, including AWL

services in the 26/28 GHz bands. However, it is expected that facility owners will assist in the management of interference between AWL and LIPD class licensed services which are both operating within the boundary of their property. Furthermore, AWL receivers that are located within a facility owners' premises and are operating in the range 24.7-25.1 GHz, will not be afforded protection from data communications transmitters operating under the LIPD class licence which are operating on the same frequency as the receiver and located within those premises.

> A device operated under an AWL must not cause interference to, nor is it provided protection from, a device operated under the Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018, as in force from time to time (see the AWL LCD).

Given the above, the following advisory notes are included on all standard-AWLs in the 26/28 GHz bands:

Coexistence with devices operated under the LIPD class licence
The Radiocommunications (Low Interference Potential Devices) Class Licence 2015 (the LIPD class licence) authorises the operation of data communications transmitters on controlled premises in the frequency range 24.25-25.1 GHz. Radiocommunications receivers, that are located in a controlled premises and are receiving radio emissions in the range 24.7-25.1 GHz from radiocommunications transmitters that are operated under this licence, will not be afforded protection from a data communications transmitter operating under the LIPD class licence which is operating on the same frequency and located on the same controlled premises as the receiver.

Coexistence with class licensed body scanners
Radiocommunications receivers, that are:

a) receiving radio emissions from radiocommunications transmitters that are operated under this licence; and
b) located within an area authorised by this licence;

will not be afforded protection from interference caused by a radiocommunications device operated under the Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018.

2.4.6 Notional receiver and compatibility requirement

A notional receiver and compatibility requirement is established to facilitate coordination with registered AWL receivers and to aid in the resolution of interference. Unless otherwise stated in this RALI or another document published by the ACMA, AWL receivers will be afforded protection from apparatus and spectrum licensed transmitters to the level specified in the Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020 (RAG Rx), if the receiver:

> has at least the notional level of receiver performance set out in Schedule 1 of the RAG Rx; and

> was included in the RRL prior to registration of the transmitter with which compatibility is sought has its details recorded in the Register.

The following advisory note is included on all standard-AWLs in the 26/28 GHz bands:

Notional level of receiver performance
The notional receiver performance level and compatibility requirement detailed in schedules 1 and 2 of the Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020, as in force from time to time, applies for radiocommunications receivers that:

a) *are recorded in the RRL;*
b) *receive radio emissions from radiocommunications transmitters that are operated under this licence; and*
c) *are located within an area authorised by this licence.*

Compliance with these provisions is not mandatory however the ACMA will take these provisions into account in determining whether interference has occurred.

3 Coordination procedures and pre-registration requirements

This chapter details the coordination procedures and requirements which must be met before a radiocommunications transmitter or receiver can be registered in the RRL. As required by the AWL LCD, a transmitter must not be operated under a 26/28 GHz band AWL if its details are not included in the RRL, except for transmitters which are specifically exempt.

Registration exempt transmitters

Unless otherwise stated[13], transmitters that are exempt from registration are not required to be coordinated with other devices. Although these transmitters have a low risk of causing interference, licensees should use their judgement to assess transmitters that have a high potential to cause interference such as those located on high sites. In the event that interference from unregistered transmitters occurs, the AWL LCD contains a condition that transmitters exempt from registration must not cause interference to apparatus or spectrum licensed services.

Receiver coordination and registration

AWL receivers are not required to be registered before operation; however, registration of fixed receivers is encouraged as only registered receivers will be afforded protection. Receivers must comply with the coordination requirements contained (or referenced) in this RALI before registration.

Except for the requirements detailed in sections 3.1 and 3.8, there are no coordination procedures defined for the protection of AWL receivers from existing services. Prospective licensees should assess the risk of interference from existing services before deploying services – also see the advisory notes detailed in section 2.4.

3.1 Coexistence with AWL and spectrum licensed receivers

Licensees planning to deploy radiocommunications transmitters in the 26/28 GHz bands under an AWL must have regard to AWL and spectrum licensed receivers that are registered in the RRL. The only exception to this is when the planned transmitter is operated under the fixed satellite service and the subject AWL receiver is operating in a sole-primary frequency/area.

In planning for the operation of fixed transmitters under an AWL, the licensee must coordinate with any radiocommunications receivers registered in the RRL. The coordination performed must:

> use the parameters of the radiocommunications receivers as recorded in the Register;

[13] Such as the coordination requirements in sections 3.4 and 3.8.

- use the compatibility requirement set out in Schedule 2 of the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020* (RAG Rx) as in force from time to time;
- although there are no receiver performance requirements, the notional receiver performance level set out in Schedule 1 of RAG Rx is to be used for coordination purposes.
- make use of a suitable propagation model to model path loss between the fixed transmitters and radiocommunications receivers;[14]
- take into account terrain and any other relevant factors (using a 3 second digital elevation model or better); and
- consider any special conditions and/or advisory notes which are included on the relevant licences.

In the event that the above coordination indicates that interference may occur, the AWL licensees should consider:

- replanning the deployment of the fixed transmitters to avoid causing harmful interference; or
- negotiating with the licensee of the affected receiver to find a resolution.

In the event that replanning the deployment is not possible and a negotiated resolution cannot be reached:

- for transmitters other than earth stations, at both the frequency and area boundaries interference is managed in accordance with the synchronisation requirement condition included in the AWL LCD, unless other arrangements are agreed to by the affected licensees.[15]
- For earth station transmitters:
  - If the receiver is an AWL receiver and it is operating in a sole-primary frequency/area, the proposed transmitter may be registered in the RRL; or
  - For other receivers, the proposed transmitter must not be registered in the RRL

Note: For a device with an active antenna system, the radiated power in the direction of a receiver operated under another licence is defined as the sum of the gain of the antenna in the direction of the receiver (accounting for azimuth and elevation) and the Total Radiated Power (dBm). This allowance is based on the assumption that beam pointing angles and/or power can be controlled dynamically to ensure a defined level of radiated power in a specific direction is not exceeded.

[14] An example of a suitable propagation model is that set out in section 4.5.2 of ITU-R Recommendation P.526-14 *Propagation by diffraction.*

[15] Appendix A details the applicable uplink-downlink configuration to be used when the synchronisation condition in the AWL LCD has been triggered.

The above procedure does not apply to transmitters that are not required to be registered in the RRL, noting that these transmitters operate on the condition that no interference is to be caused to other services – see the AWL LCD.

This same procedure detailed above, should also be used when planning to deploy radiocommunications receivers in the 26 GHz and 28 GHz bands under an AWL.

The ACMA will take these coordination procedures into account when resolving an interference dispute.

When using the notional receiver in the RAG Rx to coordinate proposed transmitters, it may be necessary use the relative adjacent channel selectivity (ACS) and in-band blocking requirements to determine the maximum absolute interference levels. In making this conversion, a reference bandwidth of 50 MHz is to be used. For example:

> the maximum interference level within the 50 MHz adjacent to the receiver is calculated as:

minimum wanted signal level (from the RAG Rx) + ACS – Rx antenna gain in the direction of the transmitter (from the RRL)

=-85 dBm/50 MHz +21.7 dB – Rx antenna gain in the direction of the transmitter (from the RRL)

> the maximum interference level at a frequency offset of greater than 50 MHz is:

minimum wanted signal level (from the RAG Rx) + in-band blocking – antenna gain in the direction for the transmitter (from the RRL)

= -85 dBm/50 MHz + 27 dB – antenna gain in the direction for the transmitter (from the RRL)

3.2 Registration of FSS earth stations

This RALI does not cover all matters relevant to coordination and licensing for earth stations. It should be read in conjunction with other applicable documentation including earth station licensing procedures as outlined the ACMA Business Operating Procedure: Submission and processing of applications for earth, earth receive apparatus licences and device registrations under area-wide apparatus licences for fixed earth stations (the earth station BOP).

Additional coordination may be required for earth stations located near the territory of neighbouring countries (mainly applicable for sites in northern Australia due to proximity to Papua New Guinea).

An earth station must not be operated, nor its details registered in the RRL, until all relevant coordination requirements and procedures have been completed, including obtaining ACMA support to operate and register an earth station as detailed in the earth station BOP.

3.2.1 Earth station antennas

For any earth station being registered under an area-wide licence in the range 27-29.5 GHz, its antenna must have an off-axis gain (for all off-axis angles between φ_{min} and 180°) that is lower than the off-axis gain that would be calculated using Recommendation ITU-R S.1855 (for GSO) or Recommendation ITU-R S.1428 (for NGSO), for a circular antenna ($\theta = 0°$) with the same D/λ ratio.

For the purposes of this RALI, the gain of an earth station antenna in any direction is to be calculated using the information in Table 4 and the procedures defined in Appendices F and G.[16]

Table 4 Earth Station antenna parameters to be used for coordination

Satellite type	Radiation pattern envelope	Off-axis angle (Appendix F)	
		Horizontal component, θ_h	Vertical component, ε_s
GSO	Actual if known, otherwise use Recommendation ITU-R S.1855	As defined for the Earth station [Notes 1, 2]	As defined for the Earth station [Notes 1, 2]
NGSO	Actual if known, otherwise use Recommendation ITU-R S.1428	$\theta_h = 0°$	$\varepsilon_s = \max(0, [\varepsilon_{min} - \varepsilon_h(\Theta_{S1,S2})])°$ [Note 3]

Note 1: If the longitude of the GSO satellite's orbital position is known, the azimuth and elevation angle, as seen from the earth station (i.e. the off-axis horizontal and vertical components), can be calculated according to Annex 3 to Appendix 7 of the ITU-R Radio Regulations. Note that the GSO satellite's orbital position can be determined from ITU information on the satellite network.

Note 2: If neither the azimuth and elevation angle, nor the longitude of the GSO satellite's orbital location are known, then coordination should be performed as if the earth station is communicating with an NGSO satellite.

Note 3: ε_{min} is the minimum elevation angle permitted for an earth station. Article 21.14 of the ITU-R Radio Regulations defines a minimum elevation angle of 3° for transmitting earth stations. ε_s, ε_h and $\Theta_{S1,S2}$ are all defined in Appendix F.

