Development of the 3.6 GHz spectrum licence technical framework

Technical Liaison Group Consultation Paper

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# Version Control

|  |  |
| --- | --- |
| **Version** | **Comments** |
| Version 1.0 | Initial release |
| Version 1.1 | 22/3/18  Updated timeline |
| Version 2.0 | 5/4/18  New section on ECC developments  Updates to the following sections:   * STU/MCB; * Conditions on the spectrum licence – main change is the proposed adoption of TRP levels for in-band and unwanted emission levels. A synchronisation condition to manage interference is also proposed * Unacceptable levels of interference – proposed modifications to the DBC. |
| Version 2.1 | 9/4/18  Updates to the Radiocommunications Advisory Guidelines sections. This includes:   * Short term co-channel protection criteria for the protection of incumbent FSS earth stations; * P-MP coordination criteria * Flagging potential revision of RALI MS39 * Providing additional advice and guidance on managing interference from radiolocation services * Amending the blocking requirement for the notional receiver   Update to Appendix H to include additional coordination points for the Mingenew ESPZ. |

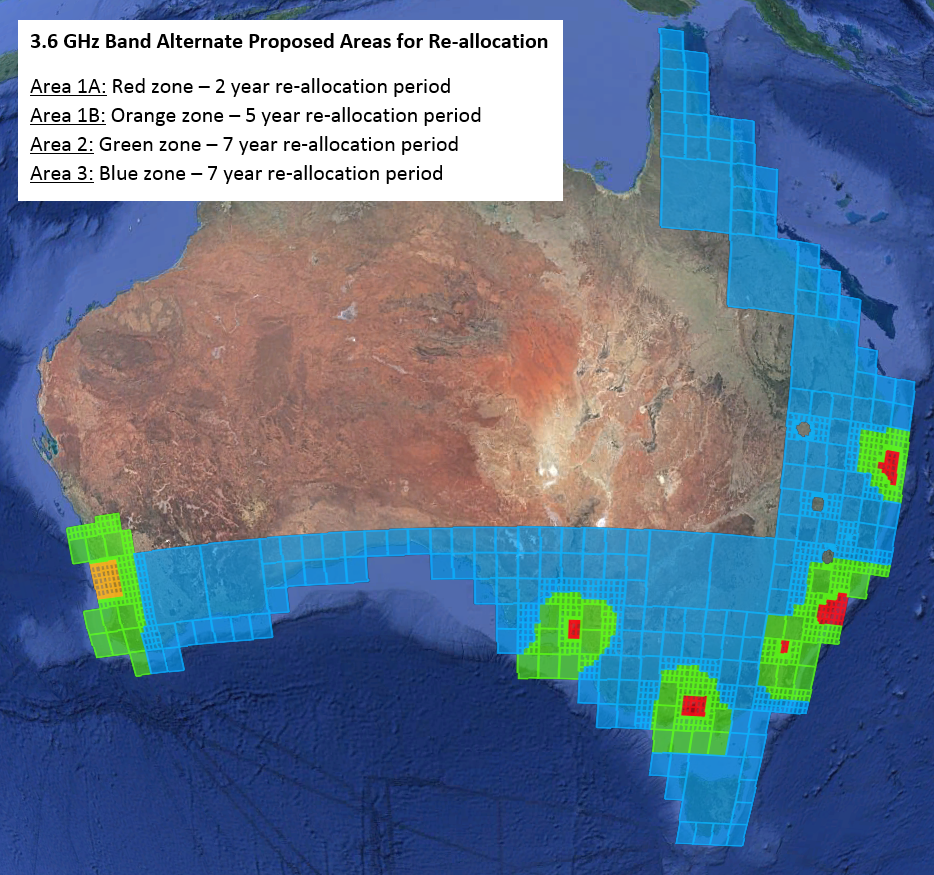
# Introduction

The Australian Communications and Media Authority (the ACMA) develops a technical framework for every band subject to spectrum licensing. Each framework is a collection of technical and regulatory conditions applicable to the use of radiocommunications devices in the spectrum-licensed band. The purpose of the technical framework is to define the technical conditions and constraints under which a device may be deployed and operated within the specified geographic area and frequency band of the licence.

Although the technical framework is optimised for technologies, or services most likely to be deployed in the band, it is intended to be technology-flexible. This means licensees can operate any type of radiocommunications device for any purpose, provided they comply with the technical framework relevant to the licence.

The frequency range 3575-3700 MHz (the 3.6 GHz band) was recently re-allocated for the issue of spectrum licences in defined regional and metropolitan areas (refer to Figure 1)[[1]](#footnote-2). The purpose of this paper is to develop a technical framework for spectrum licences issued in the 3.6 GHz band. This paper provides information and seeks comment on the proposed technical framework for spectrum licences in the 3.6 GHz band.

1. Area in the 3.6 GHz band re-allocated for the issue of spectrum licences.



## Outline

This paper has been divided into discussion on the relevant instrument that form a spectrum licence technical framework:

* Spectrum Licence:
  + Unwanted emission limits;
  + Other conditions on the licence;
* The s.145(4) determination on unacceptable levels of interference:
  + The device boundary criteria (controlling emissions across geographical boundaries);
  + Deployment constraints;
* Advisory guidelines made under s.262:
  + Managing interference from spectrum licensed transmitters to the following:
    - Point-to-point services;
    - Fixed satellite service (FSS) Earth receive stations operating in the 3400-4200 MHz band;
    - Broadband wireless access (including point-to-multipoint (P-MP) and PTS) services operating in the 3400-3700 MHz band;
    - Radiolocation services operating in the 3300-3400 MHz and 3400-3600 MHz bands;
    - Class licensed services;
    - Earth station protection zones (ESPZ);
    - Earth stations operating at the Lockheed Martin facility near Uralla, NSW
  + Managing interference to spectrum licensed receivers.

Draft versions of the spectrum licence, s.145(4) determination and advisory guidelines are provided at Appendix C-F. Where appropriate, new or draft updates to any RALIs will also be provided to the TLG for consideration. At this stage this includes:

* RALI FX19: Updates to define interference management requirements from devices deployed under a spectrum licence with apparatus licensed P-MP services operating in the 3.6 GHz band; and
* RALI [ESPZ]: Proposed new RALI managing interference to ESPZs and earth stations operating at the Lockheed Martin facility near Uralla, NSW.

## Scope

This paper is focused on developing a technical framework for the areas and frequencies covered in the Minister’s 3.6 GHz band re-allocation declarations[[2]](#footnote-3)while also taking into account existing 3.4 GHz band spectrum licences. It will not consider:

* Allocation issues (e.g. lot sizes, auction format): This will be covered in a separate consultation process.
* Defragging of the broader 3400-3700 MHz band: This would need to be considered as a separate process and could possibly be implemented by licensees via the use of trading mechanisms. However, technical conditions that would facilitate a future defragmentation of the 3400-3700 MHz band could be considered for implementation in the technical framework.

## Spectrum reform

The government is reforming the spectrum management framework within Australia. These reforms will simplify the regulatory framework and support new and innovative technologies and services. The reforms include implementing the recommendations of the government’s Spectrum Review report to:

1. Replace the current legislative arrangements with new legislation that removes prescriptive processes and streamlines licensing for a simpler and more flexible framework.
2. Better integrate the management of public sector and broadcasting spectrum to improve the consistency and integrity of the framework.
3. Review spectrum pricing to ensure consistent and transparent arrangements to support the efficient use of spectrum and secondary markets.

On 18 May 2017, the government released a [consultation package](https://www.communications.gov.au/have-your-say/consultation-new-spectrum-legislation) on reforms to modernise and simplify Australia’s spectrum management framework. The comprehensive consultation package included an Exposure Draft of the Radiocommunications Bill and related consultation papers, including approaches for broadcasting spectrum and transitional arrangements. Consultation papers on government spectrum holdings and spectrum pricing were also released. Consultation closed on 28 July 2017.

Currently, the Radiocommunications Bill and draft transitional and consequential legislation is being finalised before introduction into parliament. The Department of Communications and the Arts (DoCA) stated in the recent consultation package that transition to a new framework would take place over a number of years. In addition, the commencement of the new legislation would occur approximately 12 months after passage of the Bill through parliament.

Given the timeframes associated with the 3.6 GHz band review, the ACMA is proposing to develop new arrangements in this band assuming the existing regulatory regime will apply. It is acknowledged that any new arrangements for the 3.6 GHz band may need to be accommodated under the new legislative framework, once it commences. The ACMA will take into account relevant opportunities offered by the implementation of the new legislative framework, if and when applicable.

Further information on spectrum reform is available from DoCA at [spectrumreform@communications.gov.au](mailto:spectrumreform@communications.gov.au).

## Timeline

The ACMA is working towards allocating the 3.6 GHz band in Q4 2018. To do this the following timeframe for the TLG is:

| Key steps | Proposed Date |
| --- | --- |
| TLG process   * Initial release of TLG paper * Deadline for submissions/comments on initial TLG paper * Revision to TLG paper * Deadline for submissions/comments on revised TLG paper * Second (final) revision to TLG paper | March-April 2018  9th March 2018  29th March 2018  5th April 2018  19th April 2018  27th April 2018 |
| Public consultation on the draft updates to the following technical framework instruments (the consultation will also include a draft 3.6 GHz band marketing plan):   * Draft spectrum licence; * Draft update to *Radiocommunications (Unacceptable Levels of Interference – [3.4/3.6] GHz Band) Determination 2015;* * Draft update to *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — [3.4/3.6] GHz Band) 2015;* * Draft update to *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band) 2015* * Draft update to *Radiocommunications (Trading Rules for Spectrum Licences) Determination 2012* * Draft updates to relevant RALIs\* | May-June 2018 |

*\* Consultation on the draft updates to the relevant RALIs may occur at a later point depending on when discussion on them is finalised within the TLG.*

It is noted that the TLG is just the first step in the process of developing a technical framework. While the aim is to complete the work in the timeframe defined this will ultimately depend on the complexity of the issues identified. It is intended that the ACMA will use the outcomes of the TLG to publicly consult on the relevant instruments that will form the 3.6 GHz band technical framework. This means TLG members will be able to provide comments on the technical framework both as part of the informal TLG and subsequent formal public consultation processes.

## Legal Review

It is noted that the draft instruments at appendices A-F have not undergone legal review. It is possible there could be changes to the text in the draft instruments after such a review has been conducted.

Under the currently proposed timeline, a legal review of the draft instruments will be performed after the 16th April and finalised in time for public consultation of the draft technical framework in May 2018.

# Discussion on proposed technical framework

A technical framework consists of three interlocking regulatory elements provided for under the Act:

* The conditions specified on the spectrum licence—in particular, the core conditions that define the spectrum space (both frequency and geographical area) and the level of emissions permitted inside and across the frequency boundaries of the licence (section 66 of the Act).
* A determination of unacceptable interference for the purpose of device registration in each band (section 145 of the Act). This defines permissible levels of emissions across geographical licence boundaries and can also define various deployment constraints.
* Radiocommunications advisory guidelines (RAG) that provide assistance and advice for coordination with stations in other services when and where required (section 262 of the Act). This includes detailing interference management criteria with incumbent apparatus and other spectrum licences.

A more comprehensive explanation of spectrum licence technical frameworks is provided in the document *[Know your obligations—Spectrum licensees](http://www.acma.gov.au/theACMA/Library/Industry-library/Spectrum/know-your-obligationshelp-for-spectrum-licensees)*.

This section of the paper considers the development of each of these components along with the standard trading unit and minimum contiguous bandwidth.

## 3.4 GHz Band Spectrum Licence Technical Framework

It is noted that the 3.4 GHz spectrum licence band is directly adjacent the 3.6 GHz band. Since the same equipment is likely to be deployed in both bands and it is possible the same licensees could hold licences in both bands, there could be benefit in having the same or a similar technical framework in place in both the 3.4 GHz and 3.6 GHz bands. Such a move could also facilitate a future defragging of the broader 3400-3700 MHz band. However, any changes to the technical framework for the 3.4 GHz band licences would require the agreement of affected 3.4 GHz band licensees to implement in that band.

It is also noted that Time Division Duplex (TDD) technologies are expected to be predominantly used in the band.

1. **The ACMA proposes to combine the technical frameworks for the 3.4 GHz and 3.6 GHz bands. This includes optimising use of the band for TDD technologies.**

The relevant 3.4 GHz band technical framework instruments are:

* Spectrum Licence ([Current licence holders and copies of licences](http://web.acma.gov.au/rrl/browse_licences.licence_list?pSV_ID=85&pSS_ID=861));
* *[Radiocommunications (Unacceptable Levels of Interference - 3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Details/F2015L00727" \t "_self);*
* *[Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 3.4 GHz Band) 2015](http://www.comlaw.gov.au/Details/F2015L00728" \t "_self);*
* *[Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band) 2015](http://www.comlaw.gov.au/Details/F2015L00729" \t "_self).*

Details of the TLG process (including relevant papers) that developed the current 3.4 GHz band technical framework are available on the [ACMA website](https://www.acma.gov.au/-/media/Spectrum-Transformation-and-Government/Information/zip-file/2014--34-GHz-TLG-Package-zip.ZIP?la=en).

