Development of the 26 GHz spectrum licence technical framework

Technical Liaison Group Consultation Paper

MAy 2020

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# Version Control

|  |  |
| --- | --- |
| **Version** | **Comments** |
| Version 1.0 | Initial release |
| Version 2.0 | * Provides additional discussion on:   + The rationale for equal status of spectrum and area-wide apparatus licensed services   + The additional conditions for coexistence with FSS gateway uplinks   + The potential impact of the unwanted emission limits agreed at WRC-19   + Potentially increasing the in-band TRP limit   + The co-site distance   + the notional receiver ACS and blocking requirements   + coexistence arrangements with class licensed body scanners * Provides additional clarification on:   + the application of the SRS exclusion zones and revised minimum elevation angles   + legacy point to point services in the 28 GHz band   + the proposed system model * Propose that spectrum licensed receivers are not required to coordinate with earth station protection zones (defined in RALI MS 44) * Synchronisation fallback requirement:   + Move the fallback frame structure definition to RALI[new]   + Request more detail how to the frame structure should be defined * Unwanted emission limits:   + Proposed the frequency offset breakpoint should be based on 0.1xBW to align with 3GPP standards   + Potentially adopt WRC-19 unwanted emission limits in 23.4-24 GHz, pending further consideration   + Propose that separate limits are defined for device type (base station or UE) instead of whether or not a device needs to be registered * Change definition of ‘indoor’ to be based on a pfd limit * DBC:   + Increase LOP when a transmitter is using AAS   + Change receiver gain to 0 dBi   + Allow use of a 3-second DEM and remove terrain averaging process * Correction of typographic errors |
| Version 2.1 | * Inclusion of a proposed condition to manage coexistence with incumbent apparatus licences during the reallocation period. |
| Version 3.0 | * Provides additional clarification on:   + Coexistence with passive EESS   + Coexistence with SRS earth stations * Adoption of resolves 2.1 and 2.2 of ITU-R Resolution COM4/8 (WRC-19) for deployments in 24.7-27.5 GHz * Revised the additional conditions to protect FSS uplinks, including:   + Updated fixed UE GSO avoidance angles   + Clarification on applicability and rationale of TRP limit * Updated system model to reflect updated notional receiver parameters * Proposed new in-band TRP limit * Proposed fallback synchronisation uplink-downlink configuration * Updated definition of ‘base station’ * Include registration exemption arrangements of high-powered UE * Include an additional pfd limit for indoor transmitters in some frequencies/areas * Confirmed proposed co-side distance * DBC:   + Reinstate terrain averaging   + Limit clutter losses to ≥ 0 dB * Notional receiver:   + Use of relative values with additional guidance on conversion to absolute values. |
| Version 4.0 | * Provide additional clarification on:   + coexistence arrangements with SRS earth stations   + The rationale for the indoor definition using two pfd limits * Passive EESS   + Provide an update on developments in Europe regarding the unwanted emission limits adopted at WRC-19   + Provide additional clarification on how the stage-2 limits will be applied * Proposed fallback synchronisation uplink-downlink configuration:   + Inclusion of two possible configurations (subject to further consideration)   + Discussion on additional mitigation if the fallback configuration does not resolve the interference issue. * Notional receiver:   + Provide additional clarification when calculating the maximum tolerable interference level using the notional receiver   + Update of in-band and out of band blocking specifications to better align with 3GPP TS 38.104. * Indicate that minor amendments to the proposed technical framework may be needed after a decision has been made on the licensing arrangements for FSS earth stations. * Minor editorial changes and correction of typographic errors |

# Introduction

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

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

The ACMA commenced planning for wireless broadband service delivery in the 26 GHz band with a Spectrum Tune-up event 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.