[16] Appendices F and G provide details on calculating the antenna off-axis angle in two and three dimensions respectively.

3.3 Coordination at the geographic boundary

3.3.1 Coordination at the AWL boundary

Co-channel interference between area-adjacent AWL services is managed through coordination at the geographic boundary (detailed in this section) and the coordination requirements detailed in section 3.1.

An AWL transmitter must not be registered in the RRL if the pfd at the boundary of the geographic area authorised by the licence, caused by the proposed transmitter, would exceed the levels detailed in Table 5. The pfd limits in Table 5 are designed to provide adequate protection to user devices (which are not included in the RRL) without placing overly onerous restrictions on where base stations could be deployed.

In Table 5, the limits for transmitters in 24.7-27.5 GHz allow pfd emissions at the geographic boundary to be 8 dB higher for transmitters using an active antenna system (AAS)[17]. This provision is based on the dynamic behaviour of AAS beams when serving mobile traffic and the non-deterministic nature of the interference environment (in particular the likelihood of an AAS beam dwelling on a specific azimuth/elevation for a protracted period of time).

However, this rationale does not directly apply for transmitters above 27.5 GHz given no mobile operation is permitted (fixed user terminals will mean base station beam steering will be less dynamic even when AAS are employed). That said, given the expected deployment of NGSO and FWA (base stations) which will have some time variance in terms of antenna steering (albeit less dynamic than a mobile scenario), it has been determined that specifying a percentage of time that the pfd limit can be exceeded for will provide a more balanced approach for these types of transmitters.

The limits in Table 5 only need to be met at the licence area boundary, higher pfd levels beyond the boundary can be ignored. Further examples are contained in Appendix C. The limits in Table 5 apply at all frequencies authorised by the licence.

Table 5 Pfd limits at the geographic boundary

Transmitter operating range[18]	**pfd limit (dBW/m²/MHz measured at a height of 5 metres above the ground)**
24.7-27.5 GHz	For transmitters incorporating an active antenna system: -83
	For transmitters without an active antenna system: -91

[17] An active antenna system refers to an antenna system where the amplitude and/or phase between antenna elements is continually adjusted resulting in an antenna pattern that varies in response to short term changes in the radio environment.

[18] Transmitters which operate across the 27.5 GHz boundary must comply with the specified limits in both frequency ranges.

27.5-29.5 GHz	-91, not to be exceeded for more than 5% of time within a 24-hour window

The pfd limits in Table 5 do not apply:

> In the range 25.1-27.5 GHz and at parts of the geographic boundary authorised by the AWL which are directly adjacent to the geographic areas listed in the Radiocommunications (Spectrum Re-allocation—26 GHz Band) Declaration 2019 (the 26 GHz reallocation declaration). See subsection 3.3.2 for coordination at the spectrum licence boundary.

> At parts of the geographic boundary authorised by the AWL which are directly adjacent to the geographic area of one or more AWLs (which also authorises operation in the frequency range of the proposed transmitter), and there is an active agreement in place with the other licensee(s). Under this exemption, the limits in Table 5 would still need to be met at the geographic boundary of the other AWL(s). This exemption would no longer apply if any relevant AWL is no longer effective in the future (e.g. they have expired or were cancelled).

> In the range 25.5-27 GHz and at parts of the geographic boundary authorised by the AWL which are directly adjacent to HCIS cells MW4H6 or BV2A3 (requirements to protect SRS earth stations in these cells are detailed in section 3.4).

> For earth station transmitters in sole-primary frequencies/areas, except at a boundary of a defined area.[19] If the pfd limit is exceeded at a defined area boundary then additional area within the defined area can be included on the licence (subject to availability).

> For emissions in the frequency range 29.5-30 GHz.[17]

Calculation of the pfd at the area boundary is not required when the distance from the proposed transmitter to the licence boundary exceeds the minimum distances shown in Figures 3 and 4, for the maximum EIRP level of the transmitter.[20]

[19] The exemption will mean that at a minimum only the single HCIS level 00 cell which contains the earth station is required to be included on the licence.

[20] The curves in Figures 3 and 4 are based on free space loss and smooth earth diffraction with a k-factor of 4/3 and both antenna heights of 200m (allowance for high located sites).

Figure 3 Minimum distance from licence boundary where the pfd limits do not need to be calculated – for distances less than 50km

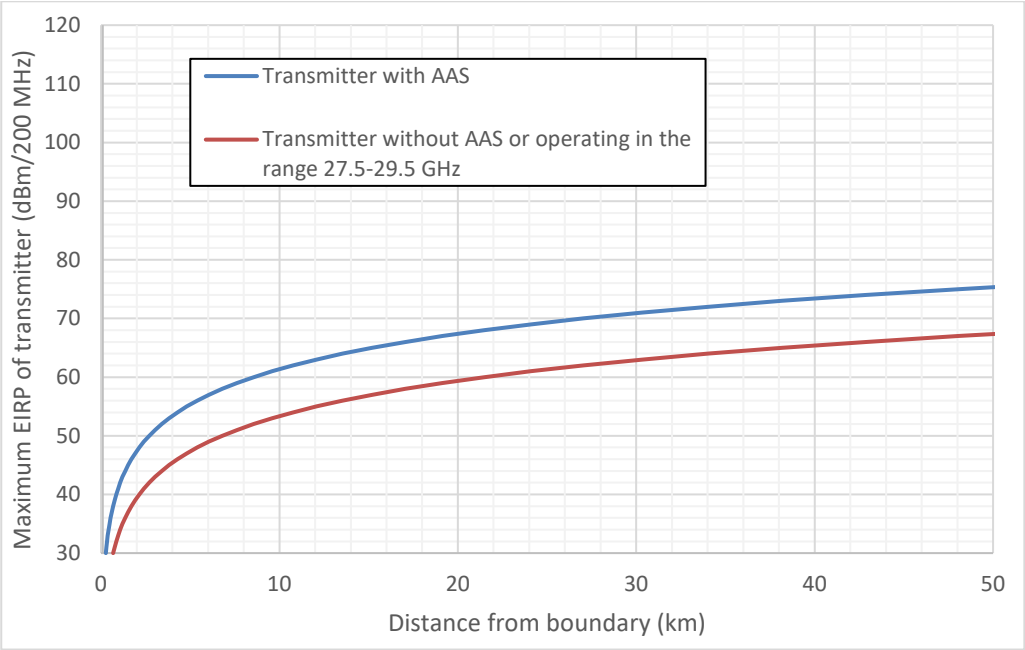
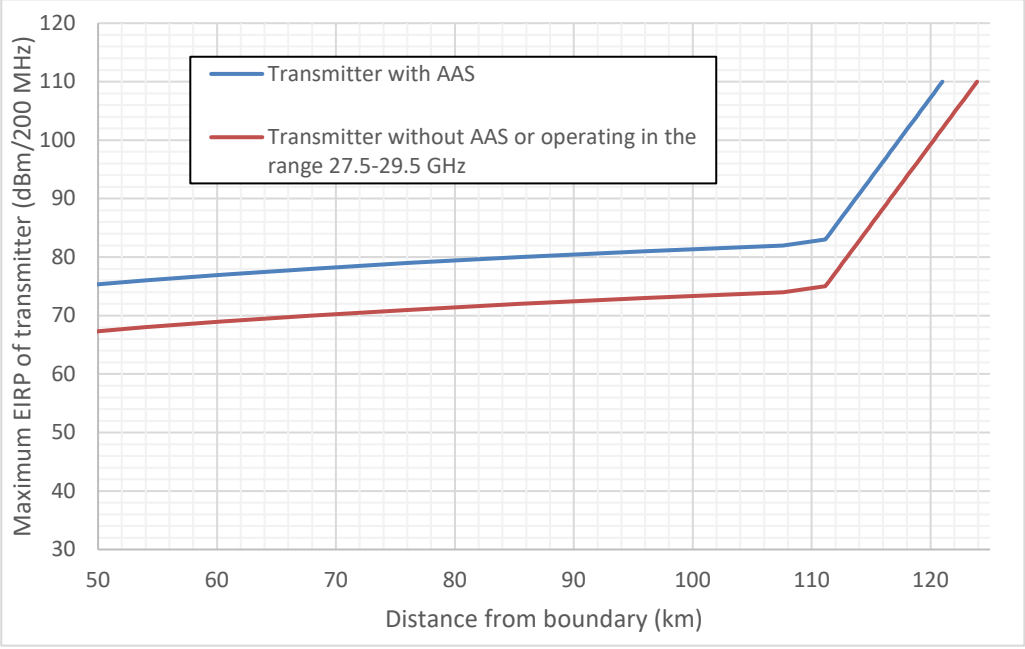


Figure 4 Minimum distance from licence boundary where the pfd limits do not need to be calculated – for distances greater than 50km



When calculating the pfd at the boundary the assigner should apply good engineering practice and consider all factors which may impact the actual pfd level for the proposed transmitter. These factors may include, but are not limited to, the following:

- Transmitter parameters including:
  - Transmission power and feeder losses
  - Antenna gain and directivity. For transmitters with an active antenna system, the radiated power at a particular bearing can be defined as the sum of the gain of the antenna in the bearing and the total radiated power. This allowance is based on the assumption that beam pointing angles and/or power can be controlled dynamically.
  - The limits in Table 5 apply to the entire radiated emission from a parabolic dish or antenna array, so for dual-polarised systems, the total power for both polarisations combined is to be used.
- Propagation losses including losses from:
  - Terrain – all modelling must use a 3 second digital elevation model or better
  - Clutter/shielding from structure/vegetation etc
  - Building penetration loss (for transmitters located indoors).

As radio waves propagate in different ways because of factors such as frequency, terrain, atmospheric conditions and topography, there are several ways to predict path loss. ITU-R Recommendation P.1144 *Guide to the application of the propagation methods of Radiocommunications Study Group 3* provides a guide on the application of various propagation methods developed internationally by the ITU-R. It advises users on the most appropriate methods for particular applications as well as the limits, required input information, and output for each of these methods. It is recommended that the most recent version of propagation models defined by the ITU-R should be used.