## ECC Developments

ECC is currently consulting on the following two new reports:

* [CEPT Report 67](https://www.cept.org/files/9522/Draft%20CEPT%20Report%2067%20PF_1.docx): Review of the harmonised technical conditions applicable to the 3.4-3.8 GHz ('3.6 GHz') frequency band;
* [ECC Report 281](https://www.cept.org/files/9522/Draft%20ECC%20Report%20281%20PF_1.docx): Analysis of the suitability of the regulatory technical conditions for 5G MFCN operation in the 3400-3800 MHz band.

In developing a technical framework for the 3.6 GHz band, it is proposed that the above draft new reports from the ECC PT1 be taken into account.

## Standard Trading Unit and Minimum Contiguous Bandwidth

A spectrum licence may be traded in whole, or in part, by geographic area or frequency or both. Under section 88 of the Act, the ACMA may determine the rules that apply to trades under spectrum licensing. These rules are contained in the *[Radiocommunications (Trading Rules for Spectrum Licences) Determination 2012](https://www.legislation.gov.au/Details/F2015C00469)* (trading determination).

The trading determination specifies (a) the smallest parcel of spectrum space that can be traded (the standard trading unit) and (b) the minimum contiguous holding of spectrum space required by a licensee after the completion of a trade. This minimum holding is a combination of frequency and geographic requirements. Where:

1. the frequency requirement is equal to the minimum contiguous bandwidth (MCB)
2. the geographical requirement is equal to the geographical component of the standard trading unit (STU)

The minimum quotas of frequency and area that can be traded are defined by the STU. The definition of an STU is contained in the trading determination.

The STU that applies to the 3.4 GHz band (and every other spectrum licence band) is defined as a parcel of spectrum space that consists of:

1. a geographic area equal to a Level 1 HCIS cell of the 2012 Australian Spectrum Map Grid (ASMG)[[3]](#footnote-4)– approximately a 9×9 kilometre in size
2. a frequency band where the lower and upper frequency limits of each segment are integers when described in Hertz

This means the frequency component of the STU is defined as 1 Hz for the 3.4 GHz band and all other spectrum licence bands. This provides licensees with flexibility in the quantum of spectrum that may be traded, subject to the value of the MCB. The minimum area is referenced to the ASMG mapped consistently in five-minute increments by latitude and longitude.

One submission to the TLG process proposed to change the STU to 0.5 MHz. It is noted that changing the STU would affect every spectrum licensees in every band. It would therefore require consultation with all affected licensees. However, given the current flexibility in the STU (coupled with the MCB) and the broader effect any change would have, the ACMA does not propose making any changes to it as part of the 3.6 GHz band TLG process.

1. **There is no proposed change to the STU.**

The current MCB for the 3.4 GHz band is 10 MHz. This means that any 3.4 GHz SL band trades must not result in a licensee holding a contiguous bandwidth less than the 10 MHz in any area. The same MCB is proposed for adoption in the 3.6 GHz band.

1. **Is a 10 MHz MCB appropriate for both the 3.4 GHz and 3.6 GHz spectrum licence bands?**

## Conditions on the spectrum licence

Each spectrum licence includes both core conditions and statutory conditions specified under relevant sections of the Act. The Act also provides that other specific conditions may be included by the ACMA.

* **Core conditions**—required under section 66, these conditions define the spectrum space within which the licensee is authorised to operate radiocommunications devices under the licence, and the maximum permitted level of radio emissions inside and outside the band. These conditions are included in all spectrum licences.
* **Statutory conditions**—required under sections 67 to 69A, these conditions include information about payment of charges, use by third parties, residency, registration of transmitters and devices exempt from registration. These conditions are included in all spectrum licences.
* **Other conditions**—conditions placed on licences under section 71 generally provide for the efficient management of the spectrum and administration of the Act. These conditions may vary from one band or licence to another.

The core conditions of a spectrum licence form the fundamental building blocks for operation of a spectrum-licensed device, and for managing interference with adjacent frequency bands and geographic areas. Section 66 of the Act states spectrum licences must specify the following core conditions:

* the part or parts of the spectrum in which operation of radiocommunications devices is authorised under the licence (frequency range of operation)
* the maximum permitted level of radio emission, in parts of the spectrum outside the frequency range specified on the licence, that may be caused by operation of radiocommunications devices under the licence (outside-the-band emission)
* the area within which operation of radiocommunications devices is authorised under the licence (geographic area of operation)
* the maximum permitted level of radio emission that may be caused by the operation of radiocommunications devices under the licence (outside-the-area emission).

When developing conditions on the spectrum licence it is proposed to use those on the 3.4 GHz spectrum licence as a starting point. The 3.4 GHz band spectrum licence technical framework was updated in 2015. It was optimised for the deployment of TDD LTE services.

### In-band emission limits

***Current 3.4 GHz band limits***

The current in-band emission limits for 3.4 GHz band spectrum licences are:

* 25 dBm/5 MHz EIRP in upper 5 MHz that is adjacent to another spectrum licence (referred to as the ‘restricted use block’);
* Otherwise 68 dBm/5 MHz EIRP.

Note: Adjacent band licensees are free to negotiate relaxation of the 25 dBm/5 MHz EIRP limit to a maximum of 68 dBm/5 MHz.

***Proposed limits***

Maximum in-band limit

For active antenna systems (AAS) [ECC Report 281](https://www.cept.org/files/9522/Draft%20ECC%20Report%20281%20PF_1.docx) suggest an in-band limit of 47 dBm/5 MHz per cell/sector measured as a total radiated power. This provides flexibility for licensees to deploy AAS with an increasing number of antenna elements.

Specifically the [ECC Report 281](https://www.cept.org/files/9522/Draft%20ECC%20Report%20281%20PF_1.docx) limit equates to a radiated power of 68 dBm/5 MHz (the current 3.4 GHz in-band limit) if a 21 dBi gain antenna is assumed. Alternatively, for an 8x8 or 16x16 antenna array of 5 dBi elements the maximum antenna gain equates to 23 dBi and 29 dBi respectively. This results in maximum in-band EIRPs of 70 dBm/5 MHz and 76 dBm/5 MHz respectively.

It is also noted that the maximum conducted Tx power for fixed/mobile devices operating in the 3400-3700 MHz band on recorded on the RRL is currently 46 dBm/5MHz.

To provide the greatest flexibility for licensees into the future, it is therefore proposed to adopt an in-band TRP limit of 47 dBm/5 MHz per cell/sector.

Managing adjacent channel interference

The current 3.4 GHz band technical framework defines a 5 MHz restricted block at the upper end of any spectrum licence that is adjacent to another spectrum licence. This restricted block in conjunction with the ‘additional unwanted emission limit’ defined in Schedule 3 of the RAG Rx were put in place to manage adjacent channel interference. In affect it means that, unless frequency adjacent licensees can come to an agreement to synchronise their services (or some other agreement), there is a fall back solution to assist in the management of interference between adjacent channel unsynchronised services.

However, this approach may not be appropriate for emerging 5G technologies, particularly those making use of active antenna systems (AAS). Reasons for this include:

* Fixed and mobile network operators have indicated that they would ideally obtain up to 100 MHz of contiguous spectrum to deploy 5G services in the 3400-3700 MHz band. Given the level of interest from various operators, it is unlikely there will be enough spectrum for every operator to obtain this amount of spectrum. Under these conditions, the application of a restricted block would further reduce the amount of spectrum available for macro cell deployments.
* The ‘additional unwanted emission limit’ only applies in the event it is needed to manage interference. It could be something that is known to apply at the time of planning a network or it may not apply until sometime in the future when an adjacent band licensee deploys a service. This could be problematic for 5G systems, as it may not be possible to apply additional RF filtering to an AAS base station post manufacture. This is due to the integrated nature of the antenna and RF unit. For this reason it would be more appropriate to define an unwanted emission limit between spectrum licensees that does not need to (or is unlikely to) change over time.
* It is expected there will be interest from licensees to defragment spectrum holdings across the broader 3400-3700 MHz band after the allocation of the 3.6 GHz band. The timing of any such process is not currently known and will be largely dependent on agreements being reached between relevant licensees. It is likely that any services deployed before such an agreement is reached may need to be re-tuned. However, if unwanted emission limits stricter than those defined by 3GPP standards are in place, this may not be possible due to the integrated nature of the antenna and RF unit. To help simplify any potential defragmentation process and avoid unnecessary costs, the least restrictive unwanted emission mask within the 3400-3700 MHz band is preferred.

Based on the dot points above, an alternative approach to manage adjacent channel interference is proposed. Specifically instead of a fall back solution to ‘unsynchronised use’, it is proposed that a fall back solution to ‘synchronised use’ be adopted. The proposed details are:

* Remove the restricted block requirement;
* Require licensees to synchronise services when it is needed to manage interference. Licensees would also be free to negotiate alternative arrangements on a case-by-case basis;
* A requirement to synchronise UL and DL operations and frame starting points with a proposed UL/DL of 30:70 and a sub-frame duration of 1 ms (to align with existing LTE systems in the 3.4 GHz band);
* A guard period of 33.2 μs which supports a cell radius of up to 10 km (this is the assumed cell size for a fixed network in the 3400-3700 MHz band).

It is noted that synchronisation may, depending on the final parameters adopted, result in the removal of low latency options for operators as well as the flexibility associated with dynamically adjusting UL/DL. However, it also removes the need for guard bands or restricted blocks, reduces the need for and costs associated with additional filtering and could also reduce the effect of dead zones when managing cross-border interference (discussion on whether to apply synchronisation .

It is therefore proposed to attach the following condition to spectrum licences in the 3.4/3.6 GHz band:

**Synchronisation Requirement**

1. In the event one or more other spectrum licensees in the 3.4 GHz band indicate they are experiencing interference from devices operated under this licence and no agreement can be reached on how to manage this interference, the licensee is required to synchronise devices operated under this licence with other affected licensees. This includes:

1. Implementing an uplink-to-downlink ratio of 30:70
2. Aligning the timing of uplink and downlink operations including the timing of frame start points with other affected licensees; and
3. Employing a sub-frame duration of 1 ms and a guard period of 33.2 μs.
4. **Is the proposed in-band limit appropriate?**
5. **Noting that adjacent band licensees can negotiate alternative arrangements, is a synchronisation fall back solution to manage interference suitable? If so are the parameters proposed appropriate? Is there a need to define any other parameters? Is an additional condition required to manage BS to BS interference that occurs even when systems are synchronised (e.g. due to guard time not being large enough)?**

### Unwanted emission limits

Existing unwanted emission limits that apply to 3.4 GHz band spectrum licences have been reproduced at Appendix B.

When defining unwanted emission limits (both out-of-band and spurious), consideration has been given to the following list of 3GPP defined operating bands for TDD services that cover the 3400-3700 MHz:

* E42 (E-UTRA operating band 42): 3400-3600 MHz
* E43: 3600-3800 MHz
* E48: 3550-3700 MHz
* N77 (New radio operating band 77): 3300-4200 MHz
* N78: 3300-3800 MHz

***Registered devices***

*Current 3.4 GHz band limits*

The current out-of-band emission limits defined for 3.4 GHz spectrum licences are reproduced at Appendix B. A summary of how they were developed follows:

* While stricter out-of-band emission limits would ensure greater compatibility with adjacent band apparatus and spectrum licence services, less stringent limits were adopted. The reasons for this were to:
  + avoid unnecessary costs and burdens on licensees to implement strict unwanted emission limits that are only required to enable compatibility in specific situations;
  + minimise costs and complexity of retuning services as part of any future defragmentation of licence holdings across the broader 3400-3575 MHz frequency range.

It was also expected that, irrespective of who was first-in-time, spectrum licensees would work with relevant adjacent band apparatus licensees (in particular PTS and point-to-multipoint licensees) and spectrum licensees to manage interference. This includes reducing out-of-band emissions down to a specified level when appropriate (taking advantage of the restricted block for emission roll-off) and accepting a higher level of interference for in-band blocking as defined by the notional receiver. These expectations are specified in the *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters – 3.4 GHz Band)* and *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band)*;

* Within the 3390-3610 MHz frequency range, the out-of-band emission limit for devices that are required to be registered are based on the E-UTRA category B masks for base stations[[4]](#footnote-5). An assumed 17 dBi gain antenna was used to convert this to a radiated power limit;
* Within the 3390-3610 MHz frequency range, the out-of-band emission limit for devices that are not required to be registered are based on the highest level for E-UTRA UE 5 and 20 MHz channel emission masks[[5]](#footnote-6). A 0 dBi gain antenna was assumed to convert this to a radiated power limit;
* Outside the 3390-3610 MHz frequency range, the same radiated spurious emission limits apply to all devices. These limits are more stringent than the standard conducted spurious emission limits defined in standards for those frequencies outside of 3390-3610 MHz when the gain of a device’s antenna is greater than 0 dBi.

