Development of the 26/28 GHz band apparatus licence technical framework

Technical Liaison Group Consultation Paper

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# Version Control

|  |  |
| --- | --- |
| **Version** | **Comments** |
| Version 1.0 | Initial release |
|  |  |

# Introduction

In recent years, the 26 GHz (24.25-27.5 GHz) and 28 GHz (27.5-29.5 GHz) bands have become the focus of the roll-out of millimetre wave band wireless broadband services (also referred to as 5G).

The Australian Communications and Media Authority (the ACMA) commenced planning for wireless broadband service delivery in the 26 GHz band with a Spectrum Tune-up held in September 2017. In September 2018, we released an [options paper](https://www.acma.gov.au/theACMA/options-for-wireless-broadband-in-the-26-ghz-band), which included details on the drivers for wireless broadband access to the band, international studies and trends and planning options for the band.

The ACMA also convened the *Working Group on Inter-service Coexistence* (the 26 GHz Working Group) which drew a membership from interested industry stakeholders. The purpose of this working group was to help inform stakeholder input on some of the technical issues canvassed in the options paper, specifically, how coexistence with satellite receivers in and adjacent to the 26 GHz band could be assured.

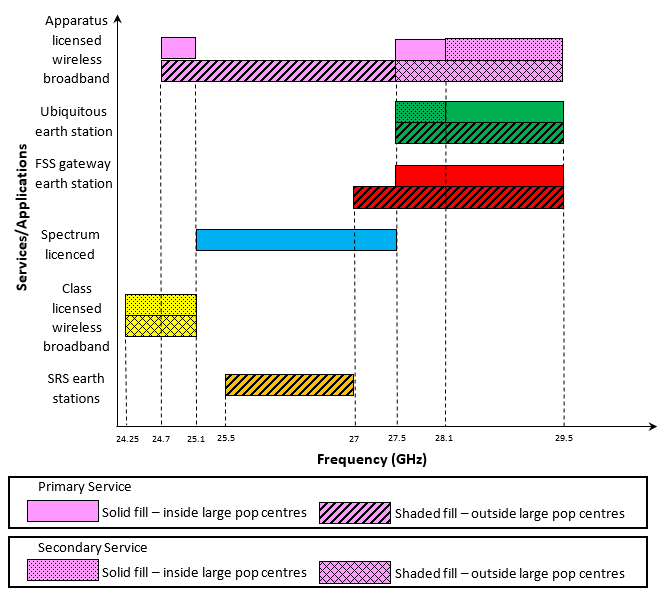
In April 2019, the ACMA released the [Future use of the 26 GHz band — planning decisions and preliminary views](https://www.acma.gov.au/theACMA/options-for-wireless-broadband-in-the-26-ghz-band) paper (the 26 GHz band decision paper). This paper outlined the ACMA’s planning decisions to introduce wireless broadband services using class, apparatus and spectrum licences in different parts of the 26 GHz band. Preliminary views on key licence conditions were also included in the decision paper, however it was noted that these conditions would be bedded down later as part of future consultation processes, such as this Technical Liaison Group (TLG) and routine consultation on updates to Radiocommunications Licensing and Assignment Instructions (RALIs) and class licences, as applicable.

Key decisions set out in the 26 GHz band decision paper included how different parts of the band would be licensed to accommodate a range of use cases. One of these was that the frequency range 25.1-27.5 GHz in areas not subject to the [*Radiocommunications (Spectrum Re-allocation—26 GHz Band) Declaration 2019*](https://www.legislation.gov.au/Details/F2019L01374) (the 26 GHz band reallocation declaration), and in 24.7-25.1 GHz would be made available for apparatus licensing. The ACMA also proposed that spectrum earmarked for apparatus licensing should be made available on an area-wide basis, possibly using a new area-based apparatus licence type (referred to at the time as spectrum-space licences).

In September 2019, the ACMA released the paper [Future use of the 28 GHz band – Planning decisions and preliminary views](https://www.acma.gov.au/sites/default/files/2019-11/Future-use-of-the-28-GHz-band-Final.docx) (the 28 GHz band decision paper). This paper outlined the ACMA’s intention to introduce new arrangements for fixed wireless access (FWA) services across the entire 28 GHz band, as well as expanded access for fixed satellite services (FSS)

The combined planning decisions in the 26 GHz and 28 GHz band are shown in Figure 1.

1. Combined 26 GHz and 28 GHz planning arrangements[[1]](#footnote-2)



### ‘Area-wide’ licence concept

The ACMA has previously indicated that it will consider an ‘area-wide’ apparatus licensing approach in the 26/28 GHz band.[[2]](#footnote-3) The purpose of this approach is to provide a technology flexible framework, where – although the framework would be optimised for the deployment of wireless broadband services – any technology or service type can be deployed within the licensed area as long as it fits within the envelope of the technical framework.

The type of apparatus licence used to deliver this proposed ‘area-wide’ technical framework is yet to be determined – options include point-to-multipoint and the potential new area-wide licence (AWL) pending an ACMA decision on whether or not to make this new licence type.[[3]](#footnote-4) Until a decision on which apparatus licence option to use, this paper will the generic term ‘area-wide’ apparatus licence.

### Purpose

The purpose of this paper is to develop a technical framework for apparatus licences to be issued in the range 24.7-29.5 GHz (in the combination of frequency ranges and areas not subject to the 26 GHz band reallocation declaration) – referred to in this paper as the ‘26/28 GHz bands’. The technical framework is proposed to be optimised for the deployment of wireless broadband services. This paper proposes and seeks comment on a draft technical framework for apparatus licences in the 26/28 GHz bands.

A technical framework is a collection of technical and regulatory conditions applicable to the use of radiocommunications devices. The purpose of the technical framework is to define the technical conditions and constraints under which devices may be deployed and operated within the specified geographic area and frequency band of the licence.

It is proposed that the apparatus licence technical framework for the 26/28 GHz bands will be *optimised* for the types of services and/or technologies most likely to be deployed in the band, however it is also intended to be technology-flexible. This means licensees would be able to operate any type of radiocommunications device for any purpose, provided they comply with the technical framework relevant to the licence.

## Outline

This paper has been divided into discussions of proposed coexistence arrangements with other services in the 26/28 GHz bands and on the proposed parameters that will form the ‘area-wide’ apparatus licence technical framework in the 26/28 GHz bands. Draft versions of a new RALI (denoted as RALI[new] in this paper) and potential updates to a relevant licence conditions determination[[4]](#footnote-5) (LCD) made under paragraph 107(1)(f) of the Radiocommunications Act 1992 (the Act), which will form the technical framework, are also included in Appendix A and B respectively.

For simplicity, in this paper, the LCD which may be subject to the updates proposed in Appendix B is denoted as the ‘updated LCD’ – until such time as a decision is made on which apparatus licence type is to be used for wireless broadband access in the 26/28 GHz band.

The ACMA is also developing the technical framework for 26 GHz band spectrum licences (applicable to frequencies and areas subject to the 26 GHz band reallocation declaration) – see the *Development of the 26 GHz spectrum licence technical framework* TLG paper on the SharePoint site. It is proposed that parts of the spectrum licence technical framework are incorporated into the apparatus licence framework. Therefore, the spectrum licence TLG paper (and appendices) may need to be read in conjunction with this paper.

## Scope

The scope of this paper is limited to developing an apparatus licence technical framework in the range 24.7-29.5 GHz (in the frequency ranges and areas not subject to the 26 GHz band reallocation declaration). It will not consider:

* Development of new spectrum licence arrangements for wireless broadband in the 26 GHz band: the spectrum licence technical framework will be developed through a separate TLG process which will run concurrently with the 26/28 GHz band apparatus licence TLG.
* Class licence arrangements for wireless broadband in the 26 GHz band. These will be developed through separate consultation processes, having regard to the technical arrangements for other licence types in the band as agreed in the TLG.
* Coordination arrangements for FSS earth stations with primary apparatus licensed wireless broadband services which were licensed ‘first-in-time’ and the proposed expansion of spectrum access for 28 GHz band ubiquitous FSS earth stations. These arrangements will be developed though separate consultation processes.
* Development of licence fees for wireless broadband services in the 26/28 GHz bands
* Any restrictions on certain persons or types of person being authorised to access spectrum in the 26/28 GHz bands. These issues will be considered in a separate process.

## Spectrum reform

The government is reforming the spectrum management framework within Australia. The Department of Communications and the Arts (DoCA) has provided the following information to stakeholders:

|  |
| --- |
| Rather than completely re-writing the legislation, modernising Australia’s spectrum management framework will now be pursued through a staged approach to amending the *Radiocommunications Act 1992*.  The first stage of amendments to the Act will deal with a number of priority issues to deliver tangible benefits to industry and consumers. The changes will be designed to remove unnecessary constraints in spectrum allocation and reallocation processes.   * Spectrum licence terms will be extended to a maximum of 20 years, with clearer licence renewal processes. * The arrangements for apparatus licences are also being aligned with spectrum licences to the extent possible. * There will also be changes to improve technical regulation, streamline device supply schemes and introduce graduated enforcement mechanisms for breaches of the Act. * To minimise disruption to spectrum users, existing licence types and planning arrangements will be retained at this time.   We are working towards the introduction of a draft amendment bill into the Australian Parliament in early 2020. |

Given the timeframes associated with the 26/28 GHz band project, 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 26/28 GHz bands 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.

## Timeline

The ACMA is working towards apparatus licences in the 26/28 GHz being available for issue from Q4 2020. To do this the following indicative 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 * TLG paper Version 3.0 | Nov 2019-Mar 2020  11 Nov 2019  22 Dec 2019  27 Jan 2019  23 Feb 2019  16 March 2019 |
| Public consultation on the draft updates to the following technical framework instruments:   * Draft updates to a LCD – which LCD that update would apply to is yet to be determined pending a decision on the type of apparatus licence to be used. * Draft RALI[new] | Q2/Q3 2020 |
| Finalisation of technical framework | Q4 2020 |

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. The ACMA will use the outcomes of the TLG to publicly consult on the relevant instruments that will form the 26/28 GHz band ‘area-wide’ apparatus licence 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

The draft LCD updates in Appendix B 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. Additional editorial changes may also be needed depending on which LCD the draft updates in Appendix B will be applicable to (subject to a decision on the apparatus licence type to use).

Under the currently proposed timeline, a legal review of the draft instrument will be performed after the conclusion of the TLG and finalised in time for public consultation of the draft technical framework in Q2/Q3 2020.

# Coexistence with other services

Devices operated under a 26/28 GHz band ‘area-wide’ apparatus licence[[5]](#footnote-6) will need to coexist not only with other ‘area-wide’ apparatus licence services, but also with services operating under another apparatus licence type or a spectrum licence in and adjacent to the 26/28 GHz band. The 26/28 GHz band ‘area-wide’ apparatus licence technical framework therefore needs to include provisions to manage coexistence with the following services:

* Spectrum licensed devices operating in the frequency range 25.1-27.5 GHz in capital cities and major regional population centres[[6]](#footnote-7)
* Space research service (SRS) earth stations receiving in the frequency range 25.5-27 GHz
* Fixed satellite service (FSS) gateway uplinks operating in the frequency range 27-29.5 GHz
* Ubiquitous FSS earth stations in the frequency range 27.5-29.5 GHz[[7]](#footnote-8)
* Space-based passive earth exploration satellite services (EESS) operating in the frequency range 23.6-24 GHz
* Legacy fixed point-to-point services operating in the frequency range 27.5-28.5 GHz

Class licensed devices operating within the frequency range 24.25-29.5 GHz – including devices operating under existing class licences as well as wireless broadband services operated under a new class licence.

This chapter outlines the proposed coexistence arrangements with the services listed above. Details of how these arrangements will be incorporated into the various parts of the technical framework are also contained in subsequent chapters.

## Spectrum licensed devices operating in the 25.1-27.5 GHz band

In response to the 26 GHz band reallocation declaration, the ACMA is currently developing the technical framework for spectrum licences to be allocated in the frequency range 25.1-27.5 GHz in capital cities and regional population centres.[[8]](#footnote-9)

Spectrum licences authorise the operation of devices in a defined frequency/area combination with licence conditions to manage out-of-area and out-of-band interference. This means that interference is primarily managed at the spectrum licence boundary (frequency and area) with a reduced requirement for device-based coordination.

It is proposed that the technical framework for 26 GHz band spectrum licences will be optimised for 3GPP NR (5G) wireless broadband (fixed and mobile) services and will be in effect very similar to the proposed technical framework for 26/28 GHz band ‘area-wide’ apparatus licences. This will result in reciprocal interference management arrangements at the licence boundaries between apparatus and spectrum licences.

It is proposed that coexistence between 26/28 GHz band ‘area-wide’ apparatus licence and spectrum licensed services will be managed by the following:

* At the frequency boundary:
* Unwanted emission limits specified on the apparatus licence (further details in the *Unwanted emission limits* section)
* The (time division duplex) synchronisation requirement specified in the updated LCD (detailed in the *In-band emission limits* section)
* At the geographic area boundary:
* Applying the 26 GHz band spectrum licence device boundary criteria (DBC) at the geographic boundary of a 26 GHz band spectrum licence.[[9]](#footnote-10) This proposed provision would only apply to ‘area-wide’ apparatus licensed services operating co-frequency with 26 GHz band spectrum licences (25.1-27.5 GHz). See draft RALI[new] in Appendix A for further details.
* The synchronisation requirement specified in the updated LCD.