3.3.2 Coordination at the boundary of a 26 GHz band spectrum licence

Co-channel interference to spectrum licensed services is managed through coordination with the spectrum licensed area (detailed in this section) and the coordination requirements detailed in section 3.1.

An AWL transmitter must not be registered in the RRL if it would operate in the range 25.1-27.5 GHz and any part of the device boundary of the transmitter lies inside a geographic area subject to the 26 GHz reallocation declaration, except in situations as described in subsection 9(4) of *Radiocommunications (Unacceptable Levels of Interference — 26 GHz band) Determination 2020*, as in force from time to time.

The device boundary is to be calculated in accordance with Part 1 of Schedule 2 of *Radiocommunications (Unacceptable Levels of Interference — 26 GHz band) Determination 2020*, as in force from time to time.

The above requirement does not apply if the non-compliant part of the device boundary falls entirely within an area authorised by a spectrum licence (which

authorises operation in the frequency range of the proposed transmitter), and there is an active agreement in place with the spectrum licensee. This exception would no longer apply if any relevant spectrum licence is no longer effective in the future (e.g. they have expired or were cancelled).

3.4 Coordination requirements with space research service (SRS) earth receive stations

Earth receive stations support SRS activities in the range 25.5-27 GHz and are currently limited to space communications facilities at New Norcia, WA, and Tidbinbilla, ACT. Coexistence of AWL devices with these SRS earth receive stations is managed via:

- Exclusion zones around SRS earth receive stations where AWL transmitters in the range 25.5-27 GHz cannot be operated. These exclusion zones are included as a condition in the AWL LCD.
- A requirement that all outdoor AWL transmitters that:
  - have a TRP greater than 23 dBm per occupied bandwidth; and
  - are located within 200 km of an SRS earth receive station;

  do not exceed a defined maximum aggregate interference level at the receiver input of these SRS earth receive stations. Coordination requirements are contained in section 3.4.1.
- A policy restricting the issue of AWLs in the HCIS level 1 cells which contain these SRS earth receive stations – see section 2.3.1.

RALI MS43 contains further information on SRS earth receive stations arrangements in other bands.

3.4.1 Coordination requirements

This section details the requirements for coordinating relevant transmitters with SRS earth stations. 'Relevant transmitters' are transmitters which are operated under the licensee's 26/28 GHz AWLs that are located within 200 km of either earth station detailed in Table 6, and:

- are required to be registered in the RRL; or
- are exempt from registration under subsection 4(2)(c) of Schedule 1 of the AWL LCD.[21]

An AWL transmitter must not be registered in the RRL if the aggregate interference level of the proposed transmitter and all other relevant transmitters would exceed the limit detailed in Table 6.

A transmitter which is exempt from registration under paragraph 4(2)(c) of Schedule 1 of the AWL LCD must not be operated if the aggregate interference level of that transmitter and all other relevant transmitters exceeds the limit detailed in Table 6.

In undertaking assessments against the maximum interference level, the SRS earth station operating parameters as recorded in the RRL, in addition to those included in Table 6, are to be used. When coordinating transmitters operating

[21] Subsection 4(2)(c) of Schedule 1 of the AWL LCD applies to fixed transmitters, which are not base stations, that operate with a total radiated power in the range 23-35 dBm per occupied bandwidth

outside the range 25.5-27 GHz, the unwanted emission levels from the transmitter in the range 25.5-27 GHz should be considered.

Table 6 Additional parameters to be used in coordination

	Canberra Deep Space Communications Complex	**New Norcia Deep Space Ground Station**
Maximum co-channel aggregate interference level[22]	-156 dBW/MHz at the input of the receiver	
Propagation model	Recommendation ITU-R P.452 (as existing from time to time), using: • percent of time propagation loss not exceeded (*p)* = 0.001%[23] • a 3 second digital elevation model or better	
Location	Latitude: -35.398335°N Longitude: 148.981942°E	Latitude: -31.048236°N Longitude: 116.191514°E
Antenna pattern	The 'multiple entry interference' pattern defined in ITU-R Recommendation SA.509 (as existing from time to time)	
Minimum antenna elevation angle above horizon	Maximum of: • 6 degrees, or • the angle between the horizontal plane and the line-of-sight to the highest terrain in the direction of each relevant transmitter plus 0.5 degrees	Maximum of: • 5 degrees, or • the angle between the horizontal plane and the line-of-sight to the highest terrain in the direction of each relevant transmitter plus 0.5 degrees

3.5 Coexistence with passive EESS

Space-borne passive sensing EESS services operate in the 23.6-24 GHz band. Coexistence between AWL devices and passive EESS is managed

[22] The interference level is based on Recommendation ITU-R SA.609-2

[23] The percent of time is from Recommendation ITU-R SA.609-2 for manned missions.

through imposing additional measures to limit aggregate unwanted emission levels into the frequency range 23.6-24 GHz. These measures are:

> Placing more restrictive limits on unwanted emission in the frequency range 23.6-24 GHz from AWL devices operating in the range 24.7-27.5 GHz (other than earth stations). Unwanted emission limits are detailed in the AWL LCD, and

> Mandating density limits for AWL base stations operating in the range 24.7-25.1 GHz – density limits are described in section 3.5.1.

3.5.1 Density limits

Table 7 provides the maximum number of transmitters in the range 24.7-25.1 GHz (which are required to be registered in the RRL) which can be deployed within a 9km radius. An AWL transmitter must not be registered in the RRL if it would operate in the range 24.7-25.1 GHz and the number of existing AWL transmitters in the RRL is equal to or exceeds the limit in Table 7 for the operating range of the proposed transmitter.

In assessing compliance with Table 7, a transmitter (either existing or proposed) with emissions overlapping more than one frequency segment in Table 7 is to be counted as a service in each of the overlapping frequency ranges. There is no deployment limit in the frequency range 25.1-30 GHz.

Table 7 Deployment limits for AWL transmitters (which are required to be registered in the RRL) in the frequency range 24.7–25.1 GHz

Wireless broadband operating frequency range	Maximum number of AWLs transmitters (which are required to be registered in the RRL) within a 9km radius
24.7–24.9 GHz	44
24.9–25.1 GHz	44

3.6 Coordination with legacy point-to-point fixed links

This section outlines the requirements for coordinating AWL transmitters with legacy point-to-point links.[24] No new point-to-point links are to be permitted in the 28 GHz band.[25] Legacy point-to-point services will be able to continue to operate for a minimum of 7 years from September 2019, with a possibility of continued operation beyond this timeframe (subject to further review).[26] During this time, AWL services will need to coexist with existing point-to-point services.

Interference from a proposed AWL transmitter into a fixed link receiver is assessed using the steps described in section 3.6.1. An AWL transmitter must

[24] Coordination arrangements for earth stations are identical to those previously contained in RALI MS38 which has now been suppressed.

[25] Also see Appendix 1 of RALI FX 3.

[26] See Future use of the 28 GHz band – Planning decisions and preliminary views for more details.

not to be registered in the RRL if the relevant coordination requirements detailed in this section are not met.

AWL receivers will not be afforded protection from interference from existing point-to-point links, therefore there is no defined procedure to assess interference from a point-to-point transmitter to an AWL receiver. A relevant advisory note is included on all standard-AWLs – see section 2.4.2. In planning deployments under an AWL, the licensee should take account of existing point-to-point transmitters and plan their services accordingly.

3.6.1 Coordination process

The coordination process calculates a wanted-to-unwanted signal level ratio at the fixed link receiver input and compares it against the relevant protection criteria in Appendix D. An appropriate propagation model[27] and a 3 second digital elevation model or better is to be used.

An AWL transmitter must not to be registered in the RRL if it fails this coordination process.

Step 1: The first step is to identify all fixed link receivers that may be affected by the operation of the proposed AWL transmitter. To identify potentially affected fixed link receivers, apply a minimum distance cull around the site of the proposed transmitter of:

> 100 km for transmitters other than earth stations
> 300 km for earth stations

A frequency cull is then applied to further reduce the number of cases requiring coordination calculations.

> For transmitters other than earth stations: Assuming a maximum transmit channel bandwidth of 400 MHz[28], all fixed links with a centre frequency within 1056 MHz of the proposed transmitter centre frequency are to be included in the detailed coordination calculations.
> For earth stations: Limit the selection of fixed service stations to those operating within 224 MHz of the upper or lower band edge of the FSS transmitter station's channel bandwidth (i.e. Δf – BWES/2 – BWFS/2 < 224 MHz—more guidance on this is provided in section 3.6.2).

Step 2: Calculate the level of wanted power at each receiver identified in step 1.

[27] Such as free space loss or ITU-R Recommendation P.526 using a k-factor of 4/3 for the wanted path, and ITU-R Recommendation P.452 under clear sky conditions for an annual time percentage of 20% or ITU-R Recommendation P.526 using a k-factor of 3. However, assigners are free to choose an alternate propagation model to be applied for a particular path, provided it is justifiable. Further guidance on propagation modelling can be found in RALI FX3.

[28] Based on the maximum channel bandwidth of 400 MHz in the current 3GPP 38-series standard.

Step 3: Calculate the level of unwanted power at each receiver identified in step 1. Two separate cases exist – unwanted levels are to be calculated for both cases):

- Case 1 – applies to AWL transmitters which are required to be registered in the RRL. Calculate the unwanted power level on the basis of the application details for the AWL transmitter, using transmit power and antenna gain (with any discrimination taken into account), the licensed fixed link receiver gain (with any discrimination taken into account), and propagation loss from an appropriate propagation model. Additional information about the transmit power and antenna gain for earth stations is in sections 3.6.3 and 3.6.4 respectively.
- Case 2 – assessment of interference potential from AWL transmitters which are not required to be in the RRL (such as user equipment). (Not applicable for the registration of earth stations).
  - If the geographical location of the transmitter in case 1 is within 20 km[29] of the fixed link receiver, coordination is deemed to fail. However, an AWL transmitter may still be registered in the RRL if it can be shown that the coverage area of the associated case 1 transmitter does not overlap the interference zone of the fixed link receiver, assuming the notional transmitter characteristics in Table 8.
  - If the fixed link receiver is located further than 20 km from the case 1 transmitter, calculate the unwanted power level at the fixed link receiver assuming a transmitter located at the same coordinates as the case 1 transmitter and operating with the notional parameters in Table 8, the licensed fixed link receiver gain (with any discrimination taken into account), and propagation loss from an appropriate propagation model.