Further details on the development of unwanted emissions for 3.4 GHz band spectrum licences is contained in the 3.4 GHz band TLG document. This document is available on the [ACMA website](https://www.acma.gov.au/-/media/Spectrum-Transformation-and-Government/Information/zip-file/2014--34-GHz-TLG-Package-zip.ZIP?la=en).

Rather than adopt the current 3.4 GHz band unwanted emission limits, it is proposed to revise them. The aim of the revision is to:

* ensure existing devices deployed under the current 3.4 GHz band framework can continue operating unaffected;
* enable new technologies (e.g. 5G and AAS) to be deployed (or existing ones to be retuned if possible) anywhere in the 3425-3492.5 MHz and 3542.5-3700 MHz frequency bands;
* ensure support for multicarrier aggregation and larger channel bandwidths for UEs;
* avoid unnecessary costs and burdens on licensees to implement strict unwanted emission limits that are only required to enable compatibility in specific situations;
* minimise costs and complexity of retuning services as part of any future defragmentation of licence holdings across the broader 3400-3700 MHz frequency range; and
* align the way spurious emission limits are defined with international practice except where stricter limits are appropriate for coexistence with other services.

In revising the existing 3.4 GHz band unwanted emissions, it is assumed that when necessary to manage interference, licensees will either synchronise their services or negotiate an alternative solution.

*Proposed out-of-band emission limits for registered devices*

The proposed out-of-band emission limits for registered devices are based on E-UTRA and NR Category B unwanted emission limits (which are the same for both E-UTRA and NR), as defined in the relevant 3GPP standards[[6]](#footnote-7), with an added 9 dB. The additional 9 dB is to account for cumulative emissions from 8 antennas (i.e. 10log(8)). The aim of this approach is to provide a higher allowance for AAS systems while still placing a cap on the upper limit of unwanted emissions. Devices with a larger number of antennas will be required to ensure the cumulative unwanted emissions do not exceed the levels defined in Table 1. This methodology for defining unwanted emissions mirrors the approach taken by the ECC in draft [CEPT Report 67](https://www.cept.org/files/9522/Draft%20CEPT%20Report%2067%20PF_1.docx).

3GPP E-UTRA standards state that, for base stations, the out-of-band emission limits do not apply ±10 MHz outside of a defined operating band. For this reason the current frequency range out-of-band emissions apply, as specified on 3.4 GHz band spectrum licences and assuming band E42 compliant equipment, is 3390-3610 MHz.

However, 3GPP NR standards state that, for base stations, the out-of-band emission limits do not apply ±40 MHz outside of a defined operating band. The two currently defined NR operating bands cover the 3300-3800 MHz and 3300-4200 MHz bands respectively. This would suggest that the out-of-band emission limits should apply over either the 3260-3840 MHz or 3260-4240 MHz frequency range.

Due to coexistence requirements with adjacent band radiolocation and fixed satellite services, this is not considered appropriate. Therefore a smaller frequency range is proposed, specifically 3380-3720 MHz. As discussed in the next section, more stringent emissions are proposed for the 3100-3380 MHz and 3720-4200 MHz bands. The application of a ±20 MHz buffer to the 3400-3700 MHz band is based on work conducted by ECC that indicates the proposed more stringent emissions can be achieved over a 20 MHz frequency range.

As a result of this discussion, the resulting out-of-band emission limits proposed are shown in Table 1.

1. Transmitter unwanted emission limits within the 3380-3720 MHz frequency band – registered devices.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm) per cell/sector** | **Measurement Bandwidth** |
| 0 kHz ≤ foffset ≤ 5 MHz | 2 – (7/5).foffset(MHz) | 100 kHz |
| 5 MHz≤ foffset ≤ 10 MHz | -5 | 100 kHz |
| foffset ≥ 10 MHz | -6 | 1 MHz |

Note that the limits above work well when adjacent band systems are using the same technology and have synchronised operation. As discussed previously, it is assumed that when required to manage interference, licensees will either synchronise their services or negotiate an alternative solution. Therefore the definition of a stricter unwanted emission limit to manage interference or unsynchronised operation is not required. For this reason it is proposed to delete the additional unwanted emission limits defined in Schedule 3 of the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band).*



*Proposed additional unwanted and spurious emission limits for registered devices*

Current 3.4 GHz band spectrum licences define spurious emission limit as a radiated mean power (in dBm EIRP per measurement bandwidth). However, standards bodies and other regulators typically define spurious emissions for LTE in terms of conducted power. Furthermore, NR standards suggests the use of TRP would be more appropriate for devices that utilise AAS.

To align with international practice, it is proposed to define a general spurious emission limit for all devices exempt from registration in terms of a TRP. Defining spurious emission limits as TRP ensures the requirement supports devices employing either non-AAS or AAS.

For registered devices, it is proposed that that unwanted emission limits outside the 3380-3720 MHz frequency range be for the most part based on Category B limits in LTE and NR standards.

To facilitate coexistence with adjacent band radiolocation and fixed satellite services, it is also proposed to define a more stringent TRP level in the 3100-3380 MHz and 3720-4200 MHz frequency ranges. The current 3.4 GHz band unwanted emissions limits in these frequency ranges is -30 dBm/MHz EIRP. Assuming a 17 dBi gain antenna (which was the gain assumed in developing the 3.4 GHz band unwanted emission limits) this is equivalent to a TRP of -47 dBm/MHz.

This resulting unwanted emission limits are shown in Tables 2 and 3. In these tables the upper frequency limit is also set to 19 GHz. This is in line with relevant standards and represents the fifth harmonic of the frequency 3.8 GHz.

1. Transmitter unwanted emission limits outside the 3380-3720 MHz frequency band – registered devices.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm) per cell/sector** | **Measurement Bandwidth** |
| 9 kHz ≤ f ≤ 150 kHz | -36 | 1 kHz |
| 150 kHz ≤ f ≤ 30 MHz | -36 | 10 kHz |
| 30 MHz ≤ f ≤ 1 GHz | -36 | 100 kHz |
| 1 GHz ≤ f ≤ 3.1 GHz | -30 | 1 MHz |
| 3.1 GHz ≤ f ≤ 4.2 GHz | -47 | 1 MHz |
| 4.2 GHz ≤ f ≤ 19 GHz | -30 | 1 MHz |

1. Receiver unwanted emission limits outside the 3360-3740 MHz frequency band – registered devices.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm) per cell/sector** | **Measurement Bandwidth** |
| 30 MHz ≤ f ≤ 1 GHz | -57 | 100 kHz |
| 1 GHz ≤ f ≤ 19 GHz | -47 | 1 MHz |

It is noted that the unwanted limits proposed in Tables 2 and 3 are less stringent than those currently defined on 3.4 GHz spectrum licences. Therefore, in addition to the limits above, it is proposed that the condition below be placed on all spectrum licences in the 3400-3700 MHz band. This ensure that when interference occurs licensees make a reasonable attempt to resolve it with affected parties. Since stricter unwanted emission limits are already defined for the 3100-3380 MHz and 3720-4200 MHz frequency ranges, the condition is proposed to only apply at frequencies below 3100 MHz and above 4200 MHz.

**Definition**

1. ***managing interference*** includes but is not limited to:

1. investigating the possible causes of the interference;
2. taking all steps reasonably necessary to resolve disputes about interference;
3. taking steps (or requiring persons authorised to operate radiocommunications devices under this licence to take steps) reasonably likely to reduce interference to acceptable levels; and
4. negotiating with other persons to reduce interference to acceptable levels.

**Managing interference caused by spurious emissions**

2. If:

(a) interference occurs between a radiocommunications device:

(i) operated under this licence; and

(ii) operated under another licence (the ***other licence***);

and the interference is due to spurious emissions at frequencies below 3100 MHz and above 4200 MHz from a radiocommunications device operating under this licence; and

(b) that interference is not the result of operation of a radiocommunications device in a manner that does not comply with the conditions of the relevant licence; and

(c) either the licensee or the holder (or authorised third party) of the other licence wishes to resolve the interference;

the licensee must ***manage interference*** with:

(d) the holder of the other licence; or

(e) if a site manager is responsible for managing interference at that location, that site manager.

Specific questions to consider in relation to the development of unwanted emission limits are:

1. **Are the unwanted emission limits proposed in this paper appropriate?**
2. **Should there be separate emission limits for registered active antenna systems (that can make use of beamforming) and non-active antenna systems?**
3. **Is an additional unwanted emission mask (as is currently defined in Schedule 3 of the RAG Rx) required to manage adjacent channel interference between unsynchronised services?**
4. **Is the proposed ‘managing interference caused by spurious emissions’ clause suitable?**
5. **Are stricter limits required to facilitate coexistence with adjacent band radiolocation and earth station receiver services?**

***Devices exempt from registration***

Devices exempt from registration, as defined on the current 3.4 GHz spectrum licences, fall into two categories:

1. Devices operating with an EIRP less than 25 dBm per occupied bandwidth (typically mobile and nomadic devices)
2. Ubiquitously deployed fixed terminals with high gain antennas placed lower than 10m above ground level (typically wall or roof mounted on the outside of homes or businesses)

The out-of-band emission limits for these cases were originally based on the limits defined for E-UTRA UEs.

It is proposed to revise the current out-of-band emission limits for devices exempt from registration taking into account both E-UTRA and NR UE out-of-band emission limits and that future UEs that could employ antenna arrays up to 4x4 in size.

*Proposed out-of-band emission limits for devices exempt from registration*

E-UTRA and NR UE standards[[7]](#footnote-8) state that the out-of-band emission limits do not apply:

* ±10 MHz and ±25 MHz from the edge of a 5 MHz and 20 MHz operating bandwidth for an E-UTRA UE;
* ±45 MHz and ±65 MHz from the edge of the aggregated bandwidth of an E-UTRA UE utilising 2x20 MHz and 3x20 MHz carrier aggregation respectively;
* ±105 MHz outside of a 100 MHz operating bandwidth for an NR UE.

Based on the above dot points, the general rule of thumb is that for UEs the out-of-band emission limits do not apply ±(aggregated bandwidth + 5 MHz) from the lower or upper edge of the channel used (or outer most channel in the case of carrier aggregation).

It is noted that the out-of-band emission limits for devices exempt from registration defined on current 3.4 GHz band spectrum licences are more stringent than those defined for LTE carrier aggregation and larger NR bandwidths. Taking this into account and the fact that only the 3400-3700 MHz band is being considered, it is proposed that the frequency range that the out-of-band limit applies be 3295-3805 MHz (i.e. 3400-105=3295 MHz and 3700+105=3805 MHz). This ensures that E-UTRA carrier aggregation and larger NR channels are accommodated.

The actual out-of-band limits proposed are then based on the combined maximum emission limits defined for UEs operating in the three different scenarios listed previously (i.e. considering 5 MHz and 20 MHz channels, multiple carrier aggregation and NR bandwidths up to 100 MHz). To provide flexibility for licensees to deploy future UE’s (and repeaters and femtocells) with antenna main-beam gains many dB’s higher than current levels, it is also proposed to define the out-of-band limits in terms of TRP.

The resulting proposed out-of-band emission limits are shown in Table 4.

1. Transmitter unwanted emission limits within the 3295-3805 MHz frequency band – devices exempt from registration.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm) per device** | **Measurement Bandwidth** |
| 0 kHz ≤ foffset ≤ 1 MHz | -15 | 30 kHz |
| 1 MHz≤ foffset ≤ 5 MHz | -10 | 1 MHz |
| 5 MHz≤ foffset ≤ 100 MHz | -13 | 1 MHz |
| foffset ≥ 100 MHz | -25 | 1 MHz |

*Proposed spurious emission limits for devices exempt from registration*

Current 3.4 GHz band spectrum licences define spurious emission limit as a radiated mean power (in dBm EIRP per measurement bandwidth). However, standards bodies and other regulators typically define spurious emissions for LTE in terms of conducted power. Furthermore, NR standards suggests the use of TRP would be more appropriate for devices that utilise AAS.

To align with international practice, it is proposed to define a general spurious emission limit for all devices exempt from registration in terms of a TRP. Defining spurious emission limits as TRP ensures the requirement supports devices employing either non-AAS or AAS.