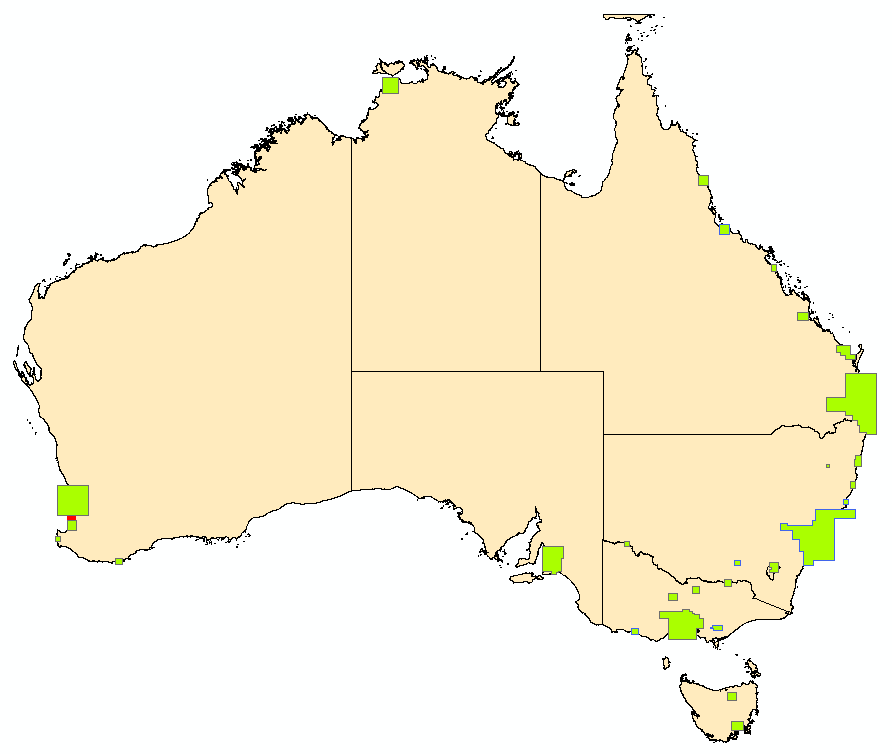
The ACMA also convened a *Working Group on Inter-service Coexistence* which drew membership from interested industry stakeholders. The purpose of this working group was to help inform stakeholder input on some of the technical issues canvassed in the options paper, specifically, how coexistence with 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 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 further developed 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 decision paper included how different parts of the band would be licensed to accommodate a range of use cases. This included identification of the frequency range 25.1-27.5 MHz as a candidate for wide-area spectrum licensing, subject to ministerial agreement. The Minister for Communications, Cyber Safety and the Arts made a reallocation declaration in October 2019 to enable the reallocation and issue of spectrum licences in defined regional and metropolitan areas (refer to Figure 1)[[1]](#footnote-2).

The purpose of this paper is to develop a technical framework for spectrum licences to be issued in that segment, which for the purposes of this paper will simply be termed ‘the 26 GHz band’. This paper proposes and seeks comment on a draft technical framework for these spectrum licences.

1. Area in the 26 GHz band re-allocated for the issue of spectrum licences. Green = spectrum licensed areas in the range 25.1-27.5 GHz, red = spectrum licensed areas in the range 25.1-27 GHz.



## Outline

This paper has been divided between a discussion on the proposed coexistence arrangements with other services in and adjacent to the 26 GHz band, and the relevant instruments that form a spectrum licence technical framework:

* Spectrum Licence:
* Unwanted emission limits;
* Other conditions on the licence;
* The determination made under s.145(4) of the *Radiocommunications Act 1992* (the Act) on unacceptable levels of interference:
* The device boundary criteria (DBC) (limiting emissions across geographical boundaries);
* Deployment constraints;
* Advisory guidelines made under s.262 of the Act:
* Managing interference from spectrum licensed transmitters;
* Managing interference to spectrum licensed receivers.

Draft versions of the spectrum licence, s.145(4) determination and advisory guidelines are provided at Appendices A-D.

The ACMA is also developing a technical framework for ‘area-wide’ apparatus licences (optimised for wireless broadband services) in the 26 GHz and 28 GHz bands (applicable to frequencies and areas not subject to the 26 GHz band reallocation declaration) – see the *Development of the 26/28 GHz band apparatus licence technical framework* TLG paper on the SharePoint site.[[2]](#footnote-3) It is proposed that parts of the apparatus licence technical framework are incorporated into the spectrum licence framework. Therefore, the apparatus 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 a technical framework for spectrum licensing in the areas and frequencies covered in the 26 GHz band re-allocation declaration[[3]](#footnote-4). It will not consider:

* Allocation issues (e.g. lot sizes, auction format): This will be covered in a separate consultation process
* Development of new apparatus licence arrangements for wireless broadband in the 26 GHz and 28 GHz bands: technical/operating arrangements will be considered in a separate workstream within the 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.