Table 8 Notional parameters for transmitters not required to be registered in the RRL

Parameter	Value	Unit
TRP	35 (for transmitters operating in the range 24.7-27 GHz, and in the range 27-27.5 GHz in areas outside those defined in Schedule 2 of the AWL LCD 23 (for all other transmitters)	dBm/occupied bandwidth
Antenna gain	17 (in the direction of the case 1 transmitter for calculation of coverage area and in the direction of the fixed link receiver for unwanted level calculations)	dBi

[29] 20 km is considered the maximum cell radius expected to be achievable under an AWL. Should larger cells be used, AWL licensees are remined that transmitters which are not required to be registered in the RRL operate on a no interference basis as defined in the AWL LCD.

Antenna height	5	metres

Step 4: Determine the applicable protection ratio for each victim receiver identified in step 1. The required protection ratios for fixed link receivers are detailed in Appendix D.

Step 5: Compare the calculated wanted-to-unwanted ratios from steps 2 and 3 to the required protection ratio from step 4. If the required protection ratio is not met, the coordination is deemed to fail and the prospective AWL transmitter is not to be registered in the RRL.

3.6.2 Determination of co-channel or adjacent-channel configuration for earth stations

This section specifies how to determine whether the earth station transmitter and the fixed service receiver being coordinated are co-channel or adjacent-channel.

Frequency offset (Δf) is the absolute value of the difference between the centre frequencies of the earth station transmitter and the fixed service receiver being coordinated.

Co-channel:

$$0 \leq \Delta f < (BW_{ES} + BW_{FS})/2$$

First adjacent-channel:

$$(BW_{ES} + BW_{FS})/2 \leq \Delta f < [max(BW_{ES}, BW_{FS}) + (BW_{ES} + BW_{FS})/2]$$

Second adjacent-channel:

$$[max\,(BW_{ES}, BW_{FS}) + (BW_{ES} + BW_{FS})/2] \leq \Delta f < [2 \cdot max\,(BW_{ES}, BW_{FS}) + (BW_{ES} + BW_{FS})/2]$$

Third adjacent-channel and beyond:

$$\Delta f \geq [2 \cdot max\,(BW_{ES}, BW_{FS}) + (BW_{ES} + BW_{FS})/2]$$

where BW_{ES} is the channel (transponder) bandwidth of the earth station transmitter and BW_{FS} is the channel bandwidth of the fixed service receiver.

3.6.3 Earth station transmit power

The value of earth station transmit power to be used when calculating the unwanted received power at the fixed service receiver should be assumed to be the total power transmitted by the earth station. In co-channel scenarios (as

determined in section 3.6.2), the transmit power can be reduced by the on-tune rejection (*OTR*) calculated as per the procedure in Appendix G.[30]

3.6.4 Earth station antenna gain

Appendices F and G provide details on calculating the antenna off-axis angle in two and three dimensions respectively. To calculate the off-axis gain of an earth station antenna in the direction of a fixed service receiver, the information in Table 4 (in section 3.2.1) and the procedures defined in Appendices F and G of this document should be used.

3.7 Coordination with the Mingenew earth station protection zone

This section outlines the coordination requirements which support the development of space communications facilities in the general area of Mingenew, WA. These arrangements replace restrictions relevant to the 26/28 GHz bands that were previously contained in Spectrum Embargo 49.

Coordination requirements for transmitters operating in the frequency range 25.5-27 GHz are detailed in section 3.7.1. Requirements for the coordination of AWL receivers, before they can be registered, are contained in RALI MS44 (also see section 3.8).

Transmitters that are exempt from registration are not required to be coordinate as per section 3.7.1, however, the AWL LCD contains a condition that transmitters exempt from registration must not cause interference to apparatus or spectrum licensed services. This condition will apply to any interference caused to future receivers located at Mingenew.

3.7.1 Coordination requirements for AWL transmitters near Mingenew

An AWL transmitter must not be registered in the RRL if the coordination requirements defined in this section are not met.

Coordination is required for transmitters that operate in the range 25.5-27 GHz and are located within 100km of -29.046389°N, 115.343056°E. For a successful coordination of proposed transmitters, the level of co-channel interference to a notional earth receive station must not exceed the level at each point listed in Table 9. Notional earth receive station parameters to be used in coordination are also defined in Table 9.

[30] On-tune rejection does not need to be calculated for non-earth station transmitters as it has already been factored into the relevant protection ratio tables in Appendix D.

Table 9 Earth receive parameters to be used in coordination

Acceptable level of co-channel interference[31]	-156 dBW/MHz at the input of the receiver.
Propagation model	Recommendation ITU-R P.452 (as existing from time to time), using: • percent of time propagation loss not exceeded (*p)* = 0.001%[32] • a 3 second digital elevation model or better
Locations (GDA94)	1. -29.045905°N, 115.350437°E 2. -29.078611°N, 115.233333°E 3. -29.078611°N, 115.457778°E 4. -28.9°N, 115.457778°E 5. -28.9°N, 115.233333°E
Antenna gain (dBi)	76.6
Antenna pattern	The 'multiple entry interference' pattern defined in ITU-R Recommendation SA.509 (as existing from time to time)
Antenna -3dB beamwidth (°)	0.03
Minimum antenna elevation angle above horizon	5 degrees
Antenna height (m a.g.l)	19

3.8 Requirements contained in other RALIs and business operating procedures (BOPs)

This RALI does not cover all matters relevant to the coordination of AWL transmitters and receivers with other services and it should be read in conjunction with other applicable RALIs and BOPs.

[31] The interference level is based on Recommendation ITU-R SA.609-2

[32] The percent of time is from Recommendation ITU-R SA.609-2 for manned missions.

An AWL transmitter or receiver must not be registered in the RRL if it does not comply with the requirements in any other applicable RALI and BOP.

Applicable RALIs and BOPs include (but are not limited to):[33]

> RALI MS31 – Notification zones for apparatus licensed services around radio astronomy facilities.

> RALI MS32 – Coordination of apparatus licensed services within the ARQZWA. Fixed outdoor transmitters that are exempt from registrations must not be operated if they cannot be successfully coordinated according to RALI MS32.

> RALI MS44 – Frequency coordination procedures for the earth station protection zones.

> Business Operating Procedure – Submission and processing of applications for earth, earth receive apparatus licences and device registrations under area-wide apparatus licences for fixed earth stations.

> Business Operating Procedure – Restriction on earth station licensing near Alice Springs.

[33] All RALIs and BOPs are available on the ACMA website.

4 Exceptions

Exceptions to the requirements of this RALI for prospective assignments and device registrations require case-by-case consideration by the Manager, Spectrum Planning Section.

A request for exemption from the requirements of this RALI would need to be accompanied by evidence to support the request.

All requests for exemptions should be submitted to freqplan@acma.gov.au.

5 RALI Authorisation

Approved 28 July 2022

Chris Worley

Manager
Spectrum Planning Section
Spectrum Planning and Engineering Branch

Communications Infrastructure Division
Australian Communications and Media Authority

Appendix A: Fallback synchronisation uplink-downlink configuration

Spectrum licences in the 26 GHz band and the AWL LCD (for AWLs in the 26/28 GHz bands) include a synchronisation requirement which may be invoked to resolve interference if negotiation between affected parties to resolve the interference fails (also see section 3.1).[34]

There are two uplink-downlink configurations to be used when the synchronisation requirement is invoked, depending on the frequency range of operation:

- For interference between devices operating in the frequency range 24.7-27.5 GHz, or for interference across the 27.5 GHz boundary – An uplink-downlink configuration which is consistent with the FR2.120-1 UL-DL pattern described in Table A.1.3-2 of 3GPP TS 38.101-4 V15.4.0[35], where:
  - The period of the slot configuration pattern is 0.625 ms;
  - The period of a slot is 0.125 ms; and
  - There are 14 symbols within a slot.
- For interference between devices operating in the frequency range 27.5-29.5 GHz – An uplink-downlink configuration which is consistent with the FR2.120-2 UL-DL pattern described in Table A.1.3-2 of 3GPP TS 38.101-4 V15.4.0[36], where:
  - The period of the slot configuration pattern is 0.5 ms;
  - The period of a slot is 0.125 ms; and
  - There are 14 symbols within a slot

In cases of a device causing/receiving interference where both configurations above apply (for example, a device is receiving interference from two transmitters, one operating above 27.5 GHz and the other operating below 27.5 GHz), the FR2.120-1 UL-DL pattern is to be used. For example, if device 'A' is operating above 27.5 GHz and needs to resolve interference between both device 'B' which is also operating above 27.5 GHz and device 'C' which is operating below 27.5 GHz, all three devices would need to apply the <27.5 GHz fallback synchronisation frame structure, even though there is no contention between devices B and C.

The uplink-downlink configurations detailed above are incorporated by reference by 26 GHz band spectrum licences and in the AWL LCD. The ACMA will not make any amendment to the uplink-downlink configurations detailed in this section without consulting with all affected parties.

[34] The synchronisation requirement is detailed on 26 GHz band spectrum licences and in the AWL LCD.

[35] Available on the 3GPP website.

[36] Available on the 3GPP website.

Appendix B: Coexistence between AWL devices operating in the same frequency and area (overlapping AWLs)

In general, a new AWL will not be issued if it would overlap with an existing AWL in both frequency and area. This arrangement provides a degree of exclusive spectrum access to a single licensee which minimises the need for direct device-to-device coordination.

However, in some scenarios, this arrangement may act to unnecessarily restrict spectrum access to a new licensee where there is minimal or no risk of interference. For example, two earth stations can be operated on the same frequency and in the same area without causing interference between the two satellite networks (assuming international coordination has, or is being, completed – see section 3.2). Similarly, FWA networks might be able to operate with stations in proximity to transmitting earth stations, if they are sited/planned in such a way that avoids interference from the earth station (i.e. 'work around' the earth station while still providing a service).