This resulting unwanted emission limits are shown in Tables 5 and 6. In these tables the upper frequency limit is also set to 19 GHz. This is in line with relevant standards and represents the fifth harmonic of the frequency 3.8 GHz.

1. Transmitter unwanted emission limits outside the 3295-3805 MHz frequency band – devices exempt from registration.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm) per device** | **Measurement Bandwidth** |
| 9 kHz ≤ f ≤ 150 kHz | -36 | 1 kHz |
| 150 kHz ≤ f ≤ 30 MHz | -36 | 10 kHz |
| 30 MHz ≤ f ≤ 1 GHz | -36 | 100 kHz |
| 1 GHz ≤ f ≤ 19 GHz | -30 | 1 MHz |

1. Receiver unwanted emission limits outside the 3295-3805 MHz frequency band – devices exempt from registration.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm) per device** | **Measurement Bandwidth** |
| 30 MHz ≤ f ≤ 1 GHz | -57 | 100 kHz |
| 1 GHz ≤ f ≤ 19 GHz | -47 | 1 MHz |

It is noted that, in some case, these revised spurious emission limits may be less stringent than those currently defined on 3.4 GHz band spectrum licences (e.g. devices exempt from registration with a gain greater than 0 dBi). To account for this all spectrum licences in the 3400-3700 MHz band will have a condition that states devices exempt from registration must not case harmful interference to other licensed services. Such a condition is already contained on 3.4 GHz band spectrum licences in clause 9 of Licence Schedule 4.

### Statutory conditions on the licence

It is proposed to maintain all the statuary conditions that are currently on 3.4 GHz band spectrum licences (refer to the PDF image of current 3.4 GHz band spectrum licences available on the [RRL](https://web.acma.gov.au/rrl/browse_licences.licence_list?pSV_ID=85&pSS_ID=861) for more details) except the ‘device exempt from registration’ condition.

It is possible that future UE’s that employ beamforming could have antenna main-beam gains many dB’s higher than current levels. The current EIRP limit defined for devices exempt from registration would therefore be too low to encompass such devices.

To maximise flexibility for licensees to be able to deploy such devices, it is proposed to define in-band limits as a TRP rather than EIRP for devices exempt from registration. In this case a TRP of 25 dBm per occupied bandwidth is proposed. This limit would cover existing and future UEs (and other devices such as repeaters and femtocells) with higher main-beam gains as well as fixed UEs and small cells with higher gain antennas. For example a fixed UE with a transmit power 25 dBm/occupied bandwidth and a 17 dBi gain antenna would be covered by this limit.

The proposed devices exempt from registration requirement follows:

**Exemption from registration requirements**

1. The following kinds of radiocommunications transmitters are exempt from the registration requirement in Statutory Condition 3:

(a) a transmitter that operates in the 3.4 GHz band with a total radiated power of less than or equal to 25 dBm per occupied bandwidth

1. **Is the proposed exemption from registration requirement suitable?**

### Other conditions on the licence

It is proposed to maintain all of the ‘other conditions’ (i.e. those other than core and statutory conditions) that are currently contained in 3.4 GHz band spectrum licences (refer to the PDF image of current 3.4 GHz band spectrum licences available on the [RRL](https://web.acma.gov.au/rrl/browse_licences.licence_list?pSV_ID=85&pSS_ID=861) for more details).

In addition to these, it is also proposed to include the following:

* A condition that licensees do not cause unacceptable levels of interference to earth stations operated by Lockheed Martin at Uralla, NSW
* A condition that licensees protect the currently identified earth station protection zones (ESPZ) defined in:
  + [Embargo 49](https://www.acma.gov.au/-/media/Spectrum-Engineering/Regulation/pdf/Embargo-No-49.pdf?la=en) – the west Australian ESPZ centred around Mingenew, WA; and
  + [Embargo 72](https://www.acma.gov.au/-/media/Spectrum-Engineering/Regulation/pdf/Embargo-No-72-pdf.pdf?la=en) – the three proposed east Australian ESPZs around the towns of Quirindi, Moree and Roma.

The proposed wording of the second and third conditions follow:

**Managing interference with Uralla Earth station facility**

1. The licensee must not cause unacceptable levels of interference to Earth stations operated within HCIS identifier NU7K4 in accordance with the criteria specified in *RALI[ESPZ]*

**Coordination with Earth station protection zones**

1. Before seeking to register a radiocommunications transmitter, the licensee must follow the procedures set out in *RALI[ESPZ]* for the protection of the defined Earth station protection zones.

RALI[ESPZ] is a proposed new RALI that will developed as part of the TLG process. Refer to the *Managing interference from spectrum licensed transmitter* section of this paper for more detail.

It is also recognised that a decision is yet to be made regarding which (if any) of the locations in east Australia may be a viable ESPZ. Therefore by defining procedures for the general protection of these areas in a new RALI (i.e. RALI[ESPZ]), in the event one or more of them is found to be unsuitable, it can be removed at short notice and allow greater utility of spectrum licences in the adjacent areas.

1. **Do stakeholders have any concerns or alternative proposals for the proposed additional conditions?**
2. **Are there any other conditions stakeholders propose to include?**

## Unacceptable levels of interference

Spectrum licensees are required to register a radiocommunications transmitter in the Register of Radiocommunications Licences before they may be operated under the licence. The only exception to this is if there is a condition on licences that exempts certain types of transmitter.

Subsection 145(1) of the Act gives the ACMA the power to refuse to register a radiocommunications transmitter if it is satisfied that the operation of the transmitter could cause an unacceptable level of interference to the operation of other radiocommunications devices. Under subsection 145(4) of the Act, the ACMA can make a determination (referred to as a section 145 determination) that sets out what is considered unacceptable levels of interference for each spectrum-licensed band.

A section 145 determination sets out the circumstances in which devices are deemed to cause unacceptable levels of interference. These circumstances typically include:

* if the levels of emissions from a device at the geographical boundary of a licence exceed a defined level;
* if the operation of the transmitter will cause a breach of a core condition of the licence; and
* if the deployment of the device is outside any deployment constraints defined for the band.

### 3.4 GHz band section 145 determination

The current section 145 determination for the 3.4 GHz band is the *[Radiocommunications (Unacceptable Levels of Interference - 3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Details/F2015L00727" \t "_self)*. Details on the development of this s.145 determination are contained in the [3.4 GHz band TLG papers](https://www.acma.gov.au/-/media/Spectrum-Transformation-and-Government/Information/zip-file/2014--34-GHz-TLG-Package-zip.ZIP?la=en).

Some of the key details of the 3.4 GHz band section 145 determination are:

* It is optimised for TDD use;
* The only deployment constraint is clause s.7(8) which prevents devices being registered on an airship or balloon (note this does not prevent the use of devices exempt from registration on an airship or balloon);
* The device boundary criteria (DBC) is based on the following:
* A defined level of protection of -111 dBm/MHz to a receiver with a gain of 0 dBi at a height of 5m above the ground;
* Use of Recommendation ITU-R P.526-13 as the propagation model; and
* A calculation procedure similar to that implemented in other spectrum licence bands.

### Options for consideration

The current 3.4 GHz band section 145 determination was developed in 2015 and may be suitable for the 3.6 GHz band. The main questions to consider here are:

* whether or not it adequately caters for active antenna systems capable of beamforming or if a different approach to manage the level of emissions across geographical boundaries would be more appropriate;
* whether, with the benefit of 2 years implementation of the current 3.4 GHz section 145 determination, any of the parameters associated with the DBC should be adjusted (e.g. level of protection).

Considering the above points, the ACMA has identified the following options with regards to development of a section 145 determination for the 3.6 GHz band:

* use the current 3.4 GHz band section 145 determination; or
* use the current 3.4 GHz band section 145 determination but modify one or more of the parameters of the current DBC

While changes to deployment constraints could be considered, the ACMA does not currently propose any changes to those currently defined in the 3.4 GHz band section 145 determination.

### Proposed changes

Based on submissions received during the TLG process the ACMA proposes to amend the following parts of the DBC:

* Increase the LOP from -111 dBm/MHz to -98 dBm/MHz. This better support the registration of devices employing AAS and also allow devices to be deployed closer to geographical boundaries.
* Decrease the height of the notional receiver from 5m to 2m above ground level. This more closely reflects the interference case from a BS to a mobile UE which occurs under synchronised operation; and
* Increase the resolution of calculations from 500m increments to 250m increments. This aligns better with the accuracy of the DEM-9S. It is noted that in the event a proposed device fails the DBC, licensees are able to register it via guard space. In this case licensees can use higher resolution DEMs and clutter data when determining whether or not to deploy a service.

The following additional changes are also proposed:

* Exempt spectrum licensees from having to meet the device boundary criteria around the areas excised for consideration as earth station protection zones and the earth s station facility operating at Uralla; and
* Include the following note to provide guidance on how to cater for devices with active antenna systems capable of beamforming:

*Note: RP[[8]](#footnote-9) for a device that is capable of beamforming is defined as the maximum intended EIRP in the horizontal plane for azimuth from 0-360 degrees.*

In addition to the above changes, submissions to the TLG also proposed the following changes:

* A DBC radial that:
  + falls outside the license area;
  + only crosses sea or ocean (and no land) outside the licence area;

Is not deemed to cause an unacceptable level of interference.

* The antenna pattern for beamforming antennas should be time and spatially averaged to represent the 95th percentile real EIRP expected in any direction.

Regarding the first of the proposed changes, the ACMA believes that this is something that should be covered via agreements with adjacent area licensees. There are also areas where this type of exemption could have unintended consequences. For example, there is a strong risk of interference to and from services deployed in Adelaide and Yorke Peninsula as well as between Victoria and Tasmania (a known ducting hot spot).

Regarding the second proposed change, it is unclear how such an approach could be policed by the ACMA. In this case the ACMA’s preference is to make the changes to the DBC as previously proposed (i.e. higher LOP, lower notional antenna height and greater resolution for DBC calculations). In addition to this, if a device fails the DBC licensees can seek to register it either via agreement of through the use of guard space as defined in the [Radiocommunications (subsection 145(3) Certificates) Determination 2012](https://www.legislation.gov.au/Details/F2012L01719).

A draft update to the *Radiocommunications (Unacceptable Levels of Interference - 3.4 GHz Band) Determination 2015* is at Appendix C.

1. **Should the current 3.4 GHz band section 145 determination be adopted for the 3.6 GHz band with the additional changes proposed? If not, Why? Is a specific modification proposed?**

For any TLG members proposing changes to the current 3.4 GHz band section 145 determination, please keep the following in mind:

* Development of a DBC is a balance between providing protection to adjacent area services/spectrum licences and increasing the usability of a spectrum licence. For example, the greater the restriction on emissions leaving the area (equivalently: the greater the level of protection provided to adjacent area services) the less coordination is required between licensees to manage interference but the greater the ‘dead-zones’ near licence boundaries[[9]](#footnote-10).
* If a single spectrum licence technical framework is to be adopted across the broader 3400-3700 MHz band, then the effect of any deviation to the current 3.4 GHz technical framework on any existing devices deployed will need to be considered. This includes whether any measures are required to ensure existing devices can continue operating (e.g. through the inclusion of a grandfather clause).

### Managing cross-border interference

The current 3.4 GHz band DBC does not afford absolute protection from interference caused by services deployed in adjacent area licences. It was developed, via consultation with incumbent licensees, to allow higher levels of emissions across licence boundaries and increase the usability of the area encompassed by spectrum licences – particularly close to licence boundaries. This requires a negotiated agreement between licensees to manage cross-border interference and there is currently no fall back solution in the event no agreement can be reached.

The proposed changes to the DBC mentioned in the previous section have the potential to increase the levels of emissions crossing licence boundaries. To manage interference under this scenario, in lieu of negotiated outcome, it is proposed that the synchronisation fall back solution detailed in the *In-band emission limits* section of this paper be implemented.

A summary of the proposed synchronisation condition are:

* Remove the restricted block requirement;
* Require licensees to synchronise services when it is needed to manage interference. Licensees would also be free to negotiate alternative arrangements on a case-by-case basis;
* A requirement to synchronise UL and DL operations and frame starting points with a proposed UL/DL of 30:70 and a sub-frame duration of 1 ms (to align with existing LTE systems in the 3.4 GHz band);
* A guard period of 33.2 μs which supports a cell radius of up to 10 km (this is the assumed cell size for a fixed network in the 3400-3700 MHz band).

It is noted that synchronisation may, depending on the final parameters adopted, result in the removal of low latency options for operators as well as the flexibility associated with dynamically adjusting UL/DL. However, it also removes the need for guard bands or restricted blocks, reduces the need for and costs associated with additional filtering and could also reduce the effect of dead zones when managing cross-border interference (discussion on whether to apply synchronisation.