## Spectrum reform

The government is reforming the spectrum management framework within Australia. The former Department of Communications and the Arts (DoCA)[[4]](#footnote-5) 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 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 GHz band may need to be accommodated under the new legislative framework, once it commences. The ACMA will consider relevant opportunities offered by the implementation of the new legislative framework, if and when applicable.

Further information on spectrum reform is available from the Department of Infrastructure, Transport, Regional Development and Communications.

## Timeline

The ACMA is planning on allocating the 26 GHz band spectrum licences in Q1 2021. To achieve 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 * Deadline for submissions/comments on revised TLG paper * TLG paper Version 4 (final) | Nov 2019-Mar 2020  11 Nov 2019  22 Dec 2019  30 Jan 2020  27 Feb 2020  2 April 2020  15 April 2020  Week beginning 11 May 2020 |
| Public consultation on the drafts of the following technical framework instruments (the consultation will also include a draft 26 GHz band marketing plan):   * Draft spectrum licence; * Draft *Radiocommunications (Unacceptable Levels of Interference – 26 GHz Band) Determination 2020;* * Draft *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 26 GHz Band) 2020;* * Draft *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 26 GHz Band) 2020* * Draft update to *Radiocommunications (Trading Rules for Spectrum Licences) Determination 2012.*   Public consultation on coordination and licensing arrangements for new FSS gateway earth stations in the range 27-29.5 GHz. This work will include consideration of:   * Arrangements to coordinate new gateway earth stations with wireless broadband services * The apparatus licensing framework which FSS gateways will be operated under.   Consideration of updates to the Radiocommunications (Communication with Space Object) Class Licence 2015 (the CSO class licence) to consider new arrangements for ubiquitous earth stations in 27.5-28.3 GHz[[5]](#footnote-6). This work will include:   * Sharing with stakeholders the ACMA’s technical analysis and preliminary views on proposed arrangements for ubiquitous earth stations in 27.5-28.3 GHz, including consideration of a potential allocation for ubiquitous earth stations in 27.5-28.1 GHz inside high-population areas * Publicly consulting on proposed updates to the CSO class licence. | Q2/Q3 2020 |
| Finalisation of:   * Spectrum licence technical framework * FSS gateway earth station coordination arrangements * Updates to the CSO class licence | Q4 2020 |

The TLG is the first step in the process of developing a technical framework. While the aim is to complete the work within the timeframe defined this will 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 GHz band technical framework. 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 instruments at appendices A-D have not undergone legal review. This review will be conducted prior to finalisation which could result in changes to the text as drafted.

Under the currently proposed timeline, a legal review of the draft instruments 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 GHz band spectrum licence will need to coexist not only with other spectrum licensed services, but also with services operating in and adjacent to the 25.1-27.5 GHz band. The 26 GHz band spectrum licence technical framework therefore needs to include provisions to manage coexistence with the following services:

* Area-wide apparatus licensed devices operating:[[6]](#footnote-7)
* In the frequency range 24.7-25.1 GHz Australia wide
* In the frequency range 25.1-27.5 GHz is areas adjacent to 26 GHz band spectrum licensed areas
* 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 27-27.5 GHz
* 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 25.1-27.5 GHz.

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.

## Area-wide apparatus licensed devices operating in and adjacent to the 25.1-27.5 GHz band

It is proposed that area-wide apparatus licensed devices will operate:

* In the frequency ranges 24.7-25.1 GHz and 27.5-29.5 GHz Australia wide,
* In the frequency range 25.1-27.5 GHz in areas not subject to the 26 GHz band reallocation declaration,

It is proposed that area-wide apparatus licences will 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 is similar to – but on a smaller scale than – spectrum licencing, and in the same way, interference will primarily be managed at the apparatus licence boundary (frequency and area) with a reduced requirement for device-based coordination.

It is proposed that the technical framework for area-wide apparatus licences in the 26/28 GHz bands 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 GHz band spectrum licences. This will result in reciprocal interference management arrangements at the licence boundaries between apparatus and spectrum licences.