At both the frequency and area boundaries the synchronisation requirement will act as a fallback (on a case-by-case basis) should interference occur which cannot be resolved through negotiation between relevant parties. It is proposed that the same synchronisation requirement will be placed on 26 GHz band spectrum licences.

Given the similarities between services expected to be operated under spectrum and ‘area-wide’ apparatus licences, it is proposed that the above mechanisms will be used to manage interference in both directions across the apparatus/spectrum licence area/frequency boundaries.

## Coexistence with SRS earth stations in 25.5-27 GHz

Earth receive stations support space research activities in the frequency range 25.5-27 GHz and are currently restricted to two space communications facilities at New Norcia, WA, and Tidbinbilla, ACT. The 26 GHz band decision paper proposed the following measures to protect these earth stations:

* Exclusion zones where apparatus licensed devices cannot be operated
* A requirement that all licensed devices must be coordinated with these earth stations with a protection level of -156 dBW/MHz.

Rationale for the proposed exclusion areas and protect level is provided in Annex E of the 26 GHz band decision paper.

The ACMA maintains the view that apparatus licence exclusion zones are necessary to manage coexistence with the New Norcia and Tidbinbilla earth stations. It is proposed that exclusions should apply to the HCIS cells in Table 1 for transmitters operating in the range 25.5-27 GHz.[[10]](#footnote-11)

1. Proposed exclusion zones to protect SRS earth stations

| Area name | HCIS |
| --- | --- |
| New Norcia | BU7K, BU7L, BU7O, BU7P, BU8E, BU8F, BU8G, BU8I, BU8J, BU8K, BU8L, BU8M, BU8N, BU8O, BU8P, BV2B, BV2A1, BV2A2, BV2A4, BV2A5, BV2A6, BV2A7, BV2A8, BV2A9 |
| Tidbinbilla | MW4H1, MW4H2, MW4H4, MW4H5, MW4H7, MW4H8, MW4D7, MW4L2 |

It is proposed that the exclusion zones contained in Table 1 will be implemented through a condition in the updated LCD – see the draft updates to the updated LCD in Appendix B.

It is further proposed that the following provisions will be implemented in RALI[new] – see the draft RALI[new] in Appendix A:

* Before a transmitter (which would operate in the range 25.5-27 GHz) is registered it must be coordinated with existing SRS earth stations
* No apparatus licences authorising operation in the frequency range 25.5-27 GHz will be issued:
* in the level 1 HCIS cells which contain the New Norcia or Tidbinbilla SRS earth stations, these being HCIS: BV2A3 and MW4H6, or
* if the licence would solely include the HCIS listed in Table 1.

## Coexistence with FSS gateway up-links in 27-29.5 GHz

### Interference to FSS gateway satellites

FSS gateway uplinks operate in the range 27-29.5 GHz at various locations throughout Australia. The 26 GHz and 28 GHz decision papers both outlined some preliminary views on additional conditions on wireless broadband use to safeguard coexistence with gateway uplinks.

It is proposed that the following conditions be applied to ‘area-wide’ apparatus licensed devices operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5 GHz:

* Base station total radiated power (TRP) is not to exceed 25 dBm/200 MHz
* Outdoor base stations must have mechanical down tilt equal to or greater than 0˚
* Outdoor base stations must not direct antenna beams (via electrical steering) to elevation angles greater than 5˚ above the horizon for more than 5% of time

Outdoor fixed UEs must not direct their antenna beam (via electrical or mechanical steering) to within 1.5˚ of the GSO arc when the antenna beam is pointed at elevation angles of greater than or equal to 3° above the horizon.[[11]](#footnote-12)

It is proposed that the above conditions will apply to ‘area-wide’ apparatus licensed devices in the range 27.5-29.5 GHz regardless of where they are located in Australia. This will provide a favourable coexistence environment for future satellite services in the band regardless of where the earth station transmitter is located.

The rationale for these proposed conditions is contained in Appendix D. Appendix D also includes the rationale for not including limitations on emissions above the horizon for mobile UEs.

The areas in which the additional conditions should apply in the range 27-27.5 GHz (detailed in Appendix C) are based on the -3 dB contours for 56 dBi spot beam antennas on satellites at longitudes of 140˚E and 145˚E pointed at each gateway earth stations currently included in the RRL in the band.

It is currently proposed that the additional conditions outlined above will be captured in the updated LCD – see Appendix B.

A potential cap on outdoor wireless broadband base station numbers within NBN gateway areas was also mooted as a possible additional condition in the 26 GHz band decision paper. However, the ACMA is currently of the view that the other proposed additional licence conditions are sufficient to safeguard coexistence and that additional device limits are not necessary.

### Interference from FSS gateway earth stations to ‘area-wide’ apparatus licensed receivers

The potential for interference from FSS gateway earth stations to receivers operated under 26/28 GHz ‘area-wide’ apparatus licences will depend on a number of variables, in particular geographical separation and antenna discrimination. The probability of interference to ‘area-wide’ apparatus licensed receivers is low given:

* Studies undertaken by Task Group 5/1 indicate maximum separation distances of up to 7.5 km (for earth station elevation angles of at least 20˚) are required to protect IMT stations, however actual distances will depend on specific circumstances.[[12]](#footnote-13)
* The majority of existing FSS earth stations in the range 27-29.5 GHz have an elevation angle of greater than 20˚.

Noting the low potential of interference and that ‘area-wide’ apparatus licensed services will be secondary in certain frequency/area combinations in the 28 GHz band[[13]](#footnote-14), it is proposed that:

* No protection will be afforded to any 26/28 GHz band ‘area-wide’ apparatus licensed receivers from interference caused by an existing FSS earth station. Applications for new FSS gateway earth stations will be coordinated with existing ‘area-wide’ apparatus licences covering the range 27-27.5 GHz in any area or the range 27.5-28.1 GHz in areas subject to the 26 GHz band reallocation declaration – these coordination arrangements will be developed under a separate process.

For ‘area-wide’ apparatus licensed receivers in the range 28.1-29.5 GHz in any area, or in the range 27.5-28.1 GHz in areas not subject to the 26 GHz band reallocation declaration, no protection will be afforded to ‘area-wide’ apparatus licensed receivers from interference caused by an existing or future FSS earth station. Applications for new FSS gateway earth stations will not need to be coordinated with existing ‘area-wide’ apparatus licences in the range 28.1-29.5 GHz or in the range 27.5-28.1 GHz in areas not subject to the 26 GHz band reallocation declaration.

These requirements are proposed to be included into RALI[new] – see the draft RALI[new] in Appendix A.

## Ubiquitous FSS earth stations in the frequency range 27.5-29.5 GHz

As detailed in the 28 GHz band decision paper, arrangements will be introduced for ubiquitous FSS earths station:

* On a primary basis in the range 27.5-28.1 GHz and in areas not subject to the 26 GHz band reallocation declaration, and in the range 28.1-29.5 GHz
* On a secondary basis in the range 27.5-28.1 GHz and in the areas subject to the 26 GHz band reallocation declaration.

The arrangements in the previous section (to be included in RALI[new]) will also apply for coexistence between secondary ‘area-wide’ apparatus licensed services and primary ubiquitous FSS earth stations.

The ACMA will develop and consult on updates to regulatory instruments (primarily the [Radiocommunications (Communication with Space Object) Class Licence 2015](https://www.legislation.gov.au/Details/F2018C00845)) to expand current arrangements for ubiquitous FSS earth stations, as detailed in the 28 GHz band decision paper. These updates will also include appropriate protection of primary ‘area-wide’ apparatus licensed services from secondary ubiquitous earth stations. These updates are outside the scope of the TLG and will be the subject of a separate consultation.

## Passive EESS satellite receivers operating in the 23.6-24 GHz band

Space-borne passive EESS services operate in the 23.6-24 GHz band. Extensive coexistence studies between IMT-2020 and passive EESS have been undertaken both internationally (notably under ITU-R Task Group 5/1 and the ECC) and domestically (in the 26 GHz Working Group). As at the release date of this paper, this issue is also being considered at WRC-19 under agenda item 1.13 – the TLG will be able to consider outcomes of these considerations as they become available.

To manage coexistence between passive EESS receivers and wireless broadband devices in the 26 GHz band, the ACMA proposed (in the 26 GHz band decision paper) unwanted out-of-band TRP limits in the range 23.6-24 GHz of -37 dBW/200MHz for base stations and -33 dBW/200MHz for user equipment. These limits are based on the agreed European limits[[14]](#footnote-15) with adjustments to account for:

* Lower population densities in Australian cities compared to Europe

A lower contribution of aggregate emissions into the passive EESS band from fixed services operating below 23.6 GHz in Australia than in Europe. In Europe, some of the EESS interference budget included contributions from fixed services – in Australia there is an existing guard band between these services.

It was noted in the 26 GHz band decision paper and in the 26 GHz Working Group that additional filtering may be required on 5G equipment to meet the above unwanted emission limit. Given the limitations of current filter technology it may not be possible to get enough attenuation at small frequency offsets. The 26 GHz band decision paper proposed to allow higher unwanted emission limits for outdoor devices in the range 24.7-25.1 GHz with a limitation on deployment numbers so that the aggregate interference level is not exceeded. The proposed unwanted emission limits in 23.6-24 GHz and deployment limits are provided in Table 2.

1. Proposed unwanted emission and deployment limits

|  |  |  |
| --- | --- | --- |
| 26/28 GHz band ‘area-wide’ apparatus licensed transmitter operating frequency range | TRP limit into the range 23.6–24 GHz for outdoor transmitters | Maximum number of outdoor ‘area-wide’ apparatus licensed transmitters within a 9km radius |
| 24.7–24.8 GHz | -28 dBW/200 MHz for BS  -24 dBW/200 MHz for UE | 13 |
| 24.8–24.9 GHz | -29 dBW/200 MHz for BS  -25 dBW/200 MHz for UE | 16 |
| 24.9–25 GHz | -31 dBW/200 MHz for BS  -27 dBW/200 MHz for UE | 26 |
| 25­­–25.1 GHz | -33 dBW/200 MHz for BS  -29 dBW/200 MHz for UE | 41 |
| 25.1-27.5 GHz | -37 dBW/200 MHz for BS  -33 dBW/200 MHz for UE | - |
| 27.5-29.5 GHz | -13 dBm/MHz for both BS and UE | - |

It is further proposed that:

* The TRP limits in Table 2 are specified in the draft updated LCD – see the *Unwanted emission limits* section and Appendix B
* The TRP limits in Table 2 only apply to transmitters which are required to be included in the RRL (e.g. outdoor base stations) (see the *Recording device details in the RRL* section) and transmitters which do not need to be in the RRL but are located outdoors (e.g. outdoor UEs) – see the *Recording device details in the RRL* section. It is expected that unwanted emissions from indoor devices will be sufficiently attenuated due to the external structure which negates the need for more restrictive emission limits in the passive band.
* RALI[new] will contain a requirement that a transmitter cannot be included in the RRL if its deployment would exceed the deployment limits detailed in Table 2.

## Point to point services

As detailed in the 28 GHz band decision paper, no new point-to-point services are to be assigned in the 28 GHz band. Legacy point-to-point services will be able to continue to operate for a minimum of 7 years with a possibility of continued operation beyond this timeframe (subject to further review). During this time, ‘area-wide’ apparatus licensed services will need to coexist with existing point-to-point services.

It is proposed to include coordination provisions in RALI[new] to protect existing point-to-point services from ‘area-wide’ apparatus licensed transmitters. The proposed provisions are similar to those detailed in RALIs MS33 and MS34 for coexistence with fixed services. The proposed protection ratios in RALI[new] have been derived by adjusting the co-channel protection ratios in RALI FX3 using the proposed unwanted emission limits (see the *Unwanted emission limits* section) and aim to provide an equivalent level of protection as given by RALI FX3.

It is further proposed that ‘area-wide’ apparatus licensed receivers will not be afforded protection from existing point-to-point links. In planning deployments under an ‘area-wide’ apparatus licence the licensee should take account of existing point-to-point transmitters and plan their services accordingly.

For more detail see the draft RALI[new] in Appendix A.

## Class licensed devices

### Existing class licensed devices

Various class licensed devices currently operate in the 24.25-27.5 GHz range, including:

* Aviation security body scanning devices operating in the frequency range 24.25-30 GHz, authorised under the [Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018](https://www.legislation.gov.au/Details/F2018L01583)
* Devices authorised under the [Radiocommunications (Low Interference Potential Devices) Class Licence 2015](https://www.legislation.gov.au/Details/F2018C00500) (the LIPD class licence) including:
* Radiofrequency identification transmitters operated in the frequency range 24.1-26.5 GHz
* Radiodetermination transmitters operating in the frequency range 24.05-26.5 GHz
* Ultra-wideband short-range vehicle radar systems operating in the range 22-26.5 GHz

As detailed in the decision papers, the ACMA is of the view that these class licensed devices can coexist with 26/28 GHz band ‘area-wide’ apparatus licensed services without the need for specific licence conditions or coordination requirements. This is owing to the short-range nature of these services, or the requirements for them to be operated in shielded enclosures or directed towards solid structures (wall/ground).