1. **Is there a need for a fall back solution to manage cross-border interference? If so, is the synchronisation condition proposed suitable? Is an additional condition required to manage BS to BS interference that occurs even when systems are synchronised (e.g. due to guard time not being large enough)**

## Radiocommunications advisory guidelines

Further guidance on interference management with other licensed services is provided in Radiocommunications Advisory Guidelines (RAGs) made under section 262 of the Act. RAGs can refer to any aspect of radiocommunications or radio emissions.

Generally, RAGs include provisions to help assess the possible interference between spectrum-licensed devices and services operating under spectrum, apparatus or class licences. Potentially affected services are identified in the RAGs to enable licensees to assess and mitigate the risk of interference between these services.

It is important to note that where a case of interference arises between a spectrum-licensed device and another licensed device, the ACMA will refer to the provisions of the RAGs in resolving the matter. In general, affected licensees also have the ability to negotiate their own arrangements in order to manage interference. Such arrangements will also be taken into account when resolving any interference disputes.

Currently, there are two section 262 guidelines relevant to the deployment of services under 3.4 GHz band spectrum licences:

* *[Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 3.4 GHz Band) 2015](http://www.comlaw.gov.au/Details/F2015L00728" \t "_self);*
* [*Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band) 2015*](http://www.comlaw.gov.au/Details/F2015L00729)*.*

### Managing interference from spectrum-licensed transmitters

The [*Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 3.4 GHz Band) 2015*](http://www.comlaw.gov.au/Details/F2015L00728) (RAG Tx) provide guidance on the protection of adjacent band apparatus and class-licensed receivers from interference from spectrum-licensed transmitters. The existing guidelines identify the types of apparatus-licensed services potentially affected by transmitters operated under a spectrum licence in the 3.4 GHz band. They also explain the protection criteria and coordination arrangements that apply to these services, sometimes by reference to various RALIs[[10]](#footnote-11) or international standards.

It is proposed that the existing 3.4 GHz RAG Tx be updated to include the 3.6 GHz band and protection requirements of relevant services be updated to account for this. Some of the key differences between the existing RAG Tx and the proposed updated RAG Tx are[[11]](#footnote-12):

* Section 1.4(1) - Include 3.6 GHz band definition.
* Sections 2.3 & 3.1 – indicate fixed links operate ‘in and adjacent to the 3.4 GHz band’.
* Section 4.3 – update to include co-channel coordination with Fixed Satellite Service (FSS) earth stations as well as a requirement to notify affected earth station licensees of any new systems to ensure they have suitable RF filters installed.
* New section 4.4 – additional protection criteria for incumbent FSS earth stations operating in the 3600-3700 MH band;
* Section 5.2(2) – Removal of additional emission mask requirement for spectrum licences. Clarification on responsibility to bear costs Note: this also requires an update to RALI FX19 to manage interference to P-MP apparatus licences.
* Part 6 – extension of operating frequency range for radiolocation services.
* Section 7.1(1) – update frequency range to encompass 3400-3700 MHz frequency band.
* A new section providing guidance on how to manage interference with the east and west coast ESPZ.
* A new section dealing with how to coordinate with the earth station facility operated by Lockheed Martin near Uralla (NSW).

Other than the update to clause 4.3, the changes to RALI FX19 required to manage interference with P-MP licences, the new ESPZ section and protection of earth stations operating at Uralla, the proposed changes are relatively minor and self-explanatory in nature. For this reason, they are not discussed in detail in this TLG paper. However, the other proposed changes are discussed in turn below.

A draft update to the *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 3.4 GHz Band) 2015*is at Appendix D.

1. **Should the current 3.4 GHz band RAG Tx be adopted with the changes proposed for the 3.6 GHz band? If not, why? Are any other modifications proposed?**
2. **Is further guidance required in the RAG Tx (and/or the RAG Rx) on how to coordinate with devices with active antenna systems?**

***General FSS protection criteria***

In the *Australian Radiofrequency Spectrum Plan 2013* (ARSP 2013), the FSS(s-E) is a primary service in the 3600-4200 MHz band. This means apparatus licensed FSS earth station receivers or transmitters registered for use under a spectrum licence need to be coordinated against each other on a first-in-time basis.

The RAG Tx currently contains adjacent channel coordination criteria between an earth station and a transmitter registered for use under a spectrum licence. Details on the development of this criteria is available in the [3.4 GHz band TLG paper](https://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Spectrum-licences/spectrum-licence-technical-liaison-groups-1). With the re-allocation of the 3.6 GHz band for spectrum licensing there is a need to include co-channel coordination criteria. It is also proposed to revise the current adjacent band coordination criteria to facilitate better coexistence with earth stations.

*Co-channel protection criteria*

When managing co-channel interference to Earth station receivers operating on a primary basis, the following co-channel interference management criteria is proposed:

* Coordination is performed on a first-in-time basis (i.e. a proposed new spectrum/apparatus licensed service must manage interference with all pre-existing apparatus/spectrum licensed services);
* Coordination is only required with those Earth stations that have their details recorded in the Register of Radiocommunications Licences (RRL). Earth station will only be offered co-channel protection over their licensed bandwidth.
* Any Earth stations and proposed transmitters operated under a spectrum licence within 200 km of each other should be assessed to see if the relevant protection criteria is met.
* Earth stations are to be protected to a level of -128.6 dBm/MHz (corresponding to a noise temperature of 100 K and an I/N of -10 dB – as calculated using ITU-R Recommendation SF.1006) for 20% of the time. This criteria must be met for every 1 MHz bandwidth of a licensed earth station receiver, meaning the 1 MHz bandwidth with the highest level of out-of-band emissions should be considered in calculations.
* The propagation model defined in ITU-R Recommendation P.452 should be used when modelling interference.
* In the event actual antenna patterns are not available for an Earth station, ITU-R Recommendation S.465 can be used.

1. **Is the co-channel FSS protection criteria proposed adequate?**

*Adjacent band protection criteria*

The RAG Tx currently defines the adjacent band protection requirements for licensed FSS Earth receive stations operating in the 3600-4200 MHz band as:

* FSS Earth station receivers are to be protected from unwanted emissions (out-of-band and spurious) to a level of -128.6 dBm/MHz, assuming a receiver noise temperature of 100K, not to be exceeded for more than 20% of the time;
* A radiocommunications transmitter operated under a spectrum licence in the 3.4 GHz band is not considered to overload the receiver of an FSS Earth station if the total power received from the interfering service at the input of an FSS Earth station receiver (i.e. after considering Antenna gain, RF filtering and other losses) does not exceed -65 dBm.

When assessing interference using the above criteria, the RAG Tx states that the minimum RF filter performance described in Table 7, can be assumed at the front end of the Earth station receiver.

1. Characteristics of Earth station receivers RF filter in the RAG Tx

|  |  |
| --- | --- |
| **Frequency offset from the edge of the Earth station receiver licence (MHz)** | **Rejection (dB)** |
| < 25 | 0 |
| < 50 | 15 |
| < 150 | 45 |
| < 200 | 50 |
| ≥ 200 | 70 |

Details on the development of the current adjacent band protection criteria are provided in the [3.4 GHz band TLG paper](https://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Spectrum-licences/spectrum-licence-technical-liaison-groups-1). While it is not proposed to amend these, it may be worth reviewing the assumed RF filter characteristics. Figure 2 compares the current levels assumed in the RAG Tx with those defined by the FCC in [rule 96.17](https://www.gpo.gov/fdsys/search/pagedetails.action?collectionCode=CFR&browsePath=Title+47%2FChapter+I%2FSubchapter+D%2FPart+96%2FSubpart+B%2FSection+%26sect%3B+96.17&granuleId=CFR-2016-title47-vol5-sec96-17&packageId=CFR-2016-title47-vol5&collapse=true&fromBrowse=true). While the two masks are similar, there are noticeable points of difference. These include:

* The RAG Tx filter mask has a stepped response whereas the FCC mask is linear;
* The FCC filter mask assumes higher levels of attenuation from 0-50 MHz; and

The RAG Tx filter mask assumes a noticeably higher attenuation from 50-100 MHz and from 200 MHz onwards.

1. Comparison of FCC (blue) and RAG Tx (red) assumed Earth station RF filter performance

The RAG Tx filter mask was based on the technical performance of RF filters published by various manufacturers. This information was typically only defined for a set of frequency offsets (e.g. 0 MHz, 25 MHz, 50 MHz, 150 MHz etc). Consequently the RAG Tx filter mask appears stepped in nature. It is noted that this may underestimate the level of rejection at some frequency offsets, in particular from 0-50 MHz. It also suggests a higher level of rejection from 50-100 MHz offsets than the FCC filter mask.

1. **Is the current RAG Tx RF filter mask for ES suitable or should the FCC filter mask be adopted?**
2. **Is the current adjacent band protection criteria for earth stations appropriate? If not, what changes are proposed?**

The ACMA is still considering submissions that responded to the questions above. Additional responses to these questions are welcomed.

***Incumbent FSS protection criteria during the re-allocation period***

As part of re-allocation declaration the Minister defined a 5 year re-allocation period for apparatus licences services operating in Perth before their licences are cancelled. Both Optus and Telstra either have or are in the process of migrating their satellite services from the 3.6 GHz band. However, Inmarsat is unable to do this for their services located in Perth and it is expected they will make use of the five year period to migrate their services away from Perth.

In order to provide Inmarsat services with sufficient protection during the re-allocation period, in addition to the ‘general FSS protection criteria previously discussed, an additional short term protection criteria is also proposed. This is in line with the studies developed by the ACMA during the 3.6 GHz review process. The criteria proposed is based on [Recommendation ITU-R SF.1006](https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwiEvcqmkazaAhVJGpQKHYspBQQQFgguMAE&url=https%3A%2F%2Fwww.itu.int%2Fdms_pubrec%2Fitu-r%2Frec%2Fsf%2FR-REC-SF.1006-0-199304-I!!PDF-E.pdf&usg=AOvVaw2U6vwsqlMxzOiewpzUMQpc). Specifically it is proposed to define a maximum interference level of -119.9 dBm/MHz not to be exceeded for more than 0.005% of the time. It further proposed that this criteria only apply to the Inmarsat licences during the re-allocation period and only need to be met by proposed co-channel services.

1. **Is the additional protection short term protection criteria for Inmarsat services suitable?**

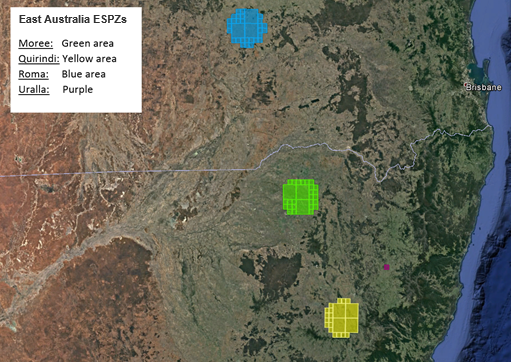
***Earth station protection zones***

The ACMA is interested in working with industry to identify and develop (ESPZs) in eastern and western Australia. The purposes of these ESPZs is to have defined areas outside of reasonably sized population centres that provide long-term certainty and flexibility for the investment in and operation of commercial space communications teleport facilities in Australia.

An ESPZ has already been identified near Mingenew in Western Australia. The area is currently protected by [Embargo 49](https://www.acma.gov.au/-/media/Spectrum-Engineering/Regulation/pdf/Embargo-No-49.pdf?la=en) (a kml file of the area viewable in Google Earth is also available on the [ACMA website](http://channelfinder.acma.gov.au/interforms/placemarks/embargo/embargo_49.kmz)).

As part of the outcomes announced in the paper *Future use of the 3.6 GHz band: Decisions and preliminary views* (3.6 GHz decision paper), the ACMA also identified three potential locations for an ESPZ in eastern Australia. These areas are currently protected by [Embargo 72](https://www.acma.gov.au/-/media/Spectrum-Engineering/Regulation/pdf/Embargo-No-72-pdf.pdf?la=en) and defined by Area 3, Area 4 and Area 5 in the embargo (a kml file of these areas viewable in Google Earth is also available on the [ACMA website](http://channelfinder.acma.gov.au/interforms/placemarks/embargo/embargo_72.kmz)). The relevant areas are reproduced in Figure 4.

1. East Australia ESPZs



The ACMA intends to work with industry to investigate the suitability each of the three eastern Australia ESPZs. Should it become apparent that one or more of these zones is not viable, the ACMA will remove any protection requirements in place and investigate mechanisms to make the area available for wide-area broadband services.

It is noted that another outcome of the 3.6 GHz decision paper was that the ACMA was open to working with stakeholders to:

* Identify a second ESPZ on the west coast of Australia. Though it is expected that any location considered would be outside of those areas re-allocated for the issue of spectrum licences in the 3.6 GHz band; and
* Determine the viability and location of an ESPZ located at latitudes above 15°.