It is proposed that coexistence between spectrum licensed and area-wide apparatus licensed services will be managed by the following:

* At the frequency boundary:
* Unwanted emission limits specified on the spectrum licence (further details in the *Unwanted emission limits* section)
* The (time division duplex) synchronisation requirements specified on the spectrum licence (detailed in the *In-band emission limits* section)
* At the geographic area boundary:
* The device boundary criteria (DBC) (further details in the *Device boundary criteria* section)
* The synchronisation requirements specified on the spectrum licence

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 apparatus licensed services through an update to the [Radiocommunications Licence Conditions (Area-Wide Licence) Determination 2020](https://www.legislation.gov.au/Details/F2020L00070) (AWL LCD).[[7]](#footnote-8)

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. Further details are contained in the *Managing interference from spectrum-licensed transmitters* and *Managing interference to spectrum-licensed receivers* sections.

Some TLG submissions disagreed with the proposed arrangements which gave equal status to both spectrum licensed and area-wide apparatus licensed services. It was suggested that spectrum licences should be protected from future area-wide apparatus licensed services, potentially meaning that some apparatus licences should not be issued until after spectrum licensed services have been deployed. It was also suggested that if interference occurred at a frequency boundary and a negotiated solution could not be found, then the spectrum licensed device(s) would have priority over the apparatus licensed device(s) (i.e. the synchronisation requirement wouldn’t apply in this scenario).

It was also noted in some submissions that the requirement to negotiate and synchronise may become overly complex if there are many different licensees and networks across both licence types. Providing spectrum licensees with the higher priority would potentially reduce the number of parties required to negotiate and synchronise with.

The ACMA is of the view that the overall utility of the spectrum will be maximised under the proposed ‘equal status’ arrangements. Restricting the rights of area-wide apparatus licensees may have a significant impact on the utility of the spectrum authorised under that regime. While there may potentially be large numbers of apparatus licensees operating in the broader 26 and 28 GHz band, negotiation and synchronisation would only be required if/when interference occurs and would be limited to impacted stations (not network wide) which is expected to ease the regulatory burden.

Based on the information provided in submissions, the ACMA does not believe that the proposed arrangements will be impractical to implement, therefore no change has been proposed to the coexistence arrangements detailed above.

TLG members also indicated that the same technology (i.e. 3GPP New Radio) is expected to be deploy under both area-wide apparatus licences and spectrum licences across the broader 26 and 28 GHz band. Therefore, there does not currently appear to be any technical reason why an agreed synchronisation regime similar to that used in other frequency bands could not be relied upon to resolve interference issues for both licence types.

In the ACMA’s view, providing AWLs with an equal status to spectrum licences will provide a high level of certainty to AWL deployments to support overall usage of the band. Without this level of certainty, if an interference resolution could not be negotiated with a spectrum licensee, the AWL licensee may need to modify their operation and potentially may need to cease operating.

## 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 decision paper proposed the following measures to protect these earth stations:

* Exclusion zones within the Canberra spectrum licence area where spectrum licensed devices cannot be operated
* A requirement that all licensed devices must be coordinated with these earth stations to meet a minimum protection level of -156 dBW/MHz.

Rationale for the proposed exclusion zones and protection level is provided in Annex E of the decision paper.

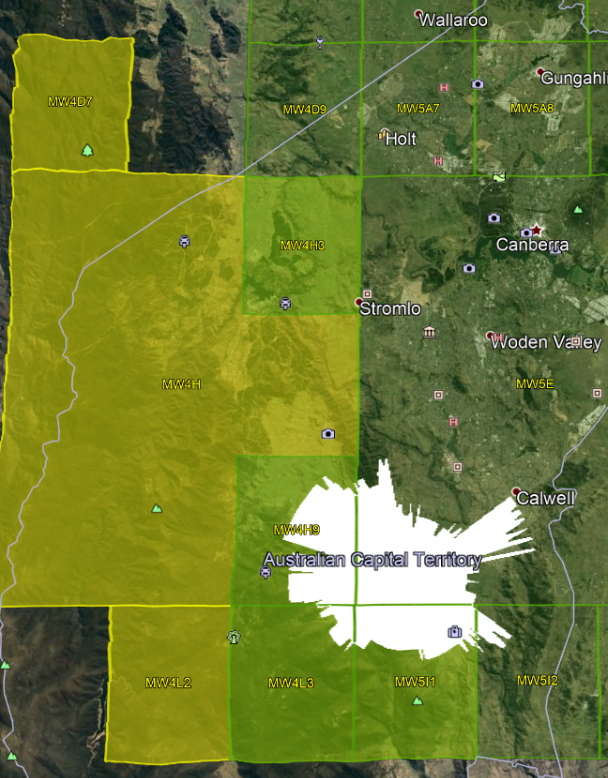
The ACMA maintains the view that exclusion zones are necessary to manage coexistence with the Tidbinbilla earth station. It is proposed that the exclusion zone for spectrum licensed transmitters (including user equipment) operating in the range 25.5-27 GHz applies to the following HCIS cells: MW4H3, MW4H9, MW4L3, MW5I1, which are proposed to be implemented via a condition on each spectrum licence – see *Other conditions on the licence*.