In some situations, effective site management may be needed to help manage coexistence (for example when operating in the vicinity of airport body scanning devices). A requirement to manage co-sited interference is proposed to be included on 26/28 GHz band ‘area-wide’ apparatus licences via the updated LCD — a similar requirement is included in all spectrum licence technical frameworks (see the *Other conditions* section) — and would also be effective in limiting the (already unlikely) potential for instances of interference between devices operated under existing class licences and ‘area-wide’ apparatus licensed services.

In addition, to avoid the need for changes to body scanner operating requirements, in the unlikely event that there is interference between body scanners and ‘area-wide’ apparatus licensed devices (in either direction) it is proposed the ‘area-wide’ apparatus licensee will be responsible for resolving any such issues.

It is proposed that the above provision be included in an update to the updated LCD — see Appendix B.

### Class licensed wireless broadband devices

As detailed in the 26 GHz band decision paper, the ACMA is planning to introduce new class licensed arrangements for wireless broadband services in the frequency range 24.25-25.1 GHz. These deployments are intended to be limited to private premise or property and arrangements are proposed to be included in a future update to the LIPD class licence.

The updated LIPD will also include provisions to allow the coexistence of class licensed devices operating co-frequency with apparatus licensed services in the range 24.7-25.1 GHz. Class licensed wireless broadband services will operate on a no-interference, no-protection basis with apparatus licensed services.

The update of the LIPD class licence is outside the scope of this TLG and will be consulted on in a separate process.

# Discussion of proposed technical framework

An ‘area-wide’ approach to apparatus licencing in the 26/28 GHz bands is a new concept first raised in the 26 GHz and 28 GHz decision papers. Broadly speaking, the technical framework underpinning these licences is intended to operate in a similar manner to spectrum licences, where it is a technology flexible regime with coexistence primarily managed via boundary conditions (at both the frequency and area boundaries). A key difference between an ‘area-wide’ apparatus licence framework and a spectrum licence framework is how the technical framework itself is specified. Whereas a spectrum licence technical framework consists of three interlocking regulatory elements provided for under the Act (i.e. core conditions, a determination of unacceptable interference and radiocommunications advisory guidelines), these building blocks are not directly available under an apparatus licence regime (although some elements can be incorporated by reference).

The main components of an apparatus licence technical framework are:

* Licence Condition Determinations made under paragraph 107(1)(f) of the Act.[[15]](#footnote-16)
* Conditions on the face of the individual apparatus licence. A transmitter must not be operated if it does not comply with the conditions specified on its licence and in any relevant LCDs. If a licence contains conditions which are contrary to a relevant LCD, then the licence condition takes precedence.
* Policy documents usually in the form of (RALIs) – these may contain specific instructions and guidance regarding coordination and coexistence between proposed and existing services. The ACMA may also adopt and publish instructions about the issuing of licences (for example, if any allocation limits or restrictions apply). RALIs are not a mandatory component of an apparatus licence technical framework and are generally only developed for frequency bands where additional guidance and instruction is required to improve the efficient use of spectrum. RALIs may also stipulates that certain conditions be placed on the face of licences when issued.

This section of the paper considers the development of each of these components.

## International Developments

There has been extensive work undertaken internationally relevant to the introduction of wireless broadband services into the 26/28 GHz bands. This section provides an outline of this work. The documents listed below have been taken into account in developing an ‘area-wide’ apparatus licence technical framework for the 26/28 GHz bands.

### ITU-R studies

The 26 GHz band is one of a number of bands being considered by the ITU-R for IMT-2020 under agenda item 1.13. As at the release date of this paper, further consideration, including decisions on potential changes to the ITU-R Radio Regulations, is being made at WRC-19 – the TLG will be able to consider outcomes of these considerations as they become available.

In November 2015, Study Group 5 of the ITU-R established a dedicated task group, TG 5/1, to conduct sharing and compatibility studies relevant to WRC-19 agenda item 1.13. This work included studies on coexistence between wireless broadband and existing services in and adjacent to the 26 GHz band. The following documents contain studies which are relevant to coexistence with existing services operating in Australia:

* Annex 1 to Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en): Systems parameters and propagation models to be used in sharing and compatibility studies
* Attachment 2 of Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en): Sharing and compatibility of passive services in adjacent frequency bands and IMT operating in the 24.25-27.5 GHz frequency range
* Attachment 3 of Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en): Sharing and compatibility of the FSS and IMT operating in the 24.25-27.5 GHz frequency range

Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-WP5D-C-0036/en): Definition of parameters for IMT-2020 evaluation.

### Electronic Communications Committee (ECC) outcomes

The ECC has also been active in developing arrangements for wireless broadband services in the 26 GHz band and have produced the following documents:

* [ECC Decision (18)06](https://www.erodocdb.dk/document/3361): ECC Decision of 69 July 2018 on the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25-27.5 GHz, corrected 26 October 2018

[CEPT Report 68](https://www.erodocdb.dk/document/3358): Harmonised technical conditions for the 24.25-27.5 GHz (’26 GHz’) frequency band.

### 3GPP standards

Bands n258 and n257 (consisting of the frequency ranges 24.25-27.5 GHz and 26.5-29.5 GHz respectively) are standardised by 3GPP for New Radio (NR) technologies (also referred to as 5G). The 3GPP has developed a range of standards and technical papers in relation to NR, including:

* 3GPP [TS 38.101-2](https://www.3gpp.org/DynaReport/38101-2.htm): NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone
* 3GPP [TS 38.104](https://www.3gpp.org/DynaReport/38104.htm): NR; Base Station radio transmission and reception.

## System model

System models are used to simplify the development of the technical framework. This section outlines the proposed system model for the 26/28 GHz band ‘area-wide’ apparatus licence technical framework.

Given the international developments outlined in the previous section, the choice in technology type that has formed the basis of this technical framework is limited to fixed and mobile wireless broadband services. However, this does not exclude the use of other technologies under the licence or the operation of systems using different parameters than those specified in this paper, so long as they fit within the technical framework

1. **Views are sought on details of any other systems which may be deployed under an ‘area-wide’ apparatus licence in the 26/28 GHz bands.**

The specific technology being considered in the development of the new technical framework is 3GPP NR (3GPP 38-series).

1. **Views are sought on details of any other technologies which may be deployed under an ‘area-wide’ apparatus licence in the 26/28 GHz bands.**

It is proposed that the technical framework is optimised for TDD operation, which aligns with 3GPP standards and international developments.

It is further proposed that the following two different system models are considered:

* Mobile wireless broadband network (in the frequency range 24.7-27.5 GHz only)
* ‘Hot-spot’ type deployments to provide high capacity in highly populated areas.
* Low base station antenna heights (e.g. light pole mounted) at heights below 6m above ground level and typically immersed in local clutter.
* User equipment (UE) antenna height typically around 1.5m above ground
* Fixed wireless broadband network
* Providing high capacity broadband access to fixed locations (e.g. domestic and/or commercial premises)
* Station antenna heights positioned to get above local clutter and maximise coverage, typically 15m above ground level. Path to user terminals is typically clutter free.
* UE antennas typically mounted on the external surface of a building (e.g. roof, eave), at a height of around 5m above ground.

It is proposed that the system model detailed above be used in the development of the 26/28 GHz band technical framework.

1. **Is the proposed system model suitable for the development of the 26/28 GHz band ‘area-wide’ apparatus licence technical framework?**

## Assignment conditions

This section provides an outline of the proposed conditions dealing with the allocation of ‘area-wide’ apparatus licences in the 26/28 GHz bands. These conditions would apply if ‘area-wide’ apparatus licence in the 26/28 GHz band are administratively allocated.

It is proposed that ‘area-wide’ apparatus licences are designed to be scalable (in both frequency and area) to suit the needs of individual licensees.[[16]](#footnote-17) However, it is necessary to specify some assignment conditions to help enable the efficient and effective use of spectrum:

* The area/frequency combination of an ‘area-wide’ apparatus licence is large enough to support a service (i.e. the area and/or bandwidth authorised by the licence is not too small to make the licence unusable)
* Improve spectrum efficiency:
* Spectrum can be more efficiently used if the same licensee holds co-frequency licences on both sides of geographic boundaries (e.g. across the spectrum/apparatus licence boundary in the 26 GHz band). Having contiguous geographic holdings will allow a licensee to more effectively manage in-band interference between adjacent cells
* An ordered frequency assignment priority will reduce the instances of small unusable ‘pockets’ of spectrum being left unlicensed in-between frequency adjacent licensees.

This section discusses proposals to address the above issues.

### Minimum area and bandwidth limits

The smallest geographic ‘building-block’ used in spectrum licences (referred to as a standard trading unit or STU) is a geographic area equal to a Level 1 HCIS cell of the 2012 Australian Spectrum Map Grid (ASMG)[[17]](#footnote-18) – which is 5x5 minutes in size (approximately 9×9 kilometre). In consideration of the new use cases that 5G is expected to facilitate and given the relatively short propagation distances in the 26/28 GHz range, it may be beneficial to introduce a smaller HCIS level. For example, smaller cell sizes of 1x1 minute (approximately 1.8x1.8 km), or 15x15 seconds (approximately 500mx500m).

The ACMA is seeking views from TLG members if a smaller ASMG grid size should be developed for use with 26/28 GHz band ‘area-wide’ apparatus licences – noting that the ACMA is still exploring if a smaller grid would be feasible to implement in its licensing business system (Spectra). A smaller grid would also need to be compatible with the HCIS structure of the ASMG.

A smaller map grid could provide a finer geographic resolution (i.e. smaller ‘building-blocks’) so that ‘area-wide’ apparatus licences can be designed to more accurately match the needs to individual licensees. A smaller map grid would also allow a licence to be issued for a smaller area, which may be useful for small localised wireless broadband networks (e.g. an industrial 5G network in a factory).

In consideration of the relatively short signal propagation distance in the 26/28 GHz band, and the potential use cases for small-localised networks, it is proposed that the minimum geographic area of a licence is set to no larger than a single HCIS level 1 cell (and potentially smaller if smaller map grid is implemented).

1. **Should the ACMA create a smaller ASMG cell for use by 26/28 GHz band ‘area-wide’ apparatus licences? What dimensions would be appropriate?**
2. **Is setting the minimum area of a licence to a single HCIS level 1 cell appropriate? If the ACMA defines a smaller ASMG cell, should the minimum licence area be set to a HCIS level smaller than level 1?**

All spectrum licences are subject to a minimum bandwidth requirement (known as the minimum contiguous bandwidth – or MCB), which is enforced when spectrum is traded on the secondary market.[[18]](#footnote-19) The difference with a ‘area-wide’ apparatus licence is that, for administratively issued licences, a minimum allocation bandwidth needs to be specified to help limit unnecessary segmentation of the band at the allocation stage.

The minimum allocation bandwidth should be set at the minimum amount of spectrum needed to provide a viable service. The minimum channel bandwidth of the technology likely to be deployed under a 26/28 GHz band ‘area-wide’ apparatus licence, 3GPP NR (see the *System model* section), is 50 MHz. However, more efficient use of spectrum is achievable if channels sizes in multiples of 100 MHz are used, indicating that 100 MHz may be the minimum bandwidth for an “efficient” service.

Based on the above, an appropriate minimum allocation bandwidth for the 26/28GHz bands could be 50 or 100 MHz. Given that 50 MHz is the minimum channel size, and that this amount of spectrum can still provide a viable service, it is proposed that the minimum allocation bandwidth for the 26/28 GHz bands should be set at 50 MHz. It is proposed that RALI[new] includes a provision that an ‘area-wide’ apparatus licence in the 26/28 GHz band cannot be administratively issued if the bandwidth is smaller than 50 MHz

1. **Should 50 MHz be the minimum bandwidth that a 26/28 GHz band ‘area-wide’ apparatus licence can be** **administratively issued for?**

### Maximum area and bandwidth limits

The are no maximum bandwidth limits proposed by this framework at this time, however it should be noted that the potential for restrictions on certain persons or types of person being authorised to access spectrum in the 26/28 GHz bans may be subject to further consideration outside of the TLG.

It is also proposed that 26/28 GHz band ‘area-wide’ apparatus licences can consist of an aggregation of any number of HCIS cells (of all levels) with no maximum geographic area limit.

### Assignment rules

The following assignment rules are proposed to be included in RALI[new] which aim to improve the efficient allocation and use of spectrum as well as aiding coexistence with incumbent services. These rules would apply for licences which are administratively allocated.

* Frequency assignments must follow a 50 MHz channel raster, where multiple channels can be aggregated (maximum aggregated bandwidth limits are still under consideration outside of the TLG).
* Only a single apparatus licence can be issued for a frequency range in a particular geographic area.
* The geographic area authorised by an ‘area-wide’ apparatus licence must consist of only whole HCIS cells of a specified minimum size (see above in the *Minimum area and bandwidth limits* section).
* Where possible, the frequency range of a new apparatus licence should align with an existing 26/28 GHz band (either spectrum or apparatus licensed) licence held by the licensee. This aims to help manage adjacent-area interference.
* If the licensee does not already hold 26/28 GHz band spectrum, channels are to be assigned according to the assignment priority detailed in Table 3.
* An apparatus licence which includes the range 25.5-27 GHz is not to be issued in the following HCIS cells: MW4H6 and BV2A3, or if it only contains HCIS cells in Table 1 – see *Coexistence with SRS earth stations in 25.5-27 GHz.*

1. Proposed channel assignment priority

|  |  |
| --- | --- |
| Frequency range (GHz) | Channel assignment direction |
| 24.7-25.1 | Descending order |
| 25.1-27.5 | Ascending order |
| 27.5-29.5 | Ascending order |

## Recording device details in the RRL

To aid in the management and resolution of interference issues, it is proposed that the details of certain types of transmitters operated under a 26/28 GHz band ‘area-wide’ apparatus licence are required to be included in the RRL before they are operated (for simplicity, this is referred to ‘registration’ in this paper). This is a similar approach used under the spectrum licensing regime.