However, work on these issues is outside the scope of the 3.6 GHz band TLG and will be considered under a separate process.

*Protection of ESPZs*

The existing embargoes, while an effective tool, are considered too conservative for the protection of the ESPZs. The ACMA believes the same level of protection can be provided while also allowing greater utilisation of the areas surrounding the ESPZs.

A summary of the proposed coordination procedure for ESPZs follows:

* No transmitters will be allowed within the designated ESPZ area (refer to Appendix G for area definitions);
* Spectrum licensees wishing to deploy a transmitter within 200 km of the ESPZ will be required to coordinate with a notional earth station receiver at each of several ‘defined’ locations within each ESPZ;
* The currently proposed locations for coordination at each ESPZ are at Appendix H. Each of these locations was chosen so as not to be located on top of a hill and as far as possible to take advantage of local terrain shielding.
* The same co-channel protection criteria that was defined for the protection of FSS earth stations is proposed to apply to each notional earth station receiver.
* The characteristics of the notional earth station receiver are:

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Height | 10m |
| Feeder loss | 0 dB |
| Antenna pattern | ITU-R S.465 with a D/λ value of 100 |
| Maximum Antenna gain | 58 dBi |
| Minimum antenna elevation | Protection must be afforded for the antenna pointing anywhere at the geostationary arc, down to a minimum elevation of 15° |
| Interference threshold | -128.6 dBm/MHz, assuming a receiver noise temperature of 100K, not to be exceeded for more than 20% of the time |

* As described in the *FSS protection criteria* section of this paper, any proposed transmitters will also be required to coordinate with any apparatus licensed earth station receivers in the ESPZ. Such coordination will occur on a first-in-time basis.

1. **Is the proposed coordination procedure for ESPZs suitable?**
2. **Are the proposed locations sufficient to provide nominal protection of each of the ESPZs?**
3. **Are the characteristics of the notional earth station receiver representative of gateway earth stations that could be deployed in each ESPZ?**
4. **Do stakeholders have any views on the viability of any of the proposed eastern Australia ESPZs?**

The ACMA is still considering submissions that responded to the questions above. Additional responses to these questions are welcomed.

***Protection of Lockheed Martin facility near Uralla (NSW)***

Earth stations operating at the Lockheed Martin facility near Uralla, NSW (the Uralla facility), are used to provide services such as TT&C as well as temporary missions to support Transfer Orbit and In-orbit satellite testing. While some of these services are permanent, others are temporary (or intermittent) and can operate in any portion of the band depending on each satellite’s design.

As of 1st March 2018, there are 4 earth station receiver licences for the Uralla facility. These licences occupy four 1 MHz bandwidths across the 3400-3700 MHz frequency range. However, as indicated other licences are taken out on ad hoc basis to support different missions. Therefore there is a need to provide a notional level of protection for the site so such missions can continue to be conducted across the 3400-4200 MHz band. Unfortunately this also means that the use of RF filtering to manage adjacent band interference is not possible.

*Protection requirements*

Co-channel interference for existing licensed services at the Uralla facility (inside HCIS NU7K4) would be provided by the co-channel protection requirements for earth stations previously discussed[[12]](#footnote-13). The adjacent band protection criteria also applies, however, in this case, the use of RF filtering cannot be assumed.

Broader protection of the entire 3400-4200 MHz band cannot be provided due to existing spectrum licences that cover the Uralla facility in the 3.4 GHz band and the fact the earth stations are a secondary service in the 3400-3600 MHz frequency range. For this reason general protection can only be considered for the 3600-4200 MHz frequency ranges. This means earth stations operating in the 3400-3600 MHz band at the Uralla facility do so on a ‘no protection from interference’ basis.

In order to provide general protection of the broader 3600-4200 MHz band a coordination process similar to that developed for the ESPZs is proposed.

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Location | Latitude -30.6315°, Longitude 151.5661° (GDA94) |
| Height | 25m |
| Antenna pattern | ITU-R S.465 with a D/λ value of 100 |
| Maximum Antenna gain | 58 dBi |
| Minimum antenna elevation | 5° (any direction) |
| Interference threshold | -128.6 dBm/MHz, assuming a receiver noise temperature of 100K, not to be exceeded for more than 20% of the time |
| Receiver overload | -65 dBm (total received power) |

It is further proposed that the protection criteria for the Lockheed Martin facility also be contained in a new RALI (with a working title of RALI[ESPZ]) which would then be incorporated by reference into the RAG Tx. A draft version of RALI[ESPZ] will also be made available to the TLG to consider in due course.

Given some of the services operating at the Uralla facility are temporal in nature and/or may only track certain parts of the sky, there may be opportunity for detailed negotiations between licensees to manage interference while improving spectrum utilisation.

Please note that as indicated in the paper *Future use of the 3.6 GHz band—Decisions and preliminary views*, the long-term viability of the Uralla facility may be reviewed in the future. This is in light of the increasing demand for fixed and mobile broadband capacity, growing international interest in the 3700–4200 MHz band for use by fixed and mobile broadband services and the proximity of the site to major regional population centres. However, if it is shown that fixed and mobile broadband service deployments in nearby major towns are not unreasonably restricted (noting there is likely to be some restrictions), this would be taken into consideration when assessing the long term viability of the Uralla facility.

1. **Are the protection requirements proposed for the Uralla facility suitable?**

The ACMA is still considering submissions that responded to the questions above. Additional responses to these questions are welcomed.

***Frequency assignment requirements for point-to-multipoint licences in the 3.6 GHz band***

Frequency assignment criteria for P-MP licences in the 3425-3700 MHz frequency range are contained in [RALI FX14](https://www.acma.gov.au/-/media/Spectrum-Engineering/Information/Word-Document/RALI-FX14-PMP.doc?la=en) (P-MP licences in the 3425-3442.5 MHz and 3475-3492.5 MHz bands) and [RALI FX19](https://www.acma.gov.au/theACMA/frequency-coordination-licensing-bwa-19001920-20102025-and-35753700-mhz-bands) (P-MP licences in the 3575-3700 MHz band). It is proposed to revise the criteria in RALI FX19 to account for the Minister’s 3.6 GHz band re-allocation declaration and updates to the 3.4 GHz band spectrum licence technical framework. No changes are proposed to RALI FX14.

An overview of the changes proposed to RALI FX19 include:

* The inclusion of co-channel protection criteria between P-MP licences issued before 9th March 2018 (the date the Minister’s 3.6 GHz band spectrum re-allocations take affect) and transmitters registered for operation under a spectrum licences;
* The inclusion of a device boundary requirement for new P-MP licences in remote areas to manage the strength of emissions into regional areas re-allocated for the issue of spectrum licences;
* Revision of the adjacent channel coordination requirements between P-MP licences and transmitters registered for operation under a spectrum licence, to reflect updates to the 3.4 GHz band spectrum licence technical framework;
* General editorial updates to reflect the Minister’s 3.6 GHz band re-allocation declaration and the changes made to the frequency assignment criteria.

A draft update to RALI FX19, which details all these changes, will be made available to the TLG to consider in due course. In the meantime the proposed protection criteria for P-MP licences is in the next section.

**Proposed Changes to RALI FX 19**

With the spectrum licensing frequency range increasing, the scenario of co-channel sharing arrangements between P-MP licences and services operated under a spectrum licence needs to be considered. The ACMA has also taken this opportunity to ensure the specifications for both services accurately represent modern deployment.

***P-MP Tx to Spectrum Licensed Rx***

As a result of the Minister recent re-allocation declaration, the licensing of new apparatus licensed P-MP transmitters is now restricted in metropolitan and regional areas of the 3.6 GHz band. This means that, except under special circumstances, new deployments in the 3.6 GHz band will be under spectrum licences. To provide maximum flexibility to spectrum licensees, it is proposed that they be responsible for performing an assessment of interference into receivers deployed under their own spectrum licence. Each licensees can then determine what, if any, mitigation measures are required to manage interference. As such, no formal coordination process is proposed for this scenario. General protection criteria if required for coordination is contained in the RAG Rx.

***Spectrum Licensed Tx to P-MP Rx***

While the licensing of new P-MP receivers is now restricted in regional and remote areas of the 3.6 GHz band, there are a number of existing P-MP receivers need to be protected until the end of the seven year re-allocation period. The proposed protection criteria is detailed below. The ACMA has tried to ensure the rules developed not only provide sufficient protection to P-MP licensees, but allow spectrum licensees the ability to design and deploy any new spectrum licensed service with the suitable flexibility. Of course licensees are also free to negotiate alternative arrangements.

The ACMA proposes to specify a recommended minimum distance cull and minimum separation distance. The minimum distance cull is the distance from the spectrum licence transmitter which a P-MP receiver needs to be considered for potential interference. The minimum separation distance is the minimum distance that a spectrum licence transmitter can be to a P-MP receiver.

*Minimum separation distance*

The proposed minimum separation distance for co-channel services is 20 km. This is based the understanding that the typical coverage area for a WAS system is 15 km. The ACMA has provided an additional 5 km to ensure that any new spectrum licence transmitter is located outside the notional coverage area of a P-MP licence. This ensures that interference from spectrum licence user terminals into P-MP user terminal is minimised.

To manage adjacent channel interference it is proposed that the 20 km minimum separation also apply to the adjacent 10 MHz as well.

The is no minimum separation distance for adjacent channel services

*Minimum distance cull*

Based on the parameters specified in this document the following minimum distance cull were calculated for different frequency offsets:

|  |  |
| --- | --- |
| **offset\*** | **Minimum distance cull** |
| Co-channel | 92.5 km |
| 0-5 MHz | 61 km |
| 5-10 MHz | 56 km |
| >10 MHz | 49 km |

\* Note: Offset is the frequency separation between the edge of the transmitter’s occupied bandwidth and the P-MP receiver licence channel edge

The proposed coordination methodology in RALI FX 19 has been streamlined to allow spectrum licensees the flexibility to use situation specific modelling to maximise spectrum efficiency. As such the ACMA has specified:

* a general cull distance of 95 km for both co-channel and adjacent channel coordination;
* a frequency cull that extends ±1.5BWTx from the centre frequency of the proposed transmitter, to a minimum of ±12.5 MHz, where BWTx is the occupied bandwidth of the proposed transmitter.
* an unwanted interference level of -115 dBm/ 1 MHz (based on a receiver noise floor of -109 dBm/1 MHz and an I/N of – 6 dB); and
* a notional receiver mask for P-MP systems.

As a starting point for the purpose of this analysis, the notional receiver mask for the P-MP system has been based on the E-UTRA specifications provided in the 3GPP TS 36.104 standard. The notional receiver is proposed to be:

* a selectivity of 45 dB between 0 and 5 MHz offset\* (based on Adjacent Channel Selectivity criteria); and
* a selectivity of 53 dB for offsets\* greater than 5 MHz (based on in-band Blocking criteria)

\* Note: Offset is the frequency separation between the edge of the transmitter’s occupied bandwidth and the P-MP receiver licence channel edge

Using the above information and the spectrum licenced transmitter details, the spectrum licensees can calculate the necessary Frequency Dependent Rejection (FDR) ratio based on methodology provided in [Recommendation ITU-R SM.337-6](https://www.itu.int/rec/R-REC-SM.337-6-200810-I/en) and quantify the potential interference. This give spectrum licensees the flexibility to determine the level of unwanted emissions for their system that will be appropriately to ensure coexistence with BWA services.

It is the responsibility of the spectrum licensee to take the necessary action to ensure a proposed transmitter does not cause interference with an existing P-MP receiver within the minimum distance cull.

Please note that:

* Under the criteria proposed, coordination is not required beyond the first adjacent channel of the proposed transmitter.
* Spectrum licensees can forgo adjacent channel coordination (not co-channel), if they align the transmit/receive timing of their systems with existing P-MP licence(s) to avoid interference.

***Specifications used for analysis***

When developing the proposed coordination criteria, the following details have been used to determine the minimum distance to avoid unacceptable interference (cull distance) and a minimum separation distance.

For the purposes of determining cull distances, the worst case scenario has been used. In this cases that is a base (high site) to base station (high site) interference. Antenna heights of 50 m have been assumed.

Free space loss and empirical smooth earth (as defined in [Recommendation ITU-R P.526](https://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj3n7-er6zaAhVIvbwKHbWXCbEQFggnMAA&url=https%3A%2F%2Fwww.itu.int%2Frec%2FR-REC-P.526%2Fen&usg=AOvVaw3YS9x0KhsW9WgxYNzgCAXS)) has been used for the propagation modelling.