It is proposed that the coordination requirement be included in the RAG Tx, and is discussed further in the *Radiocommunications advisory guideline*s chapter.[[8]](#footnote-9)

Spectrum licences in the Canberra area are expected to include the four HCIS cells above (subject to a decision on allocation arrangements), however the condition detailed above will preclude the operation of transmitters in these areas. This would result in the spectrum licence area overlapping the exclusion zone but with no material increase to interference potential into SRS Earth stations due to the requirement for all outdoor base stations and high-powered UEs (i.e. with a TRP greater than 23 dBm) to be coordinated with the SRS earth station and meet an aggregate protection level of -156 dBW/MHz at the input terminal of the SRS receiver. The purpose of these measures is to allow the Device Boundary Criteria (DBC)[[9]](#footnote-10) to cross into these overlap areas and therefore maximise the utility of areas near, but outside, the exclusion zone.

Figure 2 shows an example of the DBC (white) overlapping parts of the Tidbinbilla exclusion zone (HCIS cells MW4H9, MW4L3 and MW5I1). Transmitters (including user equipment) will not be permitted to operate in the overlapping areas but the DBC can spill into these areas. Allowing the DBC to overlap these areas removes unnecessary deployment restrictions at the boundary of the exclusion zones without compromising the protection afforded to the Tidbinbilla earth station (due to the requirement for all outdoor base stations and high-powered UEs (i.e. with a TRP greater than 23 dBm) to be coordinated with the SRS earth station with an aggregate protection level of -156 dBW/MHz at the input terminal of the SRS receiver).

1. Example of a DBC overlapping the Tidbinbilla exclusion zone



In summary, protection of the New Norcia and Tidbinbilla earth stations will be ensured through application of the following requirements:

* all outdoor transmitters in the range 25.5-27 GHz with a TRP > 23 dBm will be required to directly coordinate with these earth stations
* no transmitters in 25.5-27 GHz (of any type) will be permitted to operate in an SRS exclusion zone

## Coexistence with space station receivers

Article 5 of the ITU-R Radio Regulations provides allocations for various space services in the range 24.25-27.5 MHz on a co-primary basis with terrestrial services (including IMT). In ITU-R Region 3, these space services include:

* inter-satellite services in 24.45-24.75 GHz and 25.25-27.5 GHz,
* FSS(E-s) in 24.65-25.25 GHz and 27-27.5 GHz

ITU-R Resolution COM4/8 (WRC-19) resolves that administrations shall apply a number of conditions on IMT base station deployments in the range 24.25-27.5 GHz to protect co-frequency space station receivers operating under the allocations detailed above as well as passive EESS in the adjacent 23.6-24 GHz band. These conditions are:

* Taking practical measures to ensure the transmitting antennas of outdoor base stations are normally pointing below the horizon, when deploying IMT base stations. The mechanical pointing needs to be at or below the horizon.

As far as practical, sites for IMT base stations within the frequency band 24.45-27.5 GHz employing values of equivalent isotropically radiated power (eirp) per beam exceeding 30 dBW/200 MHz should be selected so that the direction of maximum radiation of any antenna will be separated from the geostationary-satellite orbit, within line of sight of the IMT base station, by ±7.5 degrees.

The above provisions are also broadly consistent with the proposed coexistence arrangements with FSS gateway uplinks detailed in the following section.

To enable alignment with the ITU-R Radio Regulations and to ensure coexistence with incumbent services, it is proposed to include a requirement in RAG Tx that spectrum licensees are to adhere to the provisions detailed in resolves 2.1 and 2.2 of ITU-R Resolution COM4/8 (WRC-19) for deployments in the range 25.1-27.5 GHz – see the *Managing interference from spectrum-licensed transmitters* section and Appendix C.