To avoid such unnecessary restrictions, a new AWL may be issued which has a frequency and area that overlaps those of existing AWL(s) for the following scenarios:

> When the proposed licence is an FSS-only AWL – a licence condition is included on the licence which states that the licensee must not cause interference to receivers operating under the AWL being overlapped (further guidance is detailed below).

> When the proposed licence overlaps existing AWL(s) which are all FSS-only AWLs – an advisory note is included on all standard-AWLs which details that AWL receivers will be required to accept interference from transmitters operated under the AWL being overlapped (further guidance is detailed below).

This means that the ACMA will not issue two (or more) AWLs which authorise wireless broadband services and which overlap in frequency and area, owing to the increased risk of interference between co-frequency wireless broadband services in the same area.

This arrangement will:

> Allow co-frequency earth stations, which are operated by different licensees, to operate at the same location without impacting terrestrial services operated by an existing licensee.

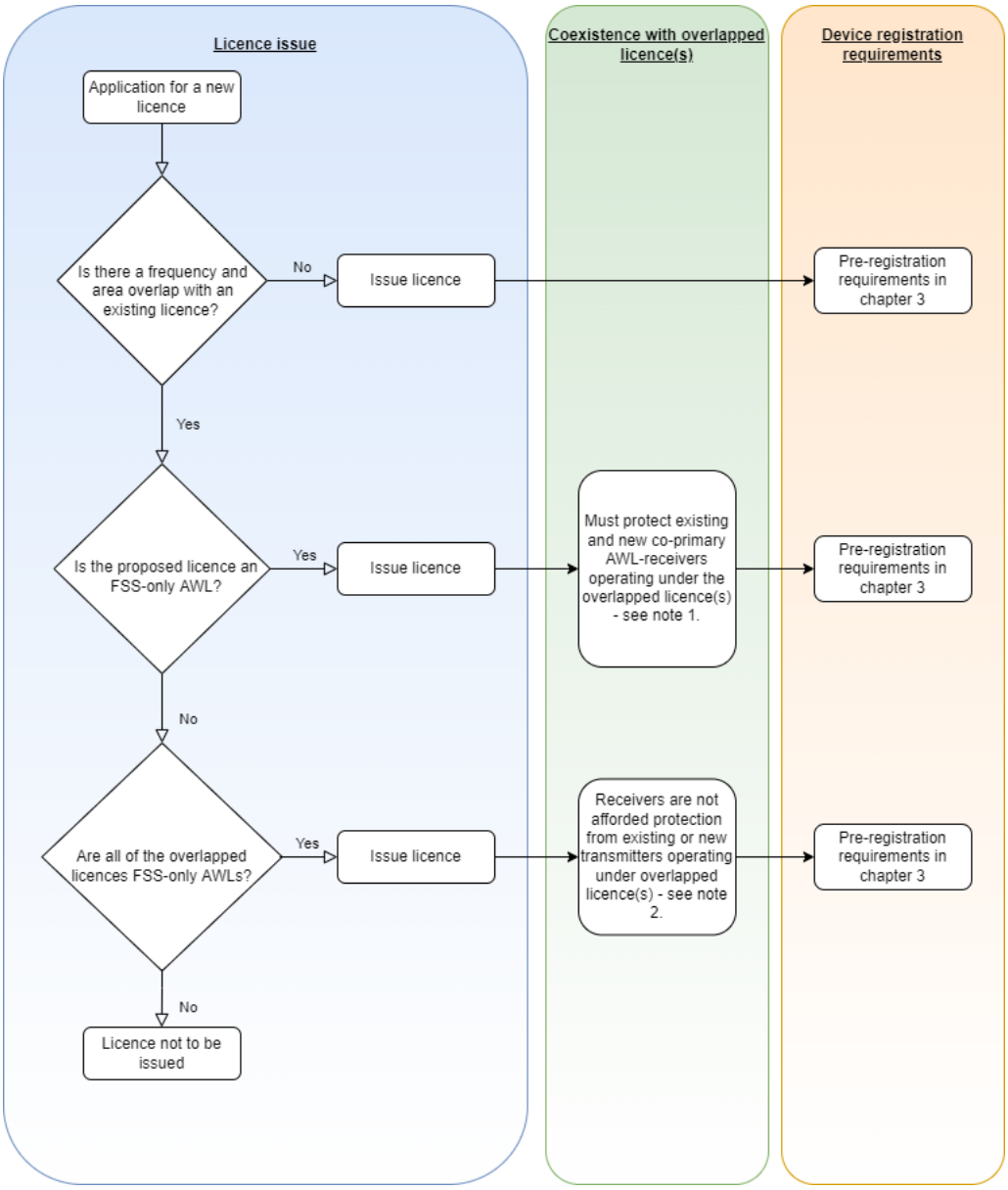
> Ensure that access to spectrum by a prospective earth station operator will not be impeded by an AWL used to operate lower-priority services.

> Allow FSS-only AWLs to be issued for a frequency range which does not comply with the channel raster, limited to AWLs that authorise operation in sole-primary frequencies/areas and in 29.5-30 GHz.

> Allow a new wireless broadband service to be deployed on a ‘best-efforts’ basis by accepting (and/or planning around) any potential interference from earth stations operating under an existing AWL which is being overlapped.

These arrangements are enacted through the licence assignment instructions in section 2.3.1 and the application of the ‘FSS-only licence condition’ and the relevant advisory note (detailed in sections 2.3.4 and 2.4.4 respectively). An overview of these arrangements is provided in Figure 5, including the notes which outline requirements for devices operating under overlapping AWL, including devices located outside of the frequency and area being overlapped.

Figure 5 Arrangements for overlapping AWL (see notes)



Note 1: The licensee of the FSS-only AWL must not cause harmful interference to existing and future AWL receivers (in a co-primary frequency/area) operating under an existing AWL which is being overlapped. This applies for interference from:

- A transmitter located inside the overlapped area[37] to:
  - A co-channel receiver located inside or outside the overlapped area.
  - An adjacent-channel receiver located inside the overlapped area
- A transmitter located outside the overlapped area to a co-channel receiver located inside the overlapped area

[37] Overlapped area means the geographic area in which both licences authorise the operation of transmitters in the same frequency range, example in Figure 6.

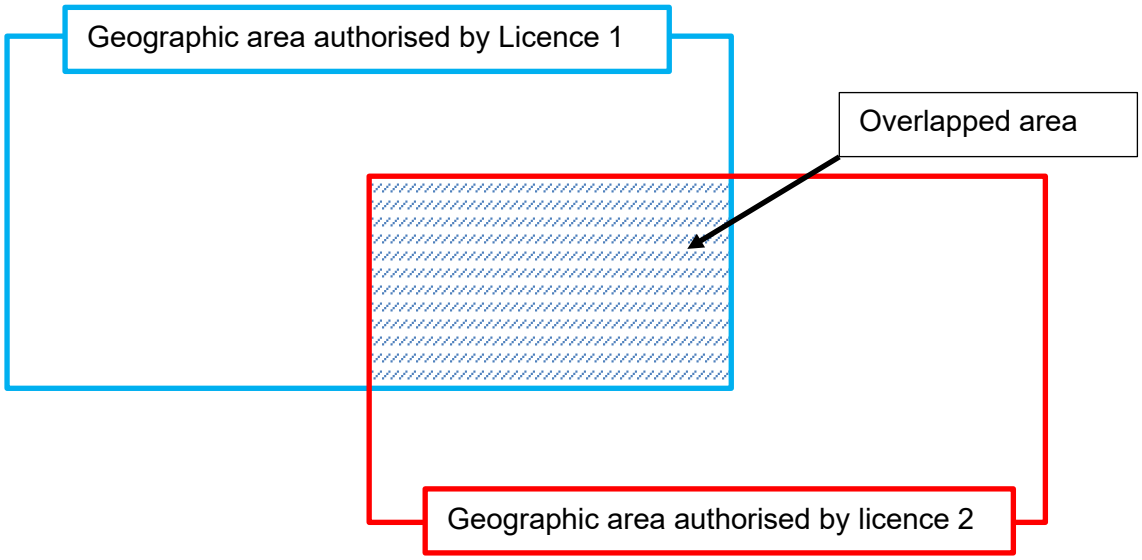
Coexistence between transmitters and receivers not listed above is managed via the first-in-time device registration process detailed in chapter 3.

Note 2: Standard-AWLs have an advisory note which states that AWL receivers communicating with transmitters operating under the licence will not be afforded protection from existing and future transmitters operating under an existing AWL which is being overlapped. This applies for interference to:

- A receiver located inside the overlapped area from:
  - A co-channel transmitter located inside or outside the overlapped area
  - An adjacent-channel transmitter located inside the overlapped area
- A receiver located outside the overlapped area from a co-channel transmitter located inside the overlapped area.

Coexistence between transmitters and receivers not listed above is managed via the first-in-time device registration process detailed in chapter 3.

Figure 6 Example of 'overlapped area'



As evident in notes 1 and 2 above, in some cases the coexistence arrangements for overlapping AWLs also applies to devices which are not located in an overlapped area. These devices have been included as some coexistence arrangements which would apply to non-overlapping AWLs, do not afford an adequate level of protection when licences are overlapped.

For example, referring to Figure 6, services operating in the overlapped area under Licence 1 are not provided adjacent-area protection (as detailed in section 3.3.1) from a transmitter which is located outside the overlapped area and operated under Licence 2 (i.e. the area-boundary requirements in section

3.3.1 apply at the boundary of Licence 2 (red) and not at the boundary of Licence 1 (blue)). Therefore, to ensure that the utility of Licence 1 is not degraded by an overlapping AWL (assuming Licence 1 was issued first), the FSS-only condition applies to co-channel transmitters located outside the overlapped area.

Appendix C: Examples of compliance at the geographic boundary

As detailed in section 3.3.1, the prescribed pfd limits in Table 5 are to be met at the boundary of the geographic area authorised by the AWL. The following figures provide examples of when a transmitter would pass or fail this criterion.