Given that the risk of interference is not the same for all types of transmitters operated under a 26/28 GHz band ‘area-wide’ apparatus licence, it is proposed that some transmitters be exempt for the registration requirements.

User terminals, both fixed and mobile, are the most obvious devices that need to be exempt from registration due to their nomadic/mobile nature and ubiquitous deployment. Table 4 lists the maximum TRP and EIRP limits from ITU-R Working Party 5D and 3GPP.

1. User equipment output power limits.

|  |  |  |  |
| --- | --- | --- | --- |
| **User terminal type** | **Max TRP (dBm)** | **Max EIRP (dBm)** | **Source** |
| Handheld UE | 22 | 39[[19]](#footnote-20) | ITU-R WP 5D – see Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en) |
| 23 | 43 | 3GPP (TS 38.101-2) |
| Fixed wireless access UE | 35 | 55 | 3GPP (TS 38.101-2) |

While it is not considered ideal to require user terminals to be registered, it is not desirable to exempt devices which meet the limits for fixed wireless access devices in Table 4, given these limits would also exempt base stations (and would not be permitted by the proposed in-band limit of 30 dBm/200 MHz – see the *Maximum in-band limit* section).

It is proposed that any device operating with a TRP less than or equal to 23 dBm per occupied bandwidth be exempt from registration. This value will allow handheld UEs compliant with 3GPP standards to be registration exempt. Although this value is 1 dB higher than the TRP used in ITU-R sharing studies for the 26 GHz band, the fact that UEs will in most cases operate with transmit powers well below this level (due to adaptive power control) means that this 1 dB increase is expected to have a negligible impact on other services.

This proposed registration exemption would require power class 1 devices to be registered, however it is expected that not all fixed applications would require the use of high powered user terminals. It may be feasible for fixed wireless access networks to use power class 3 devices in many cases (potentially with the use of higher gain antennas). The ACMA seeks views on the suitability of the proposed registration exemption limit.

It is also proposed to exempt all indoor devices from registration (base stations and UEs). The high building entry loss at frequencies in the 26/28 GHz bands (based on Recommendation ITU-R P.2109) is expected to reduce the risk of interference from indoor devices and negate the need for these devices to be registered.

The building entry loss model in Recommendation ITU-R P.2109 is based on measurement data collated in Report ITU-R P.2346. While the model in P.2109 assumes that terminals will have an equal probability of location within a building, the measurements in Report ITU-R P.2346 used a wide range of different transmitter locations within the building. The majority of these studies took measurements at distances of approximately 2 metres or more from the external surface of the building. Based on this, it is proposed that the definition of ‘indoor’ operation is when the transmit antenna is located at least 2 metres from the external surface of the building in the direction of its main beam. For a device using an active antenna systems (AAS), this condition would need to be met in all directions in which the main beam is to be steered.

The proposed devices exempt from the registration requirement is as follows:

**Recording devices in the Register**

(1) Subject to (2), a licensee must not operate a radiocommunications transmitter under this licence unless;

(a) the requirements under Part 3.5 of the Act relating to registration of the transmitter have been met; and

(b) the transmitter complies with the details about it that have been entered in the Register.

(2) Subsection (1) does not apply to the following kinds of radiocommunications transmitters:

(a) a transmitter that operates with a maximum total radiated power of less than or equal to 23 dBm per occupied bandwidth; or

(b) a transmitter which has its antenna located indoors.

***Indoors*** means an enclosed space where the antenna is located at least 2 metres from the external surface of the part of the enclosed space which is illuminated by the antenna’s half-power beamwidth.

It is proposed that there be no requirement to record receivers operated under a 26/28 GHz band ‘area-wide’ apparatus licence in the RRL. However, in order to gain protection (which is often provided on a first-in-time registered basis), it is recommended that these devices be included in the RRL.

1. **Are the proposed exemption from registration requirements suitable?**

## Geographic boundary conditions

In the 26 GHz and 28 GHz decision papers, the ACMA proposed that the application of boundary conditions may be needed to manage coexistence between adjacent services, for example specifying a power flux density (PFD) limit at the geographic boundary.

This section outlines the rationale for the proposed PFD limit. As indicated in the *Coexistence with other services* chapter it is proposed that the 26 GHz band spectrum licence DBC is used to manage coexistence (in both directions) at the geographic boundary between 26/28 GHz ‘area-wide’ apparatus licences and 26 GHz band spectrum licences).[[20]](#footnote-21) Therefore the proposed PFD limit would be applicable at all area boundaries of an ‘area-wide’ apparatus licence except boundaries with spectrum licences.

### Receive antenna height and gain

As detailed earlier, it is proposed to optimise the 26/28 GHz band ‘area-wide’ apparatus licence technical framework for TDD operation and that a fall-back synchronisation requirement will manage interference between base stations operated by adjacent licensees. Therefore, the device boundary criteria will need to manage interference from base station to UE across the geographic boundary.

It is proposed that the receive antenna height be set to 5m based on the typical UE antenna height in fixed broadband networks – this is also consistent with the antenna height used in the 3.4 GHz band technical framework.[[21]](#footnote-22)

Although UEs are expected to use high gain beamforming antenna’s (e.g. 17 dBi for a 4x4 antenna array) it is likely that the antenna gain in the direction of an adjacent area base station will be low because:

* UEs will be electronically steering their antenna beams towards their own base station
* A relatively narrow beamwidth (approx. 29˚ for a 4x4 array when it is not being electronically steered)
* UEs located at (or near) the geographic boundary will be steering their antenna beam away from the boundary (i.e. its base station will need to be further away from the boundary in order to meet the boundary condition).

Considering the above points, it is proposed to use an antenna gain of -8 dBi, based on a 4x4 antenna array with a main beam gain of 17 dBi and a front-to-back ratio of 25 dB.[[22]](#footnote-23) This results in an antenna gain of -8 dBi out the rear of the antenna.

### Level of protection

The level of protection (LOP) is the benchmark protection given to receivers from co-channel emissions of transmitters operating in adjacent geographic licence areas. The level of protection is a compromise between the level of emissions over the geographic boundary of the licence and the protection requirements of receivers (i.e. more protection afforded to receivers will mean more restriction on transmitters).

It is proposed that the LOP is based on a protection criterion of I/N = -6 dB – this is consistent with the protection level set by WP 5D.[[23]](#footnote-24) Using a noise figure (NF) of 10dB[[24]](#footnote-25), receiver noise is calculated as:

Therefore, noting the proposed antenna gain of -8 dBi, the proposed LOP is:

This LOP value can then be converted to a PFD as follows:[[25]](#footnote-26)

Based on the above, the proposed geographic boundary conditions to be included in the updated LCD is shown below (also see Appendix B). It is also proposed that this PFD limit does not apply at:

* At a boundary with a 26 GHz spectrum licence (as discussed above), and

At the boundary of HCIS cells MW4H6 and BV2A3 (these cells contain the Canberra Deep Space Communications Complex and New Norcia SRS earth receive stations). The protection provided by the proposed PFD limit is based on wireless broadband technologies with synchronised TDD operation and will not provide adequate protection to SRS earth stations. As previously discussed, protection of SRS earth station is proposed to be provided by an exclusion zone and a coordination requirement. Therefore, omitting the PFD limit from the boundary of these HCIS cells will not impact coexistence between SRS and spectrum licensed devices.

|  |
| --- |
| **Power flux density at the geographic boundary**   1. Subject to (2) and (3), the licensee must ensure that emissions from the operation of radiocommunications transmitters which are not exempt from registration under section 5(1) do not exceed an aggregate power flux density of -82.7 dBW/m2, measured at a height of 5 metres above the ground at the boundary of the geographic area authorised by the licence. 2. For radiocommunications transmitters operating in the frequency range 25.1 GHz to 27.5 GHz, subsection (1) does not apply to the parts of the boundary of the geographic area authorised by the licence which are directly adjacent to the geographic areas listed in the Radiocommunications (Spectrum Re-allocation—26 GHz Band) Declaration 2019. 3. For radiocommunications transmitters operating in the frequency range 25.5 GHz to 27 GHz, subsection 6(1) does not apply to the parts of the boundary of the geographic area authorised by the licence which are directly adjacent to HCIS cells MW4H6 or BV2A3. |

It is proposed that the above PFD limit is specified as a licence condition applicable to the operation of devices under a 26/28 GHz band ‘area-wide’ apparatus licence and not as a pre-condition of device registration (i.e. there is no requirement for the ACMA to check compliance before a device is included in the RRL). In this regard, it is proposed that it will be specified in the updated LCD – see Appendix B. It will be up to the licensee to ensure that applicable[[26]](#footnote-27) transmitters operated under a 26/28 GHz band ‘area-wide’ apparatus licence comply with the proposed PFD boundary condition (i.e. it is proposed not to mandate a procedure to determine compliance with the PFD limit).

This approach is different to the DBC used for spectrum licences, where the DBC is a defined procedure to be completed prior to device registration. The ACMA is interested in views on the practicality of the proposed approach, in particular, whether licensees will be able to ascertain compliance with a high degree of certainty.

1. **Is the proposed PFD limit suitable?**
2. **Is the proposed receive antenna gain of -8 dB (used to determine the PFD limit) appropriate?**
3. **Do stakeholders agree that the geographic boundary condition be included as a licence condition instead of a pre-condition of device registration?**
4. **Are there any aspects which may impact on how compliance with the PFD limit can be confirmed? Should additional guidance be provided on how to assess compliance?**

## In-band emission limits

### Maximum in-band power limit

In the 26 GHz band decision paper, the ACMA proposed an in-band total radiated power (TRP) limit of 30 dBm/200 MHz. This was based on the transmit power level specified by WP 5D[[27]](#footnote-28) to be used in sharing studies (25 dBm/200 MHz) plus an additional 5 dB margin to provide some flexibility in the framework for higher power base stations. The ECC has not specified an in-band power limit.[[28]](#footnote-29)

The ACMA continues to propose that the in-band TRP limit should be 30 dBm/200 MHz. It is further proposed that this TRP limit will be specified in the updated LCD – see Appendix B.

### Managing adjacent channel interference

As outlined in the *System model* section, it is proposed that the 26/28 GHz band ‘area-wide’ apparatus licence technical framework be optimised for TDD operation. This is consistent with 3GPP standards and ITU-R sharing studies. The most critical interference scenario that might result between adjacent TDD networks is interference from base station transmitter to base station receiver when they are operating at the same time. There are two options which have been used in other bands to manage this interference scenario:

1. Use of a ‘restricted block’ at the frequency boundary adjacent to another licence. A lower in-band emission limit would be specified in the restricted block which, together with a more restrictive unwanted emission limit, would manage adjacent channel interference.
2. Requiring adjacent networks to synchronise their operation if interference occurs.

Either option could be specified as a fall-back, which is only applied when interference occurs and an agreement to manage the interference cannot be reached between affected parties.

Both options have been used domestically in licensing arrangements applicable to other frequency bands. For example, a restricted block arrangement was implemented in the original 3.4 GHz band spectrum licence technical framework. However, concerns were raised in the development of the 3.6 GHz band framework that this approach is not spectrally efficient, particularly for 5G technologies making use of AAS.

One possible problem with the restricted block approach might be that the ‘additional unwanted emission limit’ would only apply when needed to manage interference. This 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. The latter scenario could be problematic for 5G systems, as it may not be possible to apply additional RF filtering to an AAS base station post manufacture, given the integrated nature of the antenna and RF unit. It is therefore preferable that unwanted emission limits between spectrum licensees be static, although again, this can be inefficient.

Given the above concerns, the synchronisation approach was ultimately implemented in the 3.4/3.6 GHz bands. It is proposed to use a similar synchronisation approach as a fallback if needed to manage adjacent band interference between 26/28 GHz band ‘area-wide’ apparatus licensed services. The proposed requirements are:

* When interference exceeds a specified limit, licensees will be required to synchronise services.
* Synchronisation would only be required between affected devices, not network- wide.
* Licensees would also be free to negotiate alternative arrangements on a case-by-case basis.

The proposed requirements will require the fall-back synchronisation frame structure to be defined. In the 3.6 GHz band technical framework a frame structure based on LTE technology (from 3GPP TS 36.211) was defined. The ACMA is seeking advice from the TLG on an appropriate frame structure to be codified in the 26/28 GHz band ‘area-wide’ apparatus licence technical framework as a fallback if/when required.

Synchronisation may, depending on the final parameters adopted, result in the inability of operators to implement some low latency options and/or flexible/dynamic UL/DL sequencing. However, it also negates the need for guard bands or restricted blocks, reducing the requirement for (and costs associated with) additional filtering and potentially mitigates the effect of dead zones that might occur when managing cross-border interference.