## Coexistence with FSS gateway up-links in 27-27.5 GHz

### Interference to FSS gateway satellites

NBN operate 10 FSS gateway uplinks which overlap the upper 500 MHz of the 26 GHz band (27-27.5 GHz). The decision paper outlined some preliminary views on additional conditions on wireless broadband use to safeguard coexistence with NBNs gateway uplinks.

It is proposed that the following specific conditions be applied to spectrum licensed devices operating in the range 27-27.5 GHz and within HCIS areas listed in Appendix E:

* The maximum total radiated power (TRP), for any outdoor transmitter, is 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 over the course of a single day

Outdoor fixed UEs must not direct their antenna beam (via electrical or mechanical steering) to an angle from the GSO arc which is less than the minimum angles in Table 1, when the antenna beam is pointed at elevation angles of greater than or equal to 11° above the horizon.

1. Minimum separation angles

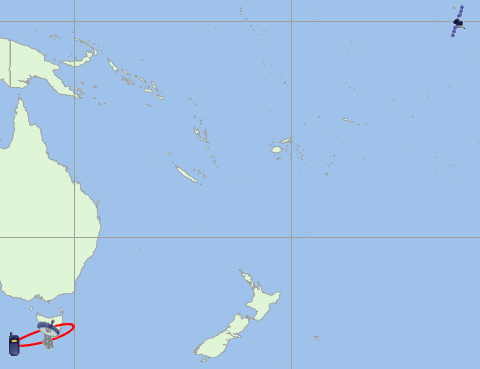
|  |  |
| --- | --- |
| Outdoor fixed UE antenna gain | Minimum separation angle from the GSO arc |
| < 34.7 dBi | 25 degrees |
| ≥ 34.7 dBi | 1.5 degrees |

The following changes have been made from the previous iteration of these additional conditions:

* Clarified that the TRP limit of 25 dBm/200 MHz applies to all outdoor transmitters (both BS and UE)
* Clarified that the time window over which a base station may direct its antenna beam above 5° for up to 5% of time is *over the course* *of a single 24 hour period*
* For the fixed UE condition, we have:
* Removed the non-line-of-sight exemption based on concerns from some TLG members that obstructions/clutter on the interference path may change over time
* Provided two GSO arc avoidance angles based on the fixed UE antenna gain. This will allow CPE using high-gain parabolic antennas to direct beams closer to the GSO arc (given the narrow beamwidth), while lower gain (wide beamwidth) array antennas will need to maintain a larger GSO separation angle.
* The 1.5° separation angle is based on the -3 dB beamwidth of a 34.7 dBi parabolic antenna.[[10]](#footnote-11) A 26 cm parabolic antenna is expected to have a gain of approximately 34.7 dBi.[[11]](#footnote-12)
* The 25° separation angle is based on the -3dB vertical beamwidth of a 2x8 element array with a M.2101 pattern.

Increased the elevation exemption from 3° to 11°. It is proposed that this condition be based on the elevation angle for a fixed UE located within the -3 dB footprint of the satellite. For a minimum earth station elevation angle of 15° (consistent with RALI MS 44 for the Quirindi, Moree and Roma earth station protection zones) and an assumed satellite antenna gain of 56 dBi, the lowest elevation angle within the -3 dB footprint is 11° – see Figure 3.

1. Minimum elevation angle with -3 dB footprint of 56 dBi satellite antenna (red) for earth station elevation angle of 15°



15°

11°

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

Some TLG submissions suggested that the TRP limit could be raised from 25 dBm/200 MHz to 40-45 dBm/200 MHz without impacting co-frequency FSS uplinks. The rationale for this suggestion was that the majority of ITU-R studies showed large interference margins with an assumed base station TRP of 25 dBm/200 MHz, so increasing the TRP would not result in the aggregate interference level exceeding the protection requirement.

While studies (including those undertaken domestically) did show large interference margins, that doesn’t mean those margins should be ‘used up’ by an increased TRP limit. International deployments of mmWave IMT-2020 are currently in the early stages and potential use cases and network configurations are still evolving. The additional conditions detailed above, including the TRP limit of 25 dBm/200 MHz, will help ensure confidence in the coexistence between FSS uplinks and wireless broadband services and act as a safeguard against any significant divergence of wireless broadband deployment characteristics from the models used in studies.