In Figure 7, the calculated pfd limit (red) from a proposed AWL transmitter is fully contained within the AWL licence area (black square), therefore this transmitter will comply with the boundary criteria.

In Figure 8, the calculated pfd limit is not exceeded at the licence boundary, therefore this transmitter would comply with the boundary criteria even though there are locations beyond the boundary where the pfd limit is exceeded.

In Figure 9, the calculated pfd level (red) exceeds the limit at the licence boundary, therefore this transmitter would not comply with the boundary criteria.

Figure 7 Example of pass (black = geographic boundary of licence, red = locations where pfd exceeds the Table 5 limits)

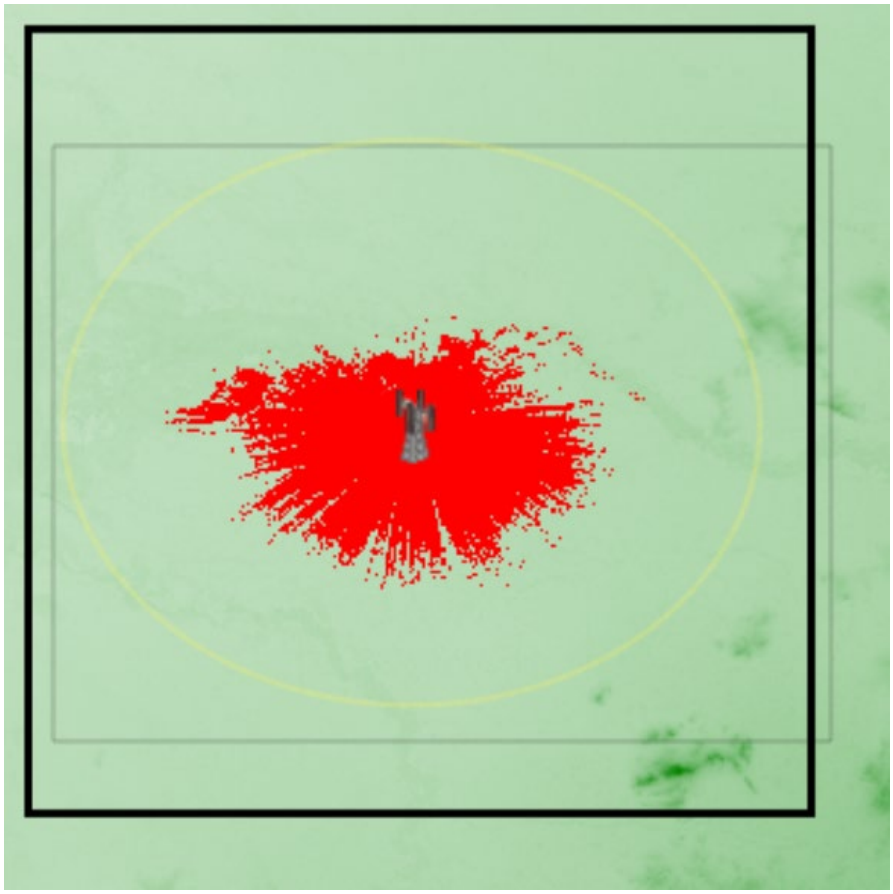


Figure 8 Example of pass (black = geographic boundary of licence, red = locations where pfd exceeds the Table 5 limits)

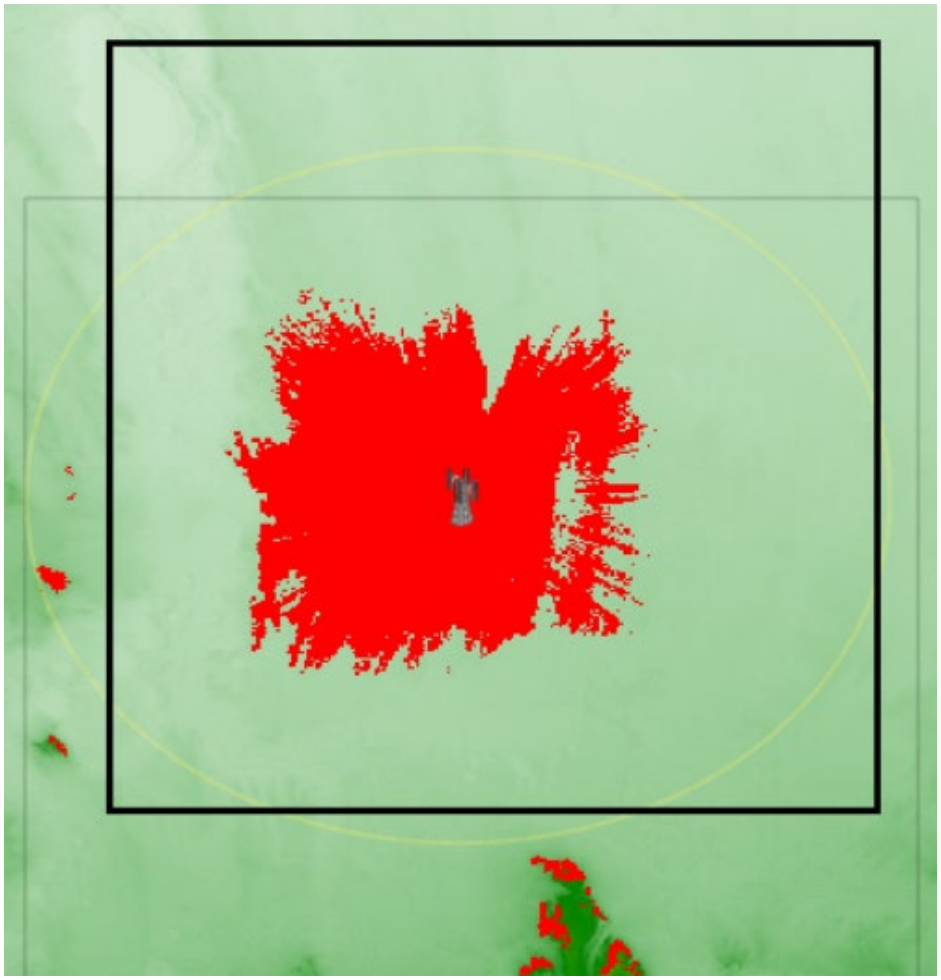
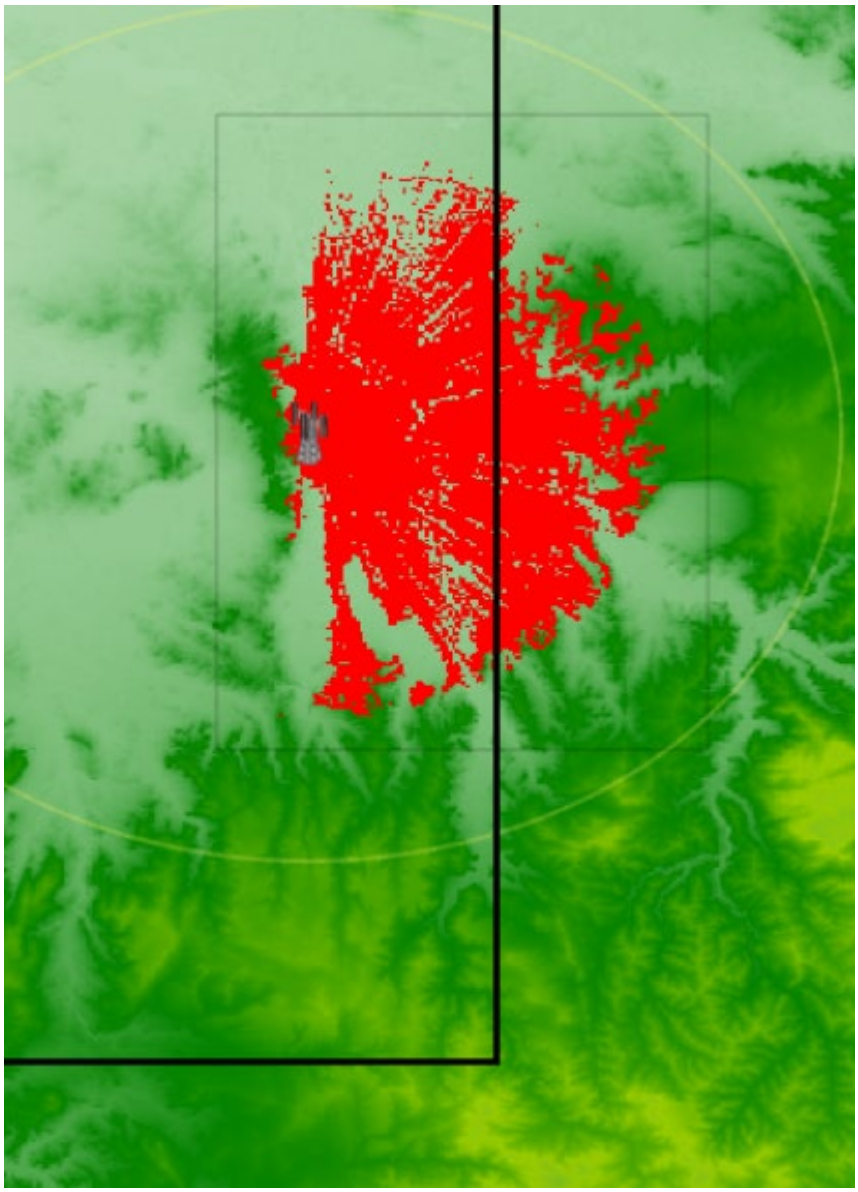


Figure 9 Example of fail (black = geographic boundary of licence, red = locations where pfd exceeds the Table 5 limits)



Appendix D: Protection criteria for fixed link receivers

This appendix outlines the protection ratios to be used when coordinating AWL transmitters with fixed link receivers. In some cases, the specified protection ratios may produce an overly conservative coordination result. In these cases, a more detailed approach may be used using engineering judgement that involves the application of equipment-specific transmitter and receiver characteristics (i.e. emission and selectivity masks) and the FDR calculation procedure.[38]

D.1 Protection from AWL-authorised transmitters other than earth stations

This section provides the protection ratios for the coordination of AWL transmitters (other than earth stations) with 28 GHz band fixed services. Protection ratios apply at frequency offsets (between the channel edge of the receiver and the edge of the transmitter's occupied bandwidth) of up to and including two-times the transmitters occupied channel bandwidth.