***Spectrum Licence BS transmitter details***

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Frequency (GHz) | 3.6 | Assumed |
| maximum TRP (dBm/ 5 MHz) | 47 | Proposed maximum in-band TRP for 3.6 GHz band |
| antenna gain (dBi) | 29 | Assumes an 16x16 array with 5 dBi gain elements |
| EIRP (dBm/ 5 MHz) | 76 | Calculated |
| EIRP (dBm/ 1 MHz) | 69 | Calculated |

The final EIRP (dBm/1 MHz) is based on the proposed maximum in band TRP and an active antenna system with an assumed maximum 16x16 array and elements with a 5 dBi gain.

The proposed spectrum licence unwanted emission masks have also been assumed to determine the levels of emissions in adjacent channels.

***P-MP receiver details***

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Frequency (GHz) | 3.6 | Assumed |
| antenna gain (dBi) | 19 | RRL Data |
| feeder loss (dB) | 0 | Worst case assumption |
| Noise Floor (dBm/ 1 MHz) | -109 | RALI FX19 |
| I/N (dB) | -6 | Same protection afforded to Rx operated under a 3.6 GHz spectrum licence |

***Link Budget***

The following is a summary of link budget used to derive the minimum cull distances.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| offset (MHz) | 0 | 0 - 5 | 5 - 10 | >10 |
| **SL transmitter** | | | | |
| frequency (GHz) | 3.6 | | | |
| bandwidth (MHz) | 5 | | | |
| power into antenna (dBm) | 47 | 12 | 5 | -6 |
| antenna gain (dBi) | 29 | | | |
| array loss (dB) | 0 | | | |
| EIRP (dBm/5MHz) | 76.0 | 41.0 | 34.0 | 23.0 |
| EIRP (dBm/1MHz) | 69.0 | 34.0 | 27.0 | 16.0 |
|  | | | | |
| **BWA receiver** | | | | |
| bandwidth (MHz) | 1 | | | |
| antenna gain (dBi) | 19.0 | | | |
| sensitivity (dBm/1MHz) | -109 | | | |
| protection ratio (dB) | 6 | | | |
|  | | | | |
| **Analysis** | | | | |
| loss required (dB) | 203.0 | 168.0 | 161.0 | 150.0 |
| distance via free space (km) | 93802 | 1668 | 745 | 210 |
| distance via smooth earth (km) | 92.5 | 68.5 | 64.0 | 56.6 |

1. **Are the proposed coordination criteria with P-MP services suitable?**
2. **Is any alternative criteria proposed?**

***Frequency assignment requirements for PTS licence in the 3.5 GHz band***

Frequency assignment criteria for PTS licences in the 3400-3425 MHz and 3492.5-3542.5 MHz frequency range are contained in [RALI](https://www.acma.gov.au/-/media/Spectrum-Engineering/Information/Word-Document/RALI-FX14-PMP.doc?la=en) MS39. If a single technical framework is adopted for spectrum licences in the 3425-3700 MHz frequency range, it is proposed to revise the criteria in RALI MS39 to match the changes to the 3.4 GHz spectrum licence technical framework. These changes will be made and consulted on if and when it is known whether a single spectrum licence technical framework applies.

### Managing interference to spectrum-licensed receivers

The [*Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band) 2015*](http://www.comlaw.gov.au/Details/F2015L00729) (RAG Rx) provides guidance on the management of interference to receivers operating under a 3.4 GHz band spectrum licence.

A key part of the management of this type of interference is the specification of a notional receiver performance level and a compatibility requirement. This provides a base for the operators of radiocommunications transmitters to coordinate their services against. While adherence to the notional receiver is optional, the ACMA will have regard to it when settling interference disputes. For this reason, it is recommended that all receivers operating under a spectrum licence have a performance level at least equal to the defined notional receiver.

It is proposed that the existing RAG Rx be updated to include the 3.6 GHz band and protection requirements of relevant services be updated to account for this. Some of the key differences between the existing RAG Rx and the proposed updated RAG Rx are[[13]](#footnote-14):

* Section 1.4(1) - Include 3.6 GHz into the frequency ranges covered by the RAG Rx. Also include a definition of unwanted emissions.
* Replace ‘out-of-band emission’ with ‘unwanted emission’ throughout out the document.
* Section 3.1(2) & (5) – Update clauses to include how in-band interference from apparatus licences is managed in the 3575-3700 MHz band.
* Section 3.1(4) – additional text pointing spectrum licensees to new section 3.2(4) for additional guidance on managing interference from radiolocation services.
* New section 3.2(4) – Providing advice and guidance on managing interference from radiolocation services.
* Section 5.1(3) – removal of reference to Schedule 3 and inclusion of text regarding the synchronisation requirement.
* Amendment to the blocking requirements of the notional receiver.
* Schedule 3 – Deletion of this section and relevant text within the RAG Rx. If a synchronisation fall back requirement is proposed to be adopted this schedule is no longer required.

Only one change is proposed to the definition of the notional receiver in Schedules 1. Since a synchronisation fall back requirement is proposed to be adopted, the stricter in-band blocking level is no longer required. Therefore aligning the in-band blocking levels with those defined in 3GPP standards is proposed. In order to manage out-of-band blocking from high powered radar services operating in the 3100-3400 MHz frequency range a higher blocking is also proposed. Development of this level is discussed in the next section.

No changes is proposed to the compatibility requirement in Schedules 2.

A draft update to the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers— 3.4 GHz Band) 2015*is at Appendix E.

1. **Should the current 3.4 GHz band RAG Rx be adopted with the changes proposed for the 3.6 GHz band? If not, why? Are any other modifications proposed?**
2. **Is further guidance required in the RAG Rx (and/or the RAG Tx) on how to coordinate with devices with active antenna systems?**

***Managing interference from Radiolocation services operating in the 3100-3500 MHz band***

The Department of Defence (DoD) operate high power radiolocation services in the 3100-3500 MHz band (potentially down to 2700 MHz) on an itinerant basis. Such radars have the potential to disrupt the throughput of 3.4GHz band receivers particularly on the uplink channel (base station receiver). The DoD already employ techniques to minimise impacting other in-band and adjacent band services. However, there will be occasions when interference cannot be fully mitigated by these techniques. In such instances the interference may be due to blocking, strong out of band emissions of the radar, or other susceptibilities within a 3.4GHz fixed or mobile wireless network configuration.

In order to best manage interference in such circumstances, spectrum licensees (in addition to mitigations measures taken by DoD) will also need to consider various mitigation techniques for their own services. Therefore when planning service deployments, spectrum licensees are urged to consider different engineering techniques to reduce the likelihood of impact to their spectrum licensed service. Such engineering techniques may include additional RF filtering, network redundancy, or resilience of network configuration where vulnerabilities to radar signal interference are identified.

The ACMA will work with DoD to provide what additional information it can to assist spectrum licensees on this matter. Such information will only be given directly to existing or likely perspective spectrum licensees in the 3.4/3.6 GHz band. The ACMA also proposes to include a new clause 3.2(4) in the RAG Rx to make current and future spectrum licensees aware of this issue.

To minimise the potential for disruption of services during general day-to-day operations, it is proposed that a stricter out-of-band blocking level be defined for receivers operated under a spectrum licence. The current level defined in 3GPP standards is an interfering signal mean power of -15 dBm. The ACMA has worked with DoD to determine that a blocking level of +20 dBm in the 2700-3340 MHz frequency range would be appropriate. While this level will not provide a 100% assurance of protection in every case, it does provide a reasonable compromise between mitigation measures employed by DoD and spectrum licensees. On a case-by-case basis, spectrum licensees may also need to consider additional mitigation techniques to assist in the management of interference.

Licensees should also be aware that while the use of various mitigation techniques by DoD and spectrum licensees will go a long way to managing inference, there may still be occasions and locations where DoD need to operate outside the mitigation measures they generally employ on a day-to-day basis.

The ACMA is currently working with Defence on a possible review of section 3.10 of RALI MS39 which relates to Radiodetermination services. Any proposed draft updates will be provided to the TLG for consideration.

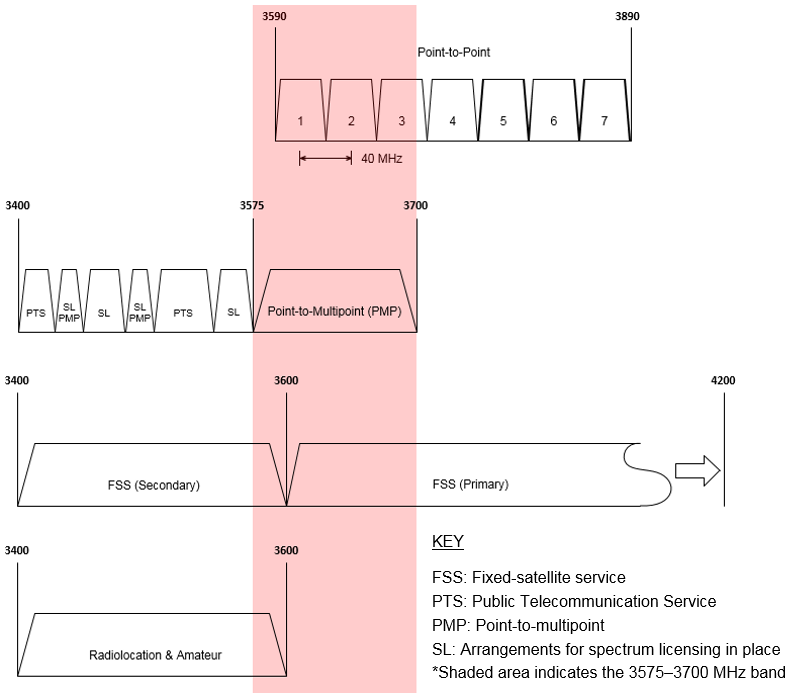
1. **Is the proposed text in new clause 3.2(4) of the Rag Rx appropriate?**
2. **Is the additional blocking level proposed in the notional receiver appropriate? Are other measures proposed to assist in the management of interference from radiolocation services?**

Please note that, as mentioned previously, it is not a requirement for spectrum licensees to meet any or all aspects of the notional receiver. However, it does provide a baseline for operators of radiocommunications transmitters to coordinate their services against. So while adherence to the notional receiver is optional, the ACMA will have regard to it when settling interference disputes. For this reasons the ACMA and DoD will work together to provide what information it can to provide guidance to licensees on where the additional blocking requirement is likely to be needed.

# Appendix A – Current use of the 3.6 GHz and adjacent bands

Figure 4 provides the current arrangements in the 3.6 GHz band (shown by the shaded area) and adjacent bands. Table 8 and Figure 5 provide information on the number and location of existing apparatus-licensed services in the 3.6 GHz band.

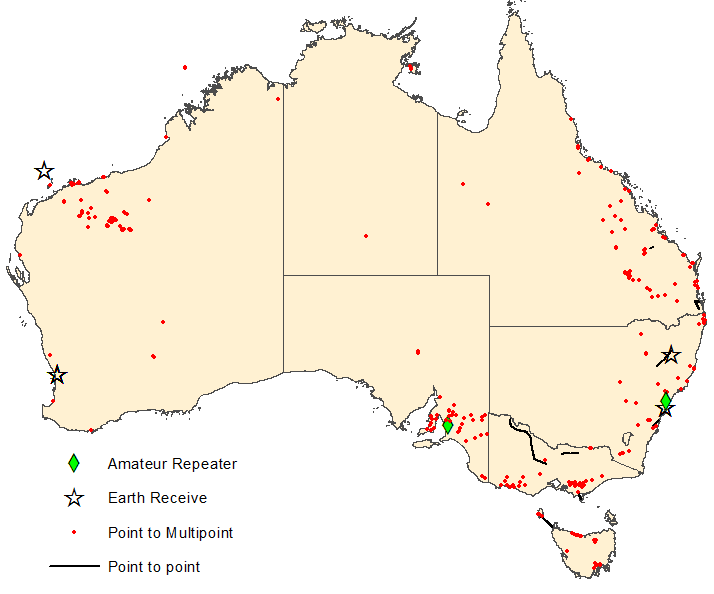
1. 3.6 GHz band arrangements



1. Breakdown of licences in the 3.6 GHz band (RRL extract, 1 February 2017)

| Licence type | No. of licences | No. of licensees | Major licensees (number of licences) |
| --- | --- | --- | --- |
| Earth receive | 19 | 5 | Telstra (9), Inmarsat (6), Lockheed Martin (2), Optus (1) |
| Point-to-multipoint | 443 | 62 | Pilbara Iron Company (63), BHP Billiton Iron Ore (46), Aus Pacific LNG (28), Aussie Broadband (28), Agile (25), Connectivity I.T. Pty Ltd (22), Dep Transport Qld (19), Tasmanet (18), QEStel (18) |
| Point-to-point | 46 | 5 | Digital Distributions Australia (37), Telstra (6) |
| Amateur repeater | 2 | 2 | Elizabeth Amateur Radio Club (1), Central Coast Amateur Radio Club (1) |

1. Location of embargoed areas and licensed services in the 3.6 GHz band (RRL extract, 1 February 2017)



# Appendix B – Current 3.4 GHz band unwanted emission limits

## Frequency band and geographic areas

1. This licence authorises the operation of radiocommunications devices in the frequency bands and within the geographic areas set out in Part 2 of Licence Schedule 1.