The ACMA’s view continues to be that the TRP limit of 25 dBm/200 MHz in those areas strikes a balance between enabling the deployment of wireless broadband services and ensuring coexistence with incumbent services. This view is also consistent with the findings of the ‘Coexistence of terrestrial and satellite services at 26 GHz’[[12]](#footnote-13) report by Plum Consulting which concluded that the mitigation measures proposed in the ACMA’s 26 GHz band decision paper (including the base station TRP limit of 25 dBm/200 MHz) “seem to strike an appropriate balance between safeguarding the critical NBN infrastructure and imposing conditions on new spectrum entrants that are not too onerous”.

However, the ACMA acknowledges that there continues to be divergent views regarding the 25 dBm/200 MHz TRP limit. The ACMA will continue to consider this issue in preparation for the public consultation phase.

If we are to consider any higher TRP limits, they will need to be accompanied with additional mitigation measures to maintain coexistence with FSS uplinks (for example, by placing addition limitations on the radiated power above the horizon). We would expect that any additional proposals that may be brought forward after this TLG process, will reflect an agreement reached between interested/affected stakeholders (specifically, stakeholders in the terrestrial wireless broadband and satellite sectors).

To provide consistency with the WRC-19 outcomes, it is proposed that licensees will be required to adhere to *resolves* 2.1 and 2.2 of Resolution COM4/8(WRC-19) for deployments in the range 25.1-27.5 GHz. It is further proposed that this requirement will be included in the RAG Tx (see the *Managing interference from spectrum-licensed transmitters* section and Appendix C). The proposed TRP limit detailed above also complies with Article 21.5 of the Radio Regulations.

It is currently proposed that the additional conditions outlined above will be captured in the RAG Tx – see the *Radiocommunications advisory guidelines* chapter. To provide additional regulatory certainty it is also proposed to include a condition on spectrum licences which will require compliance with these provisions in the RAG Tx *–* see the *Other conditions on the licence* subsection.

The areas in which the additional conditions should apply (detailed in Appendix E) 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 of the 10 NBN gateway earth stations.

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

### Interference from FSS gateway earth stations to spectrum licensed receivers

The potential for interference from FSS earth stations to receivers operated under 26 GHz spectrum licences will depend on a number of variables, in particular geographical separation and antenna discrimination. Studies undertaken by Task Group 5/1 indicate maximum separation distances of up to 7.5 km (for earth stations with a 13m antenna and elevation angles of at least 20˚) are required to protect IMT stations, however actual distances will depend on specific circumstances.[[13]](#footnote-14) The probability of interference to spectrum licensed receivers is considered low given:

* the minimum elevation angle of all existing FSS earth stations in 27-27.5 GHz is approximately 40˚

the nearest existing FSS earth station to a 26 GHz band spectrum license area boundary in the range 27-27.5 GHz is approximately 6.5km

FSS earth station locations and antenna pointing angles are static and can be accounted for in network planning.

It is therefore proposed that no interference protection will be afforded to spectrum licensed receivers from existing FSS earth station transmissions. Applications for new FSS gateway earth stations following the issue of 26 GHz band spectrum licences will be considered on a case by case basis. This guidance is proposed to be included into the RAG Rx – see the *Radiocommunications advisory guidelines* chapter.

Arrangements for coordinating new FSS earth stations with spectrum licensed services will be developed though a separate process. The ACMA is also currently considering which apparatus licence type should be used to authorise FSS earth stations in the 26 GHz and 28 GHz bands. The outcome of this work may require some minor amendments to the proposed technical framework detailed in this paper. The ACMA will discuss potential changes (if required) with relevant stakeholders prior to public consultation on the spectrum licence technical framework.

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

Space-borne passive sensing EESS services operate in the 23.6-24 GHz band. Coexistence studies between IMT-2020 and passive EESS essentially means being able to protect passive EESS receivers from aggregated out-of-band (OOB) emissions from wide-area wireless broadband services operating in the 26 GHz band. Extensive studies have been undertaken both internationally (notably under ITU-R Task Group 5/1 and the ECC throughout the WRC-19 study cycle) and domestically (in the Inter-service Working Group convened by the ACMA in October 2018).

To manage coexistence between passive EESS receivers and 26 GHz band wireless broadband devices, the ACMA proposed (in the 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 were 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 aggregated 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 in Australia.