Table 10 Protection ratios for victim 28 MHz channel fixed link receiver and interfering AWL transmitter

Frequency offset (f_{offset}) (note 1)	BW < 100 MHz	100 MHz ≤ BW < 200 MHz	200 MHz ≤ BW < 400 MHz	BW ≥ 400 MHz
f_{offset} < 0 MHz (note 2)	62	59	56	53
0 MHz ≤ f_{offset} < BW	50	47	44	41
BW ≤ f_{offset} < 2xBW	42	39	36	33

[38] A methodology for calculating FDR is contained in Recommendation ITU-R SM.337 (https://www.itu.int/rec/R-REC-SM.337-6-200810-I/en). In the first instance, actual transmitter emission and receiver selectivity characteristics should be used. In the absence of actual receiver selectivity characteristics, there are a number of methods to derive a receiver selectivity response from an emission mask, such as that contained in ETSI TR 101 854 (http://www.etsi.org/deliver/etsi_tr/101800_101899/101854/01.03.01_60/tr_101854v010301p.pdf).

Table 11 Protection ratios for victim 56 MHz channel fixed link receiver and interfering AWL transmitter

Frequency offset (f_{offset}) (note 1)	BW < 100 MHz	100 MHz ≤ BW < 200 MHz	200 MHz ≤ BW < 400 MHz	BW ≥ 400 MHz
f_{offset} < 0 MHz (note 2)	64	62	59	56
0 MHz ≤ f_{offset} < BW	52	49	46	43
BW ≤ f_{offset} < 2xBW	44	42	39	36

Table 12 Protection ratios for victim 112 MHz channel fixed link receiver and interfering AWL transmitter

Frequency offset (f_{offset}) (note 1)	BW < 100 MHz	100 MHz ≤ BW < 200 MHz	200 MHz ≤ BW < 400 MHz	BW ≥ 400 MHz
f_{offset} < 0 MHz (note 2)	64	64	62	59
0 MHz ≤ f_{offset} < BW	52	49	47	44
BW ≤ f_{offset} < 2xBW	47	44	42	39

General notes:

1. f_{offset} is the frequency offset between the channel edge of the receiver and the edge of the transmitter's occupied bandwidth.
2. f_{offset} is less than 0 MHz when there is an overlap of the receiver channel and the occupied bandwidth of the transmitter.
3. BW is the occupied bandwidth of the AWL transmitter
4. Protection ratios are based on a 2 km path length and R (Rainfall rate in mm/hr for 0.01% of the worst month) of 40 mm/hr using Recommendation ITU-R P.530-15, section 2.4 as outlined in spectrum planning report SPP 2014/07. For other path lengths and rainfall rates refer to the appropriate path length correction factors graph in section D.3 Protection ratio correction factors.
5. Separate protection ratios for analog victims have not been defined. The above-mentioned protection ratios for digital systems shall be applied in such cases.

D.2 Protection from AWL-authorised transmitting earth stations

This section specifies the protection ratios for the coordination of earth stations with 28 GHz band fixed services. Protection ratios in Table 13 are based on a 2 km path length and R (Rainfall rate in mm/hr for 0.01% of the worst month) of 40 mm/hr using Recommendation ITU-R P.530-15, section 2.4 as outlined in spectrum planning report SPP 2014/07. For other path lengths and rainfall rates refer to the appropriate path length correction factors graph in section D.3.

Table 13 Protection ratios for victim fixed link receivers and interfering earth stations

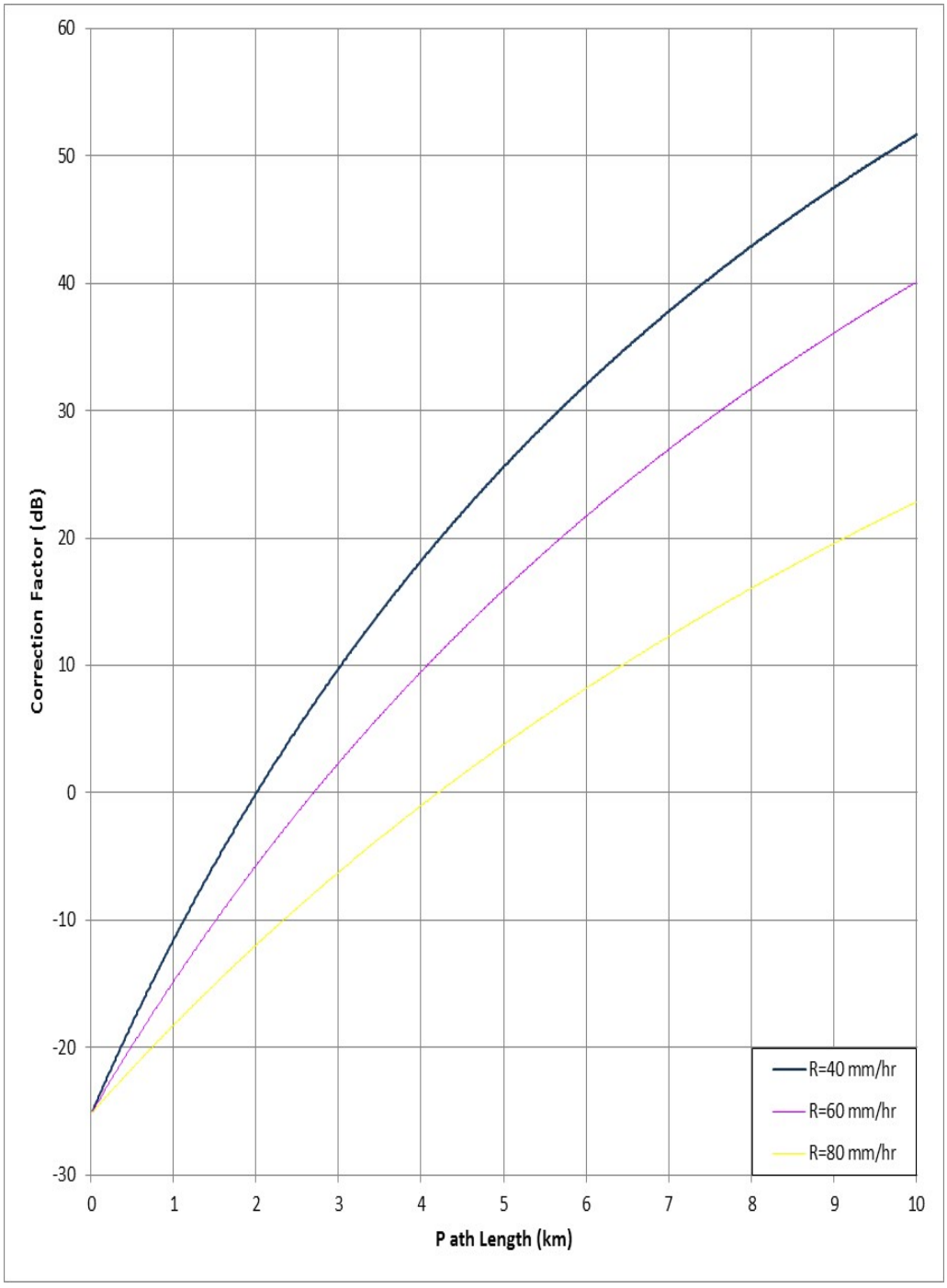
Description	Protection ratio (dB)
Co-channel overlap	65
First Adjacent-channel overlap	35
Second Adjacent-channel overlap	15
Third Adjacent-channel and beyond	No coordination required

D.3 Protection ratio correction factors

THE 28 GHz BAND (27.5 – 29.5 GHz)

PROTECTION RATIO CORRECTION FACTORS

RAIN FADE



R: Rainfall rate in mm/hr for 0.01% of the worst month.

For further details refer to Annex A to Appendix 1 of RALI FX-3.

Appendix E: Calculating antenna off-axis angle in two dimensions

The off-axis angle from an earth station's antenna boresight can be separated into its horizontal and vertical components. This appendix deals with the horizontal component only (i.e. the off-axis angle in 2-dimensions). For calculations in 3-dimensions involving the vertical component of a station's off-axis angle, also see Appendix F.

The horizontal component of the off-axis angle from Station 1 is related to the location of Station 2 relative to Station 1's antenna boresight direction (Table 14 provides definition of Station 1 and 2). The off-axis angle of Station 2 from Station 1's antenna boresight in 2-dimensions is given by the equation:

$$\theta_h = \left|\Theta_{S1} - \Theta_{S1,S2}\right| \qquad \textbf{(AE.1)}$$

where:

θ_h : Horizontal component of antenna's off-axis angle

Θ_{S1} : Station 1 azimuth (direction of Station 1's antenna relative to north, in degrees, where $0 \leq \Theta_{S1} < 360$)

$\Theta_{S1,S2}$: Azimuth of Station 2 relative to Station 1 (direction of Station 2's location from the location of Station 1, relative to north in a clockwise direction, in degrees, where $0 \leq \Theta_{S1,S2} < 360$)

Table 14 Definitions of Station 1 and Station 2 to be used in calculating θ_h.