It is therefore proposed to include the below synchronisation condition in the updated LCD (noting that the frame structure is still to be determined) – also see Appendix B. The proposed synchronisation procedure would be invoked as necessary for interference management purposes with other 26/28 GHz band ‘area-wide’ apparatus licensed services as well as with devices operated under a 26 GHz band spectrum licence.

**Synchronisation requirement**

If:

1. interference occurs between:

(i) a radiocommunications device (the ***first device***) operated under this licence; and

(ii) a radiocommunications device (the ***other device***) operated under another area-wide apparatus licence in the frequency range 24.7 GHz to 29.5 GHz or a 26 GHz band spectrum licence (the ***other licence***);

1. the level of interference to the first device or to any other devices exceeds the compatibility requirement set out in the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020,* as in force from time to time;
2. either the licensee or the holder (or authorised third party) of the other licence wishes to resolve the interference; and
3. no agreement between the licensee and each person operating one or more other devices can be reached on how to manage the interference;

then the licensee is required to manage the interference by:

1. either:

(i) operating the first device with a frame structure that uses [TBD]; or

(ii) operating the first device using a sequence and duration of radio emissions that is consistent with those configurations (disregarding any time at which the device is not making a radio emission); and

1. synchronising the timing of the frame structure or other sequence of radio emissions of the first device with the timing of the frame structure or other sequence of radio emissions of each of the other devices (disregarding any device at a time at which the device is not making a radio emission).

Note: The synchronisation requirement only applies when an interference issue occurs and where there is no other measure agreed to between the licensees to resolve the interference. This means synchronisation can be done on a site/cell specific basis. During any period in which the licensee and other licensee are taking steps to resolve the interference issue or synchronise, the ACMA will generally give priority to the device registered first in time in any interference dispute, meaning that the device or devices registered later-in-time will generally be required to accept any interference or cease causing interference during this time.

1. **Is the proposed in-band total radiated power (TRP) limit appropriate?**
2. **Noting that adjacent band licensees can negotiate alternative arrangements, is the synchronisation fall-back option the most suitable approach to manage adjacent channel interference?**
3. **Where synchronisation is needed, which frame structure for the synchronisation condition should be mandated?**

The ACMA will continue to work with stakeholders regarding appropriate wording and definition of the synchronisation requirement.

## Unwanted emission limits

When defining unwanted emission limits (both out-of-band and spurious), consideration has been given to the following documents:

* 3GPP TS 38.104 (NR base station)
* 3GPP TS 38.101-2 (NR user equipment)
* Attachment 2 to Document 5-1/36 (details IMT-2020 characteristics to be used in sharing studies)
* ECC Decision (18)06

Like the 3.6 GHz band spectrum licence technical framework, the ACMA proposes to specify the unwanted limit as a total radiated power (TRP). This acknowledges that NR (also referred to as 5G) equipment will typically utilise antenna arrays which are integrated into the base station, meaning it will be difficult to undertake conducted power measurements. A TRP specification is suitable for both AAS and non-AAS devices.

It is proposed that the unwanted emission limits detailed in this section be included in the updated LCD, so that they apply to all ‘area-wide’ apparatus licences issued in the 26/28 GHz band – see Appendix B.

### Devices which need to be included in the RRL (registered devices)

Figure 2 provides a comparison of the different base station unwanted limit specifications derived from the documents listed above. As the frequency offsets for the application of unwanted emission limits in 3GPP standards vary depending on channel bandwidth, Figure 1 includes 3GPP limits applicable to the smallest (50 MHz) and largest (400 MHz) channels. The WP 5D[[29]](#footnote-30) and 3GPP limits are dependent on the transmit power level. A transmit power level of 30 dBm (equal to the proposed in-band limit) is used to derive the limits shown in Figure 1.

1. Comparison of unwanted emission limits – base station

It is proposed that unwanted emissions should not be higher than those necessary to deploy a service. The ECC limits would allow higher levels of unwanted emissions at certain offsets than necessary for 3GPP standardised equipment. While lower unwanted emission levels would better ensure coexistence with adjacent services, specifying limits below the 3GPP standardised levels may adversely impact on device availability and/or manufacturing costs. However, from a practical perspective, it is also noted that unwanted emission levels decrease as the wanted transmit power decreases.

It is proposed that the unwanted emission limits for registered devices in the 26/28 GHz bands should align with the 3GPP 400 MHz channel limits. This will allow all currently-specified 3GPP-standardised channel sizes to be deployed under the 26/28 GHz band technical framework. Lower limits based on the WP 5D mask would better ensure coexistence with adjacent-band services – the ACMA seeks input on the feasibility and utility of specifying these lower limits instead.

The proposed unwanted emission limits for registered devices are shown in Tables 5 and 6 (based on out-of-band and spurious emission limits in 3GPP TS 38.104), excluding emissions in the range 23.6-24 GHz.

Note that the limits in Table 5 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, so it has been deemed that a definition of stricter unwanted emission limits to manage interference or unsynchronised operation will not be necessary.

1. Proposed transmitter unwanted emission limit at offsets less than or equal to 40 MHz from the licence frequency boundary – registered devices.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 0 MHz ≤ foffset ≤ 40 MHz | -5 | 1 MHz |

1. Transmitter unwanted emission limits at offsets greater than 40 MHz from the licence frequency boundary (excluding the 23.6-24 GHz band) – registered devices.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 30 MHz ≤ f < 1 GHz | -13 | 100 kHz |
| 1 GHz ≤ f ≤ 59 GHz | -13 | 1 MHz |

As discussed in the *Coexistence with other services* chapter, additional unwanted emission limits, depending on the frequency range in which the 26/28 GHz band ‘area-wide’ apparatus licensed transmitter is operating in, are proposed into the 23.6-24 GHz band to protect passive EESS. The proposed unwanted emission limits in the range 23.6-24 GHz (for registered devices) are provided in Table 7 – for consistency with other emission limits the TRP value has been converted from dBW to dBm.

1. Proposed transmitter unwanted emission limits within the 23.6-24 GHz frequency band – registered devices.

|  |  |  |
| --- | --- | --- |
| **26/28 GHz band ‘area-wide’ apparatus licensed transmitter operating frequency range** | **Total Radiated Power (dBm) in 23.4-24 GHz** | **Measurement Bandwidth** |
| 24.7-24.8 GHz | 2 | 200 MHz |
| 24.8-24.9 GHz | 1 | 200 MHz |
| 24.9-25 GHz | -1 | 200 MHz |
| 25-25.1 GHz | -3 | 200 MHz |
| 25.1-27.5 GHz | -7 | 200 MHz |
| 27.5-29.5 GHz | -13 | 1 MHz |

It is proposed that if a transmitter operates across more than one frequency segment within the range 24.7-25.1 GHz in Table 7, then the applicable TRP limit will be the higher (least restrictive) limit for the frequency ranges in which the transmitter operates.

### Devices which do not need to be included in the RRL (device exempt from registration)

UE unwanted emission limits from 3GPP TS 38.101-2 are shown in Table 8. The unwanted emission limits specified by WP 5D[[30]](#footnote-31) reflect the 3GPP limits for a 200 MHz channel shown in Table 8.

1. NR unwanted emission limits from 3GPP TS 38.101-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Spectrum emission limit (dBm)/ Channel bandwidth | | | | | |
| foffset  (MHz) | 50  MHz | 100  MHz | 200  MHz | 400  MHz | Measurement bandwidth |
| ± 0-5 | -5 | -5 | -5 | -5 | 1 MHz |
| ± 5-10 | -13 | -5 | -5 | -5 | 1 MHz |
| ± 10-20 | -13 | -13 | -5 | -5 | 1 MHz |
| ± 20-40 | -13 | -13 | -13 | -5 | 1 MHz |
| ± 40-100 | -13 | -13 | -13 | -13 | 1 MHz |
| ± 100-200 |  | -13 | -13 | -13 | 1 MHz |
| ± 200-400 |  |  | -13 | -13 | 1 MHz |
| ± 400-800 |  |  |  | -13 | 1 MHz |

To ensure that all of the available standardised channels sizes can be deployed under the 26/28 GHz band ‘area-wide’ apparatus licence framework, it is proposed that the unwanted emission limits for registration-exempt devices align with the 400 MHz channel emission limits shown in Table 8.

The proposed unwanted emission limits are shown in Tables 9 and 10 (based on out-of-band and spurious limits in 3GPP TS 38.101-2), excluding emissions in the range 23.6-24 GHz.

1. Transmitter unwanted emission limit at offsets less than or equal to 40 MHz from the licence frequency boundary – devices exempt from registration.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 0 MHz ≤ foffset ≤ 40 MHz | -5 | 1 MHz |

1. Transmitter unwanted emission limits at frequencies greater than 40 MHz from the licence frequency boundary (excluding 23.6-24 GHz) — devices exempt from registration.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 30 MHz ≤ f < 1 GHz | -36 | 100 kHz |
| 1 GHz ≤ f < 12.75 GHz | -30 | 1 MHz |
| 12.75 GHz ≤ f < 23.6 GHz | -13 | 1 MHz |
| 24 GHz ≤ f ≤ 59 GHz | -13 | 1 MHz |

As discussed in the *Coexistence with other services* chapter, additional unwanted emission limits, depending on the frequency range in which the 26/28 GHz band ‘area-wide’ apparatus licensed transmitter is operating in, are proposed in the range 23.6-24 GHz to protect passive EESS. The proposed limits for devices exempt from registration are provided in Table 11. For consistency with other emission limits the TRP values has been converted from dBW to dBm. The proposed limit into the 23.6-24 GHz band for 26 GHz band indoor transmitters and all 28 GHz band transmitters aligns with the spurious limits in relevant 3GPP standards.

1. Proposed transmitter unwanted emission limits into the 23.6-24 GHz frequency band – devices exempt from registration.

|  |  |  |
| --- | --- | --- |
| **26/28 GHz band ‘area-wide’ apparatus licensed transmitter operating frequency range** | **Total Radiated Power (dBm) in 23.4-24 GHz** | **Measurement Bandwidth** |
| 24.7-24.8 GHz (outdoor) | 6 | 200 MHz |
| 24.8-24.9 GHz (outdoor) | 5 | 200 MHz |
| 24.9-25 GHz (outdoor) | 3 | 200 MHz |
| 25-25.1 GHz (outdoor) | 1 | 200 MHz |
| 25.1-27.5 GHz (outdoor) | -3 | 200 MHz |
| 24.7-27.5 GHz (indoor) | -13 | 1 MHz |
| 27.5-29.5 GHz | -13 | 1 MHz |

It is proposed that if a transmitter operates across more than one frequency segment within the range 24.7-25.1 GHz in Table 11, then the applicable TRP limit will be the higher (least restrictive) limit for the frequency ranges in which the transmitter operates.

1. **Are the unwanted emission limits proposed in this paper appropriate?**
2. **Should the unwanted emission limits for registered devices on 3GPP standards, or on the lower WP 5D limits?**

## Other conditions

It is proposed that the 26/28 GHz ‘area-wide’ apparatus licence technical framework include additional conditions to manage coexistence with other services. Noting the intention for the 26/28 GHz band ‘area-wide’ apparatus licences to operate in a similar manner to a spectrum licence, some of these proposed additional conditions are standard inclusions on spectrum licences. The proposed additional conditions relate to:

* The distance between devices which are considered co-sited (for interference management purposes)
* Responsibility to manage interference between devices operated under licences held by the same licensee
* Management of interference from devices exempt from registration
* Restriction on the operation of mobile transmitters in the range 27.5-29.5 GHz

See the draft updated LCD in Appendix B for further details.

***Co-sited devices***

Interference between devices that are located within a few hundred metres of each other can be difficult to model and can require the implementation of unnecessarily stringent requirements to cover all possible cases. As a result, spectrum licences include additional conditions on the licence so that licensees can work together to resolve any interference caused between radiocommunications devices where the phase centre of each antenna is separated by a specified distance. It is proposed that a similar condition is included on 26/28 GHz band ‘area-wide’ apparatus licences.

The technical framework for all spectrum licensed bands other than the 3.4 GHz band define co-sited devices as being within 200m. 500m is used in the 3.4 GHz owing to the technical framework being optimised for TDD operation and lower receiver blocking requirement.

Although the 26/28 GHz band ‘area-wide’ apparatus licence technical framework is proposed to be optimised for TDD, the relatively high propagation attenuation in the band and the use of AAS is expected to present a lower risk of co-sited interference than in the 3.4 GHz band. Therefore, it is proposed to define devices within 200m as being co-sited for interference management purposes.