## Emission limits outside the frequency band

1. Core conditions 3 to 10 apply in relation to those frequencies that are outside the frequency bands set out in Part 2 of Licence Schedule 1.
2. Where a written agreement specifying the maximum permitted level of radio emission for frequencies described in core condition 2 exists between:
   1. the licensee; and
   2. all the affected licensees of frequency-adjacent spectrum licences and area-adjacent spectrum licences;

the licensee must comply with that specified maximum permitted level of radio emission.

1. Where there is no written agreement for the purposes of core condition 3 in force, the licensee must comply with core conditions 5 to 10.

## Non spurious emission limits

1. (1) The licensee must ensure that radiocommunications transmitters operated under this licence, other than a transmitter that is not exempt from the registration requirement under statutory condition 4 of Licence Schedule 3, does not exceed the non spurious emission limits in core condition 6.

(2) The licensee must ensure that radiocommunications transmitters operating under this licence that are exempt from the registration requirement under statutory condition 4 of Licence Schedule 3 do not exceed the non spurious emission limits described in core condition 7.

1. The non spurious emission limits in Table 3 apply:
   1. at frequencies outside the upper or lower frequency limits set out in Part 2 of Licence Schedule 1; and
   2. offset from the upper or lower frequency limits set out in Part 2 of Licence Schedule 1;

where:

**foffset:** is the frequency offset from the upper or lower frequency limits set out in Part 2 of Licence Schedule 1. The closest -3dB point of the specified bandwidth to the upper or lower frequency limits of the licence is placed at **foffset.**

## Licence Table 3: Radiated maximum true mean power non-spurious emission limits

|  |  |  |
| --- | --- | --- |
| **Frequency offset range**  **(foffset)** | **Radiated maximum true mean power (dBm EIRP)** | **Specified Bandwidth** |
| 0 kHz < foffset < 5 MHz | 10 - (7/5) x f offset (MHz) | 100 kHz |
| 5 MHz < foffset < 10 MHz | 3 | 100 kHz |
| foffset > 10 MHz | 2 | 1 MHz |

1. The non spurious emission limits in Table 4 apply:
   1. at frequencies outside the upper or lower frequency limits set out in Part 2 of Licence Schedule 1; and
   2. offset from the upper or lower frequency limits set out in Part 2 of Licence Schedule 1;

where:

**foffset:** is the frequency offset from the upper or lower frequency limits set out in Part 2 of Licence Schedule 1. The closest -3dB point of the specified bandwidth to the upper or lower frequency limits of the licence is placed at **foffset.**

## Licence Table 4: Radiated maximum true mean power non-spurious emission limits

|  |  |  |
| --- | --- | --- |
| **Frequency offset range**  **(foffset)** | **Radiated maximum true mean power (dBm EIRP)** | **Specified Bandwidth** |
| 0 kHz < foffset < 1 MHz | -15 | 30 kHz |
| 1 MHz < foffset < 20 MHz | -13 | 1 MHz |
| foffset > 20 MHz | -25 | 1 MHz |

**Spurious Emission Limits**

1. The licensee must ensure that radiocommunications devices operated under this licence do not exceed the spurious emission limits in core conditions 9 and 10.
2. For radiocommunications transmitters operated under this licence, the spurious emission limits in Table 5 apply at frequencies outside the 3390-3610 MHz frequency band, measured over the specified bandwidth for the relevant frequency range.

## Licence Table 5: Radiocommunications transmitter spurious emission limits

|  |  |  |
| --- | --- | --- |
| **Frequency range**  **(f)** | **Mean power**  **(dBm)** | **Specified**  **Bandwidth** |
| 9 kHz < f < 150 kHz | -36 | 1 kHz |
| 150 kHz < f < 30 MHz | -36 | 10 kHz |
| 30 MHz < f < 1 GHz | -36 | 100 kHz |
| 1 GHz < f < 12.75 GHz | -30 | 1 MHz |

1. For radiocommunications receivers operated under this licence, the spurious

emission limits in Table 6 apply at frequencies outside the 3390-3610 MHz frequency band, measured over the specified bandwidth for the relevant frequency range.

## Licence Table 6: Radiocommunications receiver spurious emission limits

|  |  |  |
| --- | --- | --- |
| **Frequency range**  **(f)** | **Radiated mean power**  **(dBm EIRP)** | **Specified**  **Bandwidth** |
| 30 MHz < f < 1 GHz | -57 | 100 kHz |
| 1 GHz < f < 12.75 GHz | -47 | 1 MHz |

# Appendix C – Draft Radiocommunications (Unacceptable Levels of Interference - 3.4 GHz Band) Determination

Refer to attachment on SharePoint

# Appendix D – Draft Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters – 3.4 GHz Band)

Refer to attachment on SharePoint

# Appendix E – Draft Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band)

Refer to attachment on SharePoint

# Appendix F – Draft spectrum licence

Refer to attachment on SharePoint

# Appendix G – ESPZ area definitions

The HCIS area definition of ESPZs is contained in Table 9.

The Australian Spectrum Map Grid (ASMG) is used to define geographical areas over which spectrum licences are issued. The Hierarchical Cell Identification Scheme (HCIS) is a naming convention developed by the ACMA that applies unique ‘names’ to each of the cells that make up the ASMG. The ASMG and HCIS are described in detail in the document *[The Australian spectrum map grid 2012](http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/About-spectrum-planning/technical-framework-3_4-ghz)*.

The HCIS coordinates in the table below can be converted into a Placemark file (viewable in Google Earth) through a facility on the ACMA website: [www.acma.gov.au/theACMA/convert-hcis-area-description-to-a-placemark](http://www.acma.gov.au/theACMA/convert-hcis-area-description-to-a-placemark)

1. ESPZ area definitions.

| Area name | HCIS |
| --- | --- |
| Moree | MU5G, MU5H, MU5L, MU5C8, MU5C9, MU5D7, MU5D8, MU5D9, MU5K1, MU5K2, MU5K3, MU5K4, MU5K5, MU5K6, MU5K8, MU5K9, MU6A7, MU6E1, MU6E2, MU6E4, MU6E5, MU6E7, MU6E8, MU6I1, MU6I2, MU6I4, MU6I5, MU6I7 |
| Quirindi | MV3G, MV3H, MV3K, MV3L, MV3C8, MV3C9, MV3D7, MV3F3, MV3F5, MV3F6, MV3F8, MV3F9, MV3J2, MV3J3, MV3J5, MV3J6, MV3J9, MV3O1, MV3O2, MV3O3, MV3P1 |
| Roma | MT4H, MT4K, MT4L, MT4F9, MT4G2, MT4G3, MT4G4, MT4G5, MT4G6, MT4G7, MT4G8, MT4G9, MT4J3, MT4J6, MT4O1, MT4O2, MT4O3, MT4O6, MT4P1, MT4P2, MT4P3, MT4P4, MT4P5, MT5E4, MT5E7, MT5I1, MT5I2, MT5I4, MT5I5, MT5I7, MT5M1 |
| Mingenew | BU4B, BU1N, BU1M6, BU1M8, BU1M9, BU1O4, BU1O7, BU1O8, BU4A2, BU4A3, BU4A6, BU4C1, BU4C2, BU4C4 |

# Appendix H – ESPZ coordination points

1. ESPZ coordination points.

|  |  |  |  |
| --- | --- | --- | --- |
| ESPZ name | Point ID | Latitude (GDA94) | Longitude (GDA94) |
| Mingenew | 1 | -29.045905 | 115.350437 |
| 2 | -29.078611 | 115.233333 |
| 3 | -29.078611 | 115.457778 |
| 4 | -28.9 | 115.457778 |
| 5 | -28.9 | 115.233333 |
| Quirindi | 1 | -31.278542 | 150.664064 |
| 2 | -31.531797 | 150.392637 |
| 3 | -31.758854 | 150.673901 |
| 4 | -31.334364 | 150.462804 |
| 5 | -31.683343 | 150.483362 |
| 6 | -31.524093 | 150.815250 |
| 7 | -31.472816 | 150.681203 |
| Moree | 1 | -29.202410 | 149.840025 |
| 2 | -29.470438 | 149.530685 |
| 3 | -29.740189 | 149.840030 |
| 4 | -29.436083 | 150.130913 |
| 5 | -29.375475 | 149.730499 |
| 6 | -29.566334 | 149.730211 |
| 7 | -29.566412 | 149.949630 |
| 8 | -29.366173 | 149.949382 |
| Roma | 1 | -26.571626 | 148.633980 |
| 2 | -26.590870 | 148.501616 |
| 3 | -26.708009 | 148.632882 |
| 4 | -26.840857 | 148.784921 |
| 5 | -26.710678 | 148.940348 |
| 6 | -26.588340 | 149.083815 |
| 7 | -26.571818 | 148.935420 |
| 8 | -26.516060 | 148.779018 |
| 9 | -26.589408 | 148.856840 |

1. Refer to [Radiocommunications (Spectrum Re-allocation—3.6 GHz Band for Adelaide and Eastern Metropolitan Australia) Declaration 2018](https://www.legislation.gov.au/Details/F2018L00225), [Radiocommunications (Spectrum Re-allocation—3.6 GHz Band for Perth) Declaration 2018](https://www.legislation.gov.au/Details/F2018L00221) and [Radiocommunications (Spectrum Re-allocation—3.6 GHz Band for Regional Australia) Declaration 2018](https://www.legislation.gov.au/Details/F2018L00222) [↑](#footnote-ref-2)
2. Refer to [Radiocommunications (Spectrum Re-allocation—3.6 GHz Band for Adelaide and Eastern Metropolitan Australia) Declaration 2018](https://www.legislation.gov.au/Details/F2018L00225), [Radiocommunications (Spectrum Re-allocation—3.6 GHz Band for Perth) Declaration 2018](https://www.legislation.gov.au/Details/F2018L00221) and [Radiocommunications (Spectrum Re-allocation—3.6 GHz Band for Regional Australia) Declaration 2018](https://www.legislation.gov.au/Details/F2018L00222) [↑](#footnote-ref-3)
3. Available at: <http://www.acma.gov.au/webwr/_assets/main/lib410188/australian_spectrum_map_grid_28feb2012.docx> [↑](#footnote-ref-4)
4. 3GPP TS 36.104, available at: <http://www.3gpp.org/DynaReport/36104.htm> [↑](#footnote-ref-5)
5. 3GPP TS 36.101, available at: <http://www.3gpp.org/DynaReport/36101.htm> [↑](#footnote-ref-6)
6. 3GPP TS 36.104, available at: <http://www.3gpp.org/DynaReport/36104.htm> and 3GPP TS 38.104, available at <http://www.3gpp.org/DynaReport/38104.htm> [↑](#footnote-ref-7)
7. 3GPP TS 36.101, available at: <http://www.3gpp.org/DynaReport/36101.htm> and 3GPP TS 38.101, available at: <http://www.3gpp.org/DynaReport/38-series.htm> [↑](#footnote-ref-8)
8. In the s.145 determination RP is defined as: *the horizontally radiated power, measured in dBm EIRP per MHz, for each bearing, σn*. [↑](#footnote-ref-9)
9. A dead-zone is an area close the boundary which is effectively rendered unusable (or where there are greater restrictions no how a service can be deployed) due to the DBC or other deployment constraints limiting the deployment of transmitters. [↑](#footnote-ref-10)
10. A full list of RALIs currently in-force is available on the [ACMA website](http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/Frequency-assignment-and-coordination/frequency-assignment-requirements-spectrum-planning-acma). [↑](#footnote-ref-11)
11. It is noted that the *Unwanted emission limits* section of this paper also sought feedback on whether it is practical for the RAG Tx (and RAG Rx) to require spectrum licensees to work with each other to manage interference including reducing OOB emissions to a more stringently defined level [↑](#footnote-ref-12)
12. It is noted that earth stations operating in the 3400-3600 MHz band are a secondary service and therefore cannot claim protection from interference caused by primary services. [↑](#footnote-ref-13)
13. It is noted that the *Unwanted emission limits* section of this paper also sought feedback on whether it is practical for the RAG Tx and RAG Rx to require spectrum licensees to work with each other to manage interference including reducing OOB emissions to a more stringently defined level. [↑](#footnote-ref-14)