Interference scenario	**Off-axis angle to be calculated**	
	Receive antenna off-axis angle	**Transmit antenna off-axis angle**
Earth station transmit, Terrestrial station receive	Station 1 = terrestrial station Station 2 = Earth station	Station 1 = Earth station Station 2 = terrestrial station Also see Appendix F

The resulting value of θ_h must be less than or equal to 180°. If θ_h > 180°, then θ_h must be adjusted by the following equation:

$$\theta_h = 360 - \theta_h \quad \textbf{(AE.2)}$$

The direction of Station 2 as viewed from Station 1 (great circle azimuth bearing) is given by the equation:

$$\Theta_{S1,S2} = \text{atan2}(y, x) \quad \textbf{(AE.3)}$$

atan2(y,x) is the two argument variation of the arctangent function, and is given by the equation:

$$\text{atan2}(y,x) = \begin{cases} arctan\left(\frac{y}{x}\right) & x > 0 \\ \pi + arctan\left(\frac{y}{x}\right) & y \geq 0, x < 0 \\ -\pi + arctan\left(\frac{y}{x}\right) & y < 0, x < 0 \\ \frac{\pi}{2} & y > 0, x = 0 \\ -\frac{\pi}{2} & y < 0, x = 0 \\ \text{undefined} & y = 0, x = 0 \end{cases} \quad \textbf{(AE.4)}$$

with:

$$y = cos(\varphi_2)\, sin(\lambda_2 - \lambda_1)$$
$$x = cos(\varphi_1)\, sin(\varphi_2) - sin(\varphi_1)\, cos(\varphi_2)\, cos(\lambda_2 - \lambda_1) \quad \textbf{(AE.5)}$$

where:

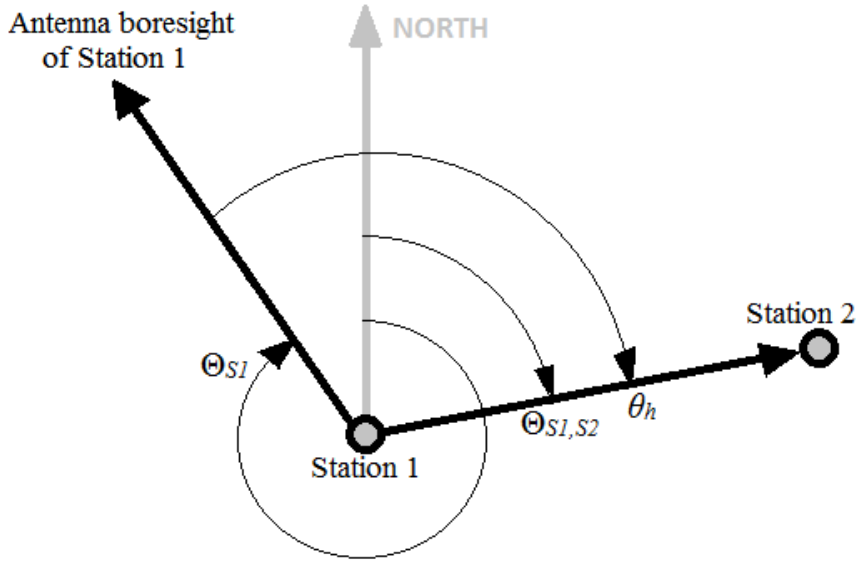
φ_1 = latitude of Station 1

λ_1 = longitude of Station 1

φ_2 = latitude of Station 2

λ_2 = longitude of Station 2

Figure 10 Diagram of azimuth angles of Station 1 and Station 2 with reference to Station 1 (denoted by Θ_{S1} and $\Theta_{S1,S2}$ respectively), and the horizontal off-axis angle of Station 2 from Station 1's antenna boresight (denoted θ_h). Note that both angles Θ_{S1} and $\Theta_{S1,S2}$ can range anywhere between 0° to 360°, this figure is just an example.



Appendix F: Calculating antenna off-axis angle in three dimensions

Once the horizontal component of an antenna off-axis angle is calculated (see Appendix E), it can be combined with the vertical component to produce the off-axis angle in 3-dimensions.

$$\varphi(\theta_{S1,S2}) = \arccos\left[\cos \varepsilon_h \left(\theta_{S1,S2}\right) \cos \varepsilon_S \cos(\theta_h) + \sin \varepsilon_h \left(\theta_{S1,S2}\right) \sin \varepsilon_S\right]$$

where:

$\theta_{S1,S2}$ is the azimuth of the interference path, relative to the Station 1's location

θ_h is the horizontal component of the antenna off-axis angle, i.e. the difference between the pointing azimuth of the Station 1, Θ_{S1}, and $\Theta_{S1,S2}$

ε_S is the vertical component of the antenna off-axis angle, or the elevation angle of Station 1

$\varepsilon_h(\theta_{S1,S2})$, if available, is the elevation angle of the horizon at azimuth $\theta_{S1,S2}$, as seen from Station 1. This potentially reduces the total 3D off-axis angle.

This formula can be used for any station where horizontal and vertical components of an off-axis angle need to be accounted for, however will generally only be relevant to earth stations for the purposes of this document.

The horizontal elevation angle should be calculated using the methods in Attachment 2 to Annex 1 to Rec. ITU-R P.452-15. If Station 1 is the transmitting station, use Θ_{td} for line-of-sight paths and $\Theta_{max} = \max(\Theta_i)$ for trans-horizon paths. If Station 1 is the receiving station, use $\Theta_{rd} = -\Theta_{td}$ for line-of-sight paths and $\Theta_r = \max(\Theta_j)$ for trans-horizon paths.

Appendix G: On-tune rejection

This section provides information on helping achieve successful coordination of an earth station by including on-tune rejection (OTR) in **co-channel** scenarios (as determined in section 3.6.2). It may be possible to reduce the power at the receiver by accounting for cases in which there is only a partial overlap of the transmitter and receiver bandwidths, which may help achieve coordination.

This means the greater the value of OTR, the lesser the value of received interference power, and improved likelihood of successful coordination.

$$OTR \approx -10\,log_{10}\left(\frac{f_{overlap}}{BW_{ES}}\right) \quad for\ f_{overlap} > 0\ MHz \qquad \textbf{(AG.1)}$$

where:

BW_{ES} : Earth station transmitter channel bandwidth (MHz)

$f_{overlap}$: frequency overlap between the transmitter and receiver channel bandwidths

If there is partial channel overlap in the frequency domain:

$f_{overlap} = BW_{FS}/2 + BW_{ES}/2 - \Delta f$

otherwise, if one channel completely overlaps the other:

$f_{overlap} = min(BW_{FS}, BW_{ES})$

Note: *OTR* should be limited to be no greater than the first adjacent-channel protection ratio in Table 13, i.e. $OTR \leq 35$ dB.

Appendix H: Coexistence with space-receive stations

This appendix provides a summary of the arrangements contained in the AWL LCD to safeguard the coexistence of AWL transmitters with space receive stations of the fixed satellite service (FSS). These arrangements are summarised here for ease of reference, however in the event of any discrepancy between this appendix and the AWL LCD, the LCD is to take precedence.

Article 5 of the ITU-R Radio Regulations prescribes allocations for various space services in the range 24.25-29.5 GHz on a co-primary basis with terrestrial services (including IMT). Domestically, FSS uplinks operate in the range 27-30 GHz.

The AWL LCD places additional licence conditions on some AWL devices to safeguard coexistence with space receive stations including FSS gateway uplinks. These conditions are summarised in Tables 15-17.

Table 15 TRP limits and additional mitigations applicable to AWL transmitters (including registration exempt transmitters (except earth stations)

Frequency/area[39]	TRP limit	Additional conditions[40]
24.7-27 GHz all areas, and 27-27.5 GHz outside both inner- and outer-footprint areas	40 dBm/200 MHz (baseline)	No extra conditions
	45 dBm/200 MHz (upper limit)	Antenna pointing restrictions* and EIRP mask (see Table 17)
27-27.5 GHz within outer-footprint areas	37 dBm/200 MHz (baseline)	No extra conditions
	42 dBm/200 MHz (upper limit)	Antenna pointing restrictions* and EIRP mask (see Table 17)
27-27.5 GHz within inner-footprint areas	25 dBm/200 MHz (baseline)	Antenna pointing restrictions**
	30 dBm/200 MHz (upper limit)	Antenna pointing restrictions* and EIRP mask (see Table 17)
27.5-29.5 GHz	25 dBm/200 MHz (baseline)	Antenna pointing restrictions***
	30 dBm/200 MHz (upper limit)	Antenna pointing restrictions* and EIRP mask (see Table 18)

* The main antenna beam is not to be mechanically or electrically steered above the horizon. This restriction applies to all outdoor transmitters.

** Outdoor base stations must not be mechanically steered above the horizon and must not direct the main beam (via electrical steering) to elevation angles greater than 5° above the horizon for more than 5% of time within a 24 hour period. Outdoor fixed transmitters, which are not base stations, must not direct their main beam to within defined angles from the geostationary orbit.

*** The main base station antenna beam is not to be mechanically or electrically steered above the horizon. Outdoor fixed transmitters, which are not base stations, must not direct their main beam to within defined angles from the geostationary orbit.

[39] HCIS descriptors for inner- and outer-footprint areas are detailed in the AWL LCD.

[40] In addition to adhering to resolves 2.1 and 2.2 of ITU-R Resolution 242 (WRC-19) for transmitters in the range 24.7-27.5 GHz.

Table 16 EIRP masks in 24.7-27.5 GHz

	Radiated maximum true mean power towards the GSO (dBm/200 MHz EIRP)			
Elevation angle above the horizontal plane (el)	**For transmitters in 24.7–27 GHz**	**For transmitters in 27–27.5 GHz and outside inner- and outer-footprints**	**For transmitters in 27–27.5 GHz and inside outer-footprints**	**For transmitters in 27–27.5 GHz and inside inner-footprints**
5 degrees ≤ el < 15 degrees	60	60	-	-
15 degrees ≤ el < 25 degrees	60	49	39	34
25 degrees ≤ el < 40 degrees	60	$= 49 - 0.43(el - 25)$	$= 39 - 0.43(el - 25)$	$= 34 - 0.43(el - 25)$
40 degrees ≤ el ≤ 90 degrees	60	42.5	32.5	27.5

Table 17 EIRP masks in 27.5-29.5 GHz

Elevation angle above the horizontal plane (el)	Radiated maximum true mean power (dBm/200 MHz EIRP)
5 degrees ≤ el < 15 degrees	$= 47 - 1.3(el - 5)$
15 degrees ≤ el < 25 degrees	34
25 degrees ≤ el < 40 degrees	$= 34 - 0.43(el - 25)$
40 degrees ≤ el ≤ 90 degrees	27.5