Subsequently, it is proposed that the following condition be included in the updated LCD:

|  |
| --- |
| **Co-sited devices**  If:  (a) interference occurs between a radiocommunication device:  (i) operated under this licence; and  (ii) operated under another licence (the ***other licence***);  when the measured separation between the phase centre of the antenna used with each device is less than 200 metres; 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 of this licence 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. |

***Responsibility to manage interference***

It is proposed to include the following condition in the updated LCD which will provide certainly for a licensee dealing with interference between devices operated under licences held by the same licensee:

|  |
| --- |
| **Responsibility to manage interference**  The licensee must manage interference between:  (a) radiocommunications devices operated under this licence; and  (b) radiocommunications devices operated under this licence and under another licence held by the licensee. |

***Management of interference from devices exempt from registration***

The risk of interference from devices exempt from registration (see *the Recording device details in the RRL* section) is low because of their low-power and/or nomadic nature, or because of their indoor operation. However, to provide certainty in managing an unlikely case of interference from these devices it is proposed that the following provision be included in the updated LCD:

|  |
| --- |
| The licensee must ensure that the operation of a radiocommunications transmitter that is a kind included in 5(2) does not cause harmful interference to other radiocommunications devices operated under a different spectrum or apparatus licence. |

***Restriction on mobile transmitters in the range 27.5-29.5 GHz***

The 28 GHz band decision paper proposed that wireless broadband services in the range 27.5-29.5 GHz band be restricted to fixed wireless access services (i.e. mobile 5G would not be permitted).

It is proposed to include the above restriction in the 26/28 GHz apparatus licence technical framework with a slight variation. That is, mobile user terminals would be permitted indoors. Indoor mobile use may be attractive to user types such as the industrial sector (e.g. for in-factory automation using 5G).

The proposed condition to be included in the updated LCD is:

|  |
| --- |
| The licensee must not operate a radiocommunications transmitter in the frequency range 27.5-29.5 GHz while it is in motion on land, on water or in the air, unless it is located indoors. |

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

# Appendix A – Draft RALI[new]

Refer to attachment on SharePoint

# Appendix B – Draft Licence Conditions Determination (LCD) updates

Refer to attachment on SharePoint

The specific LCD that these proposed conditions would be included into will be determined pending a decision on the apparatus licence type to be used for wireless broadband services in the 26/28 GHz band.

# Appendix C – Areas subject to additional conditions

The proposed areas to be subject to additional constraints for wireless broadband services in the range 27-27.5 GHz are contained in Table 12. These areas are consistent with those proposed in the decision paper and are based on the -3 dB footprint of a 56 dBi antenna on GSO satellites at longitudes of 140°E and 145°E for beams pointed at each of the 10 NBN gateway earth stations.

1. Proposed areas to be subject to additional constraints for wireless broadband services in the range 27–27.5 GHz

| Nbn gateway | HCIS |
| --- | --- |
| Bourke | LU4F, LU4G, LU4H, LU4J, LU4K, LU4L, LU4M, LU4N, LU4O, LU4P, LU5E, LU5F, LU5I, LU5J, LU5K, LU5M, LU5N, LU5O, LU7A, LU7B, LU7C, LU7D, LU7F, LU7G, LU7H, LU7J, LU7K, LU7L, LU7P, LU8A, LU8B, LU8C, LU8E, LU8F, LU8G, LU8I, LU8J, LU8M, LU4B9, LU4C5, LU4C6, LU4C7, LU4C8, LU4C9, LU4D4, LU4D5, LU4D6, LU4D7, LU4D8, LU4D9, LU4E6, LU4E9, LU4I2, LU4I3, LU4I5, LU4I6, LU4I8, LU4I9, LU5A4, LU5A5, LU5A6, LU5A7, LU5A8, LU5A9, LU5B7, LU5B8, LU5G4, LU5G7, LU5G8, LU5L7, LU5P1, LU5P4, LU5P7, LU7E2, LU7E3, LU7E5, LU7E6, LU7E8, LU7E9, LU7I3, LU7N2, LU7N3, LU7O1, LU7O2, LU7O3, LU7O4, LU7O5, LU7O6, LU7O9, LU8D1, LU8D4, LU8D7, LU8H1, LU8H4, LU8H7, LU8K1, LU8K2, LU8K3, LU8K4, LU8K5, LU8K6, LU8K7, LU8K8, LU8N1, LU8N2, LU8N3, LU8N4, LU8N5, LU8N6, LU8O1 |
| Carnarvon | AS8C, AS8D, AS8F, AS8G, AS8H, AS8I, AS8J, AS8K, AS8L, AS8M, AS8N, AS8O, AS8P, AS9A, AS9B, AS9E, AS9F, AS9G, AS9I, AS9J, AS9K, AS9M, AS9N, AS9O, AT1D, AT1H, AT2A, AT2B, AT2C, AT2D, AT2E, AT2F, AT2G, AT2H, AT2I, AT2J, AT2K, AT3A, AT3B, AT3E, AS5P9, AS6M7, AS6M8, AS8A9, AS8B5, AS8B6, AS8B7, AS8B8, AS8B9, AS8E2, AS8E3, AS8E4, AS8E5, AS8E6, AS8E7, AS8E8, AS8E9, AS9C4, AS9C5, AS9C7, AS9C8, AS9H4, AS9H7, AS9L1, AS9L4, AS9L7, AS9P1, AT1C2, AT1C3, AT1C5, AT1C6, AT1C8, AT1C9, AT1G2, AT1G3, AT1G5, AT1G6, AT1G8, AT1G9, AT1K3, AT1L1, AT1L2, AT1L3, AT1L4, AT1L5, AT1L6, AT1L9, AT2L1, AT2L2, AT2L3, AT2L4, AT2L5, AT2L6, AT2L7, AT2L8, AT2M3, AT2N1, AT2N2, AT2N3, AT3C1, AT3C2, AT3C3, AT3C4, AT3C5, AT3C7, AT3F1, AT3F2, AT3F3, AT3F4, AT3F5, AT3F7, AT3I1, AT3I2, AT3I3, AT3I4 |
| Ceduna | HV4, GV6D, GV6H, HV1F, HV1G, HV1H, HV1I, HV1J, HV1K, HV1L, HV1M, HV1N, HV1O, HV1P, HV2E, HV2I, HV2J, HV2M, HV2N, HV5A, HV5B, HV5E, HV5F, HV5I, GV3L3, GV3L6, GV3L8, GV3L9, GV3P2, GV3P3, GV3P4, GV3P5, GV3P6, GV3P7, GV3P8, GV3P9, GV6L1, GV6L2, GV6L3, GV6L4, GV6L5, GV6L6, GV6L8, GV6L9, GV6P2, GV6P3, GV6P6, HV1B8, HV1B9, HV1C7, HV1C8, HV1C9, HV1D7, HV1D8, HV1D9, HV1E5, HV1E6, HV1E7, HV1E8, HV1E9, HV2A7, HV2A8, HV2A9, HV2F1, HV2F4, HV2F5, HV2F7, HV2F8, HV2F9, HV2K1, HV2K4, HV2K7, HV2O1, HV2O2, HV2O4, HV2O5, HV2O7, HV2O8, HV5C1, HV5C2, HV5C4, HV5C5, HV5C7, HV5C8, HV5G1, HV5G4, HV5G7, HV5J1, HV5J2, HV5J3, HV5J4, HV5J5, HV5J6, HV5J7, HV5J8, HV5M1, HV5M2, HV5M3, HV5M4, HV5M5, HV5M6, HV5M7, HV5M8, HV5N1 |
| Geeveston | LY8B, LY8C, LY8D, LY8E, LY8F, LY8G, LY8H, LY8I, LY8J, LY8K, LY8L, LY8M, LY8N, LY8O, LY8P, LY9A, LY9E, LY9F, LY9G, LY9I, LY9J, LY9K, LY9M, LY9N, LY9O, LY9P, LZ2A, LZ2B, LZ2C, LZ2D, LZ2E, LZ2F, LZ2G, LZ2H, LZ2I, LZ2J, LZ2K, LZ2L, LZ2N, LZ2O, LZ2P, LZ3A, LZ3B, LZ3C, LZ3D, LZ3E, LZ3F, LZ3G, LZ3H, LZ3I, LZ3J, LZ3K, LZ3L, LZ3M, LZ3N, LZ3O, LY5N9, LY5O7, LY5O8, LY5O9, LY5P7, LY5P8, LY5P9, LY6M7, LY6M8, LY6M9, LY7H9, LY7L3, LY7L5, LY7L6, LY7L8, LY7L9, LY7P2, LY7P3, LY7P5, LY7P6, LY7P8, LY7P9, LY8A6, LY8A8, LY8A9, LY9B1, LY9B2, LY9B4, LY9B5, LY9B6, LY9B7, LY9B8, LY9B9, LY9C4, LY9C7, LY9C8, LY9H4, LY9H7, LY9L1, LY9L2, LY9L4, LY9L5, LY9L7, LY9L8, LY9L9, LZ1D2, LZ1D3, LZ1D5, LZ1D6, LZ1D8, LZ1D9, LZ1H2, LZ1H3, LZ1H5, LZ1H6, LZ1H9, LZ1L3, LZ1L6, LZ2M1, LZ2M2, LZ2M3, LZ2M5, LZ2M6, LZ2M9, LZ3P1, LZ3P2, LZ3P3, LZ3P4, LZ3P5, LZ3P6, LZ3P7, LZ3P8, MZ1A1, MZ1A4, MZ1A7, MZ1E1, MZ1E4, MZ1E7, MZ1I1, MZ1I4 |
| Kalgoorlie | DU7, CU9H, CU9K, CU9L, CU9O, CU9P, CV3B, CV3C, CV3D, CV3G, CV3H, CV3L, DU8A, DU8E, DU8I, DU8M, DV1A, DV1B, DV1C, DV1D, DV1E, DV1F, DV1G, DV1H, DV1I, DV1J, CU9D3, CU9D5, CU9D6, CU9D7, CU9D8, CU9D9, CU9G3, CU9G5, CU9G6, CU9G7, CU9G8, CU9G9, CU9J3, CU9J6, CU9J8, CU9J9, CU9N2, CU9N3, CU9N5, CU9N6, CU9N7, CU9N8, CU9N9, CV3F1, CV3F2, CV3F3, CV3F5, CV3F6, CV3F8, CV3F9, CV3J3, CV3K1, CV3K2, CV3K3, CV3K4, CV3K5, CV3K6, CV3K8, CV3K9, CV3P2, CV3P3, DU4M8, DU4M9, DU4N4, DU4N5, DU4N6, DU4N7, DU4N8, DU4N9, DU4O4, DU4O5, DU4O6, DU4O7, DU4O8, DU4O9, DU4P4, DU4P5, DU4P6, DU4P7, DU4P8, DU4P9, DU5M7, DU5M8, DU8B4, DU8B7, DU8B8, DU8F1, DU8F2, DU8F4, DU8F5, DU8F7, DU8F8, DU8J1, DU8J2, DU8J4, DU8J5, DU8J7, DU8J8, DU8N1, DU8N2, DU8N4, DU8N5, DU8N7, DV1K1, DV1K2, DV1K3, DV1K4, DV1K5, DV1K6, DV1K7, DV1L1, DV1M1, DV1M2, DV2A1, DV2A2, DV2A3, DV2A4, DV2A5, DV2A6, DV2A7, DV2A8, DV2B1, DV2E1, DV2E2, DV2E4 |
| Moonyoonooka | AU2L, AU2P, AU3C, AU3D, AU3E, AU3F, AU3G, AU3H, AU3I, AU3J, AU3K, AU3L, AU3M, AU3N, AU3O, AU3P, AU6A, AU6B, AU6C, AU6D, AU6E, AU6F, AU6G, AU6H, AU6I, AU6J, AU6K, BU1A, BU1B, BU1C, BU1E, BU1F, BU1G, BU1I, BU1J, BU1K, BU1M, BU1N, BU1O, BU4A, BU4B, BU4E, AT9O6, AT9O7, AT9O8, AT9O9, AT9P4, AT9P5, AT9P6, AT9P7, AT9P8, AT9P9, AU2H6, AU2H8, AU2H9, AU2K6, AU2K9, AU2O2, AU2O3, AU2O5, AU2O6, AU2O8, AU2O9, AU3A6, AU3A8, AU3A9, AU3B2, AU3B3, AU3B4, AU3B5, AU3B6, AU3B7, AU3B8, AU3B9, AU6L1, AU6L2, AU6L3, AU6L4, AU6L5, AU6L6, BT7M4, BT7M5, BT7M6, BT7M7, BT7M8, BT7M9, BT7N4, BT7N5, BT7N6, BT7N7, BT7N8, BT7N9, BT7O7, BT7O8, BU1D4, BU1D7, BU1H1, BU1H2, BU1H4, BU1H5, BU1H7, BU1H8, BU1L1, BU1L2, BU1L4, BU1L5, BU1L7, BU1L8, BU1P1, BU1P4, BU4C1, BU4C2, BU4C3, BU4C4, BU4C5, BU4C7, BU4F1, BU4F2, BU4F3, BU4F4, BU4F5, BU4I1, BU4I2 |
| Nugee | JV2L, JV2P, JV3B, JV3C, JV3D, JV3E, JV3F, JV3G, JV3H, JV3I, JV3J, JV3K, JV3L, JV3M, JV3N, JV3O, JV3P, JV5D, JV5H, JV6A, JV6B, JV6C, JV6D, JV6E, JV6F, JV6G, JV6H, JV6I, JV6J, JV6K, JV6L, KV1E, KV1I, KV1M, KV1N, KV4A, KV4E, JU9N8, JU9N9, JU9O7, JU9O8, JU9O9, JU9P7, JV2D6, JV2D8, JV2D9, JV2G9, JV2H2, JV2H3, JV2H4, JV2H5, JV2H6, JV2H7, JV2H8, JV2H9, JV2K3, JV2K6, JV2K8, JV2K9, JV2O2, JV2O3, JV2O5, JV2O6, JV2O8, JV2O9, JV3A2, JV3A3, JV3A4, JV3A5, JV3A6, JV3A7, JV3A8, JV3A9, JV5C2, JV5C3, JV5C5, JV5C6, JV5C9, JV5G3, JV5G6, JV5L1, JV5L2, JV5L3, JV5L5, JV5L6, JV5L9, JV6M1, JV6M2, JV6M3, JV6N1, JV6N2, JV6N3, JV6N4, JV6N5, JV6N6, JV6O1, JV6O2, JV6O3, JV6O4, JV6O5, JV6O6, JV6P1, JV6P2, JV6P3, JV6P4, KV1A4, KV1A5, KV1A7, KV1A8, KV1A9, KV1F1, KV1F4, KV1F7, KV1F8, KV1J1, KV1J2, KV1J4, KV1J5, KV1J7, KV1J8, KV1J9, KV4B1, KV4B2, KV4B3, KV4B4, KV4B5, KV4B6, KV4B7, KV4B8, KV4F1, KV4F2, KV4F4, KV4F5, KV4F7, KV4I1, KV4I2, KV4I3, KV4I4, KV4I5, KV4I6, KV4I7, KV4I8, KV4J1 |
| Roma | MT1O, MT1P, MT2M, MT4B, MT4C, MT4D, MT4E, MT4F, MT4G, MT4H, MT4I, MT4J, MT4K, MT4L, MT4N, MT4O, MT4P, MT5A, MT5B, MT5E, MT5F, MT5I, MT5J, MT5K, MT5M, MT5N, MT5O, MT7B, MT7C, MT7D, MT7H, MT8A, MT8B, MT8E, MT1K7, MT1K8, MT1K9, MT1L7, MT1L8, MT1L9, MT1M9, MT1N2, MT1N3, MT1N4, MT1N5, MT1N6, MT1N7, MT1N8, MT1N9, MT2I7, MT2N4, MT2N5, MT2N7, MT2N8, MT2N9, MT4A2, MT4A3, MT4A4, MT4A5, MT4A6, MT4A7, MT4A8, MT4A9, MT4M1, MT4M2, MT4M3, MT4M4, MT4M5, MT4M6, MT4M8, MT4M9, MT5C1, MT5C4, MT5C7, MT5C8, MT5G1, MT5G2, MT5G4, MT5G5, MT5G6, MT5G7, MT5G8, MT5G9, MT7A2, MT7A3, MT7A6, MT7A9, MT7F1, MT7F2, MT7F3, MT7F6, MT7G1, MT7G2, MT7G3, MT7G4, MT7G5, MT7G6, MT7G8, MT7G9, MT8C1, MT8C2, MT8C4, MT8C5, MT8C7, MT8F1, MT8F2, MT8F3, MT8F4, MT8F5 |
| Waroona | AV9D, AV9H, AV9L, BV4D, BV4F, BV4G, BV4H, BV4I, BV4J, BV4K, BV4L, BV4M, BV4N, BV4O, BV4P, BV5A, BV5B, BV5C, BV5E, BV5F, BV5G, BV5H, BV5I, BV5J, BV5K, BV5L, BV5M, BV5N, BV5O, BV5P, BV7A, BV7B, BV7C, BV7D, BV7E, BV7F, BV7G, BV7H, BV7I, BV7J, BV7K, BV7L, BV8A, BV8B, BV8C, BV8E, BV8F, BV8I, AV9C3, AV9C6, AV9C9, AV9G3, AV9G6, AV9G9, AV9K3, AV9P2, AV9P3, BV1P8, BV1P9, BV2M7, BV2M8, BV2M9, BV2N4, BV2N5, BV2N6, BV2N7, BV2N8, BV2N9, BV2O7, BV2O8, BV2O9, BV2P7, BV4B8, BV4B9, BV4C2, BV4C3, BV4C4, BV4C5, BV4C6, BV4C7, BV4C8, BV4C9, BV4E6, BV4E8, BV4E9, BV5D1, BV5D2, BV5D4, BV5D5, BV5D6, BV5D7, BV5D8, BV5D9, BV6A7, BV6E1, BV6E4, BV6E7, BV6E8, BV6I1, BV6I2, BV6I4, BV6I5, BV6I7, BV6M1, BV6M4, BV7M1, BV7M2, BV7M3, BV7M4, BV7M5, BV7M6, BV7N1, BV7N2, BV7N3, BV7N4, BV7N5, BV7N6, BV7O1, BV7O2, BV7O3, BV7O4, BV7O5, BV7O6, BV7P1, BV7P2, BV7P3, BV7P4, BV7P5, BV8D1, BV8D2, BV8D3, BV8D4, BV8D5, BV8D7, BV8G1, BV8G2, BV8G3, BV8G4, BV8G5, BV8G6, BV8G7, BV8G8, BV8H1, BV8J1, BV8J2, BV8J3, BV8J4, BV8J5, BV8J7, BV8M1, BV8M2 |
| Wolumla | MW8, MW5N, MW5O, MW5P, MW7L, MW9A, MW9B, MW9E, MW9F, MW9I, MW9J, MW9K, MW9M, MW9N, MW9O, MX2A, MX2B, MX2C, MX2D, MX2E, MX2F, MX2G, MX2H, MX2K, MX2L, MX3A, MX3B, MX3C, MX3E, MX3F, MX3G, MX3I, MX3J, MW5M5, MW5M6, MW5M7, MW5M8, MW5M9, MW6M1, MW6M4, MW6M5, MW6M6, MW6M7, MW6M8, MW6M9, MW6N7, MW7D3, MW7D6, MW7D8, MW7D9, MW7H2, MW7H3, MW7H5, MW7H6, MW7H7, MW7H8, MW7H9, MW7P1, MW7P2, MW7P3, MW7P5, MW7P6, MW7P8, MW7P9, MW9C7, MW9G1, MW9G2, MW9G4, MW9G5, MW9G7, MW9G8, MW9G9, MW9L7, MW9P1, MW9P4, MW9P7, MX1D2, MX1D3, MX1D5, MX1D6, MX1D9, MX1H3, MX2I2, MX2I3, MX2I6, MX2J1, MX2J2, MX2J3, MX2J4, MX2J5, MX2J6, MX2J8, MX2J9, MX2N3, MX2O1, MX2O2, MX2O3, MX2P1, MX2P2, MX2P3, MX2P5, MX2P6, MX3D1, MX3D4, MX3D7, MX3K1, MX3K2, MX3K4, MX3M1, MX3M2, MX3M3, MX3M4, MX3N1, MX3N2 |

# Appendix D – Coexistence with FSS uplinks

This appendix outlines the rationale for the inclusion of additional licence conditions on wireless broadband services to safeguard coexistence with FSS gateway uplinks. These conditions relate to limitations on base station TRP and antenna beams above the horizon and restrictions on fixed outdoor UEs pointing antenna beams at the GSO arc.

**Limitation on base station TRP**

It is proposed to place a TRP limit of 25 dBm/200 MHz on ‘area-wide’ apparatus licensed devices operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5 GHz. This TRP level is consistent with the base value used in international and domestic studies which considered coexistence with FSS uplinks.

**Limitation on base station emissions above the horizon**

To date, domestic and international sharing studies have assumed that user devices will always be below the base station – this means that base stations will always be directing their antenna beams below the horizon. While it is expected that base station antennas will predominantly be higher the UEs, the ACMA acknowledges that there may be a limited number of instances when UEs will be higher, for example when a UE in a building is connected to a street level base station (e.g. mounted on a light pole).

Placing a limit on the percentage of time base stations can direct their main antenna beams above the horizon will provide additional certainty that the aggregate interference limit into FSS satellite receivers will not be exceeded.

Table 13 provides the results of a study considering a satellite located at 145°E pointing at the NBN’s Waroona (WA) earth station.[[31]](#footnote-32) This study used methodology consistent with Australian contributions to ITU-R studies where the aggregate interference from all wireless broadband stations ‘visible’ to the satellite is summed with the aggregate interference from wireless broadband stations within the nbn’s -3 dB gateway footprint. This is to ensure that the interference from wireless broadband stations in the satellite main beam is not diluted in the averaging process.[[32]](#footnote-33) The wireless broadband station numbers in the -3 dB gateway footprint were calculated using the geographic areas of cities within the gateway footprint and using the equations and assumed deployment density figures in relevant ITU-R studies.

Table 13 also provides results of a sensitivity analysis which assumed that some UEs are located above the base station height – meaning that for 5 per cent of the time a base station would be directing its antenna beam greater the 5° above the horizon. As shown in Table 13, this would result in a 3.4 dB erosion in aggregate interference margin.

1. Impact of base station beams steered above the horizon

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **100% of base station antenna beams below horizon** | | **Base station antenna beams greater than 5° above the horizon of 5% of time** | |
| Satellite G/T | 30 dB/K | 25.2 dB/K | 30 dB/K | 25.2 dB/K |
| Satellite antenna gain | 56 dBi | | 56 dBi | |
| Interferer locations | Visible earth plus cities within 3 dB beamwidth (total city area = 1682 km²)[[33]](#footnote-34) | | | |
| I/N | -10.5 dB | | -10.5 dB | |
| Noise temp | 400 K | 1200 K | 400 K | 1200 K |
| Body Loss | 4 dB | | 4 dB | |
| Polarisation isolation | 3 dB | | 3 dB | |
| Calculated I/N | -31.9 dB | -36.7 dB | -28.5 dB | -33.3 dB |
| FSS interference margin (interference level below I/N criteria) | 21.4 dB | 26.2 dB | 18 dB | 22.8 dB |

The ACMA is of the view that a potential 3.4 dB erosion into the large interference margin is acceptable. Providing provisions which allows base stations to occasionally direct their beams above the horizon will provide flexibility in how wireless broadband networks can be deployed and operated. Therefore, to provide a balance between safeguarding coexistence with FSS gateway uplinks and not being overly restrictive on wireless broadband deployments, it is proposed to include the following licence conditions on wireless broadband stations operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5:

* Outdoor base stations:
* must not direct antenna beams (via electrical steering) to elevation angles greater than 5° above the horizon for more than 5% of time, and
* must have an antenna mechanical down tilt equal to or greater than 0°,

**Limitation of UE emissions above the horizon**

NBN has previously raised concerns about the risk of interference from UE emissions above the horizon.[[34]](#footnote-35) In particular, NBN was of the view that only a small number of UEs, with their maximum EIRP directed simultaneously towards a satellite, could cause unacceptable interference.

The following considerations were made in assessing the risk of interference from UE emissions above the horizon:

* adaptive power control will mean that UEs will predominately be operating at transmit levels below the maximum.
* Elevation angles to NBN satellite will be within the range 40°-50° above the horizon for the majority of gateway footprint areas.[[35]](#footnote-36) For a base station to be directly between the satellite and UE (so that the UE would be directing its beam directly towards both the base station and satellite) the UE would need to be located close to the base station (e.g. 4-5m from a 6m base station, or 24-34m from a 30m base station) – see Figure 2. At these distances the UE transmit power would likely be well below maximum. Simulations conducted by the ACMA (results contained in Attachment A of this appendix) indicate that:[[36]](#footnote-37)
* UEs located 4 to 5 metres from the base station would always be at least 29.5 dB below maximum transmit power.
* For UEs located 24 to 34 metres from the base station, 95% would be operating below maximum transmit power. The UEs at these distances from their base station and operating at (or close to) maximum power would be doing so to overcome clutter losses on the path to the base station (the only UEs operating at maximum power where those located indoors which also needed to overcome building entry loss) – this same clutter (and building entry loss) would also apply to the interference path, resulting in lower interference to the satellite. Based on these simulations, the average clutter and building entry losses at these distances was found to be 28 dB.
* The only instance when a UE might be operating close to maximum power would be when there was clutter in the path to the base station. This clutter would also proportionally reduce the level of interference to the satellite. In situations where there is no clutter loss, UEs would always be at least 20 dB below the maximum transmit power.
* The main beam of the UE would not only have to have the correct elevation angle, but also be oriented azimuthally towards the satellite’s equatorial longitude for the maximum EIRP to be directed towards it. The probability of this occurring is very low.

1. Geometry of direct alignment between a UE and a satellite, for a 6m base station (top) and a 30m base station (bottom) – diagrams not to scale



40°

1.5m

50°

4m

6m

5m



1.5m

30m

34m

24m

50°

40°

Table 14 shows that the number of UEs which all need to be operating in a worst-case (and unlikely) configuration at the same time to cause interference to the satellite using the UE power level discussed above. The results in Table 14 are based on UEs all operating in a worst-case (and unlikely) configuration (pointing at the satellite with no clutter or body loss) at the same time.

1. Deterministic study on number of UE needed to exceed interference threshold

|  |  |  |
| --- | --- | --- |
| Satellite G/T | - | |
| Satellite antenna gain | 56 dBi | |
| Path loss | 212.8 dB (FSL + P.676) | |
| Clutter loss | 0 dB (worst-case) | |
| Polarisation loss | 0 dB (worst-case) | |
| Body Loss | 0 dB (worst-case) | |
| I/N[[37]](#footnote-38) | -6 dB (for 0.6% of the time) | |
| Noise temp[[38]](#footnote-39) | 400 K | 1200 K |
| Aggregate interference threshold | -38.2 dBm/MHz | -43 dBm/MHz |
| Max IMT EIRP density | UE: 1 dBm/MHz (20 dB below maximum power of 22 dBm – from Attachment A (Figure 6), on paths with no clutter UE power will be at least 20 dB below maximum) | |
| Number of UE required to exceed interference threshold | 5271 | 15,814 |

Based on the above simulation, it is shown that it would take in excess of 5000 UEs, all within the same -3 dB footprint and simultaneously directing their beam towards the satellite, without any clutter losses for the interference threshold to be exceeded. It can then be concluded that the risk of interference due to emissions above the horizon from mobile UEs is very low given their transient nature.

It is acknowledged that the interference potential from fixed UE is likely to be higher than mobile UE owing to the static nature of fixed UE stations (i.e. interference will be long-term). To further mitigate the risk posed by fixed UEs it is proposed that the following condition be placed on wireless broadband devices operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5 GHz:

Outdoor fixed UEs must not direct their main antenna beam within 1.5° of the GSO arc when the antenna beam is pointed at elevation angles of greater than or equal to 3° above the horizon.

The above pointing restriction is only proposed to apply for UE antenna pointing elevation angles of 3° and greater above the horizon to account for the location of current and future FSS satellite. The 3° elevation angle is based on Article 21.14 of the ITU Radio Regulations.

### Attachment A to Appendix D – UE transmit power statistics

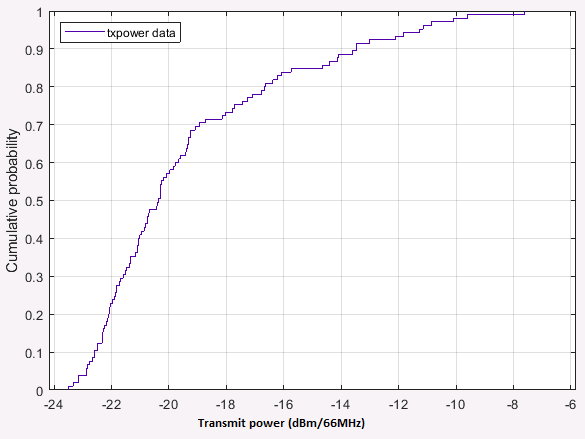
This attachment to Appendix D contains the statistical results of simulations for UE transmit powers at set distances from the base station.

For the majority of NBN gateway footprints the elevation angle to a satellite a 145°E will be between 40° and 50°. For a UE to be pointing at this elevation angle it would need to be situated at the following distances from its base station:

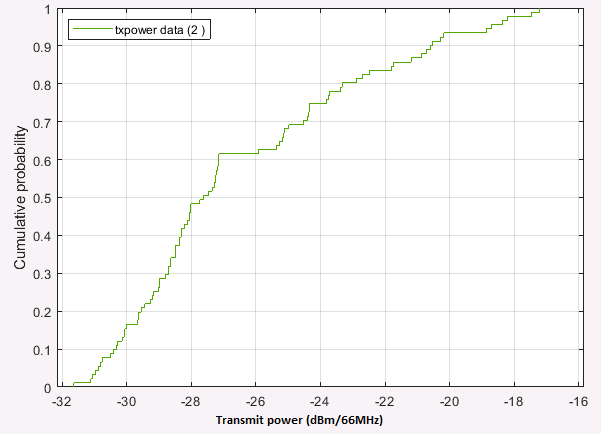
* For a 6m high base station:
* 4m for an elevation angle of 50°
* 5m for an elevation angle of 40°
* For a 30m high base station:
* 24m for an elevation angle of 50°
* 34m for an elevation angel of 40°

The following figures provide cumulative distribution function curves for UE transit powers for the above cases. Figures 3 and 5 include clutter in the signal path between UE and BS, while Figures 4 and 6 assume no clutter. The only scenario when a UE would reach maximum power would be when connected to a 30m high base station when there is clutter in the signal path. However, in this scenario, only 5% of UEs would be at the maximum power of 22 dBm/66MHz and these would be located indoors.[[39]](#footnote-40)

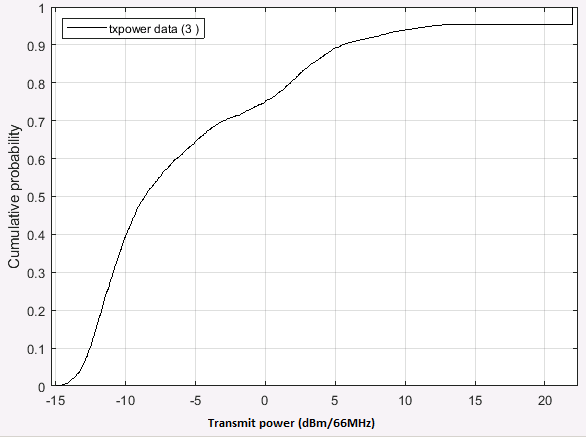
1. Transmit power for BS height = 6m, UE distance from BS = 4 to 5m, with clutter (assuming urban/suburban UE distribution model)



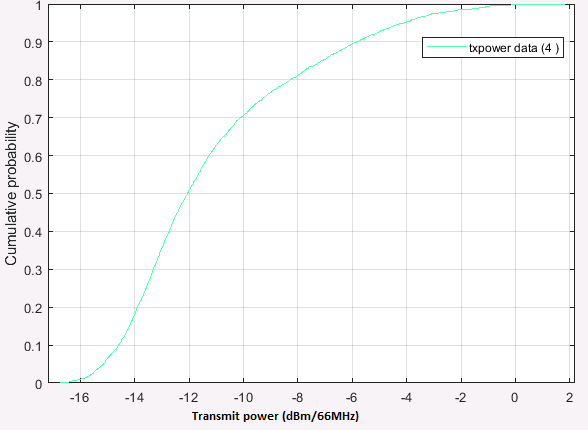
1. Transmit power for BS height = 6m, UE distance from BS = 4 to 5m, without clutter (assuming urban/suburban UE distribution model)



1. Transmit power for BS height = 30m, UE distance from BS = 24 to 34m, with clutter (assuming suburban – open space UE distribution model)



1. Transmit power for BS height = 30m, UE distance from BS = 24 to 34m, without clutter (assuming suburban – open space UE distribution model)



1. Class licensed services are also authorised to operate across the 26/28 GHz bands under the [Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018](https://www.legislation.gov.au/Details/F2018L01583) and the [Radiocommunications (Low Interference Potential Devices) Class Licence 2015](https://www.legislation.gov.au/Details/F2018C00500). [↑](#footnote-ref-2)
2. This is indicated in both the 26 GHz band and 28 GHz band decision papers. [↑](#footnote-ref-3)
3. In June 2019, the ACMA released a [consultation paper](https://www.acma.gov.au/consultations/2019-08/proposed-area-wide-apparatus-licence-consultation-192019) which proposed the introduction of a new area-wide transmitter and receiver licence type. The ACMA is currently considering submissions to this process and is expected to make an announcement in the short term. [↑](#footnote-ref-4)
4. Which LCD will ultimately be updated to include the proposed technical conditions will depend on the which type of apparatus licence is used. [↑](#footnote-ref-5)
5. In this paper, ‘area-wide’ apparatus licence is the generic term used for the proposed technical framework which could apply to either a point-to-multipoint licence type or a potential new area-wide licence (AWL) pending an ACMA decision on whether or not to make this new licence type. [↑](#footnote-ref-6)
6. Geographical areas are contained in 26 GHz band reallocation declaration [↑](#footnote-ref-7)
7. This frequency range assumes ubiquitous FSS arrangements have been expanded as detailed in the 28 GHz decision paper. [↑](#footnote-ref-8)
8. See the *Development of the 26 GHz spectrum licence technical framework* TLG paper on the SharePoint site. [↑](#footnote-ref-9)
9. The details of the proposed 26 GHz band DBC are contained in *Development of the 26 GHz spectrum licence technical framework* TLG paper, available on the TLG SharePoint website. [↑](#footnote-ref-10)
10. The HCIS in Table 1 are the exclusion areas proposed in the decision paper which are not subject to spectrum licensing minus the level 1 HCIS cells which contain the SRS earth stations. [↑](#footnote-ref-11)
11. The fixed outdoor UE pointing restriction is only proposed to apply for UE antenna pointing elevation angles of 3° and greater above the horizon to account for the location of current and future FSS satellites. The 3° elevation angle is based on Article 21.14 of the ITU Radio Regulations. [↑](#footnote-ref-12)
12. See studies B and O in Attachment 3 to Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en). [↑](#footnote-ref-13)
13. From the 28 GHz band decision paper, wireless broadband services will be secondary (with regards to FSS) in 27.5-28.1 GHz outside of areas subject to the 26 GHz reallocation declaration and in 28.1-29.5 GHz Australia wide. [↑](#footnote-ref-14)
14. See ECC Decision (18)06 [↑](#footnote-ref-15)
15. Existing LCDs are available on the Federal Register of Legislation [website](https://www.legislation.gov.au/Browse/Results/ByTitle/LegislativeInstruments/InForce/Ra/0/0/Principal). [↑](#footnote-ref-16)
16. For licences which have been aggregated over time (i.e. the frequency bandwidth and/or area authorised by the licence has changed), frequency and area boundary conditions will apply at the ‘outer’ boundary of the licence. [↑](#footnote-ref-17)
17. Available on the [ACMA website](https://www.acma.gov.au/sites/default/files/2019-10/The%20Australian%20spectrum%20map%20grid%202012.PDF). [↑](#footnote-ref-18)
18. These rules are contained in the [*Radiocommunications (Trading Rules for Spectrum Licences) Determination 2012*](https://www.legislation.gov.au/Details/F2018C00564)(trading determination). [↑](#footnote-ref-19)
19. Assuming a 4x4 antenna array with an element gain of 5 dBi. [↑](#footnote-ref-20)
20. Using the spectrum licence DBC at these boundaries will make interference management across this boundary identical in both directions. [↑](#footnote-ref-21)
21. See [*Radiocommunications (Unacceptable Levels of Interference — 3.4 GHz Band) Determination 2015*](https://www.legislation.gov.au/Details/F2018C00557)*.* [↑](#footnote-ref-22)
22. These UE antenna characteristics are provided by WP 5D, see Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-23)
23. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-24)
24. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-25)
25. Equation adapted from Recommendation ITU-R P.525 [↑](#footnote-ref-26)
26. Applicable transmitters based on the ‘power flux density at the geographic boundary’ conditions proposed above. [↑](#footnote-ref-27)
27. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-28)
28. See [Commission Implementing Decision 2019/784](https://eur-lex.europa.eu/eli/dec_impl/2019/784/oj) [↑](#footnote-ref-29)
29. See Attachment 2 to Document 5-1/36 [↑](#footnote-ref-30)
30. In Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-31)
31. The Waroona earth station was used in this analysis as, being the closest NBN earth station to a major capital city, it will be the footprint most susceptible to interference from metro wireless broadband deployments. [↑](#footnote-ref-32)
32. Whilst this could be considered as ‘double dipping’ on interference sources where the 3dB footprint overlaps the visible earth case, the ‘averaged’ interference from that overlap area in the visible earth case is not significant and doesn’t appreciably add to the aggregate (i.e. the assessed aggregate interference could be considered an over-estimate, but only very slightly). [↑](#footnote-ref-33)
33. Cities considered are Perth and Bunbury – areas obtained from Demographia World Urban Areas. This assumes that the nbn beam is directed slightly north of the Waroona (WA) earth station. It is noted that if the beam centred on the earth station then only approximately half of the Perth metropolitan area would be in the 3 dB footprint. [↑](#footnote-ref-34)
34. See NBN’s submission to the ACMA options paper ‘*Wireless broadband in the 26 GHz band ‘* available on the ACMA [website](https://www.acma.gov.au/theACMA/options-for-wireless-broadband-in-the-26-ghz-band). [↑](#footnote-ref-35)
35. Elevation angles will be higher than 50° in the remainder of nbn gateway footprint areas. [↑](#footnote-ref-36)
36. Simulated deployment characteristics and propagation modules used were consistent with those agreed by ITU-R Task Group 5/1. [↑](#footnote-ref-37)
37. Given the low probability that this scenario will occur, it is considered that the shore-term protection criteria from ITU-R Document [5-1/411](https://www.itu.int/md/R15-TG5.1-C-0411/en) is appropriate. The more conservative shore-term limit (for 0.6% of the time) is used. [↑](#footnote-ref-38)
38. NBN indicated that their satellite network operates with a G/T value of 30 dB/K, which equates to a noise temperature of 400 K for a 56 dBi antenna. NBN’s quoted noise temperature value is at odds with the noise temperatures of 800 K and 1200 K listed on their 26 GHz band satellite network filings – For example, nbn filings CR/C 4574 (published 19 March 2018) and CR/C 2926 (published 22 August 2011) have noise temperatures of 800 K and 1200 K respectively. Noting this ambiguity, this analysis uses both noise temperature values of 400 K and 1200 K to provide the upper and lower limits. [↑](#footnote-ref-39)
39. The UE emission bandwidth in this annex is 66 MHz based on the Task Group 5/1 assumption that 3 UE’s will be simulations operating in a 200 MHz channel with an equal spectral allocation (ie. 66 MHz each). [↑](#footnote-ref-40)