The protection of the passive EESS band was considered in-depth at WRC-19 under agenda item 1.13, which resulted in the following emission limits into the 23.6-24 GHz band being included in ITU-R Resolution 750[[15]](#footnote-16):

* For (IMT) stations brought into use before 1 September 2027:
* For base stations, a TRP limit of -33 dBW/200 MHz
* For mobile stations, a TRP limit of -29 dBW/200 MHz
* For (IMT) stations brought into use after 1 September 2027:
* For base stations, a TRP limit of -39 dBW/200 MHz
* For mobile stations, a TRP limit of -33 dBW/200 MHz

In late December 2019, the European Commission (EC) wrote to the ECC identifying the need to amend the Commission Decision 2019/784 in light of different emission limits agreed at WRC-19 and asked the CEPT to assess the adoption of the European baseline power limits. [[16]](#footnote-17) A response to the EC letter was agreed at the 52nd meeting of the ECC which:[[17]](#footnote-18)

* Agrees with a two-step approach which will enable the initial introduction of 5G equipment which does not meet the final WRC-19 limits.
* Acknowledges that the stage-2 WRC-19 limits would provide the same level of protection as the agreed EU limit (-42 dBW/200 MHz and -38 dBW/200 MHz) as long as there are no high-density deployments in the 22-23.6 GHz band.
* Recommends that the stage-2 WRC-19 limits are implemented on 1 January 2024 as there is a risk that mass market deployments occurring before 1 September 2027 could result in aggregate interference into EESS.

On 24 April 2020, the European Commission amended [EU decision 2019/784](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019D0784) to implement the WRC-19 unwanted emission limits (with the stage-2 limits coming into force at 1 January 2024).[[18]](#footnote-19)

Some TLG submissions indicated support for the above WRC-19 limits being adopted in the 26 GHz spectrum licensed band. These submissions suggested that adoption of these limits will allow the deployment of internationally harmonised equipment in Australia while also protecting adjacent-band passive services.

Other TLG submissions indicated support for the limits the ACMA previously proposed in the decision paper and suggested that the ACMA should wait to see the amount of international adoption of WRC-19 limits (particularly in Europe) as this would influence the level of equipment harmonisation. It was also suggested that the stage-2 WRC-19 limits could be implemented earlier (for example in 2024 or 2025) to better align with forecast 5G deployments. One TLG submission also suggested that antenna pointing restrictions should be placed on wireless broadband services to limit emissions towards EESS passive sensors.

WRC outcomes and the Radio Regulations play an important part in the consideration of Australia’s domestic spectrum planning arrangements. Alignment with internationally harmonised arrangements provides many benefits to Australia, in particular providing access to internationally harmonised equipment.

Careful consideration is needed to inform a decision on which emission limits will apply in the passive EESS band. These considerations include the impact that the WRC-19 limits would have on the utility of the passive band, and the impact of not aligning with internationally agreed unwanted emission limits.

Up until September 2027, the WRC-19 limits will allow unwanted emissions into the passive band to be 4 dB higher than the limits previously proposed for Australia. After that date the WRC-19 limits for IMT base stations will become 2 dB stricter than the proposed limits. Some thoughts on the potential implications of adopting the WRC-19 limits include:

* 4 dB higher unwanted emissions would theoretically mean that it would take fewer base stations to exceed the EESS passive protection limits than the previous domestic studies indicated. For example, the previously proposed limits were based on 224 base stations in the footprint of an EESS satellite (a 12x18km oval). If emissions were allowed to be 4 dB higher the maximum base station number would reduce to 89 (i.e. 89 base stations would need to be deployed in the footprint area before an aggregate interference level equivalent to the previously proposed limit would be reached).
* Any impact to the passive band, in comparison with the previously proposed limits, would only materialise over time as IMT stations are deployed.
* Given that the WRC-19 limits apply to devices over the entire 24.25-27.5 GHz range, and that the frequency separation between the spectrum licensed band and the passive band would be at least 1.1 GHz, unwanted emissions into the passive band from spectrum licensed devices manufactured to meet the WRC-19 limits are likely to be considerably lower than those limits.
* The WRC-19 limits are expected to be widely adopted internationally. If this is the case, would there be any benefit in prescribing stricter limits in Australia, even if the 1.1 GHz guard band for spectrum licences means that equipment manufactured in accordance with the WRC-19 limits would likely be able to meet a stricter limit?

After September 2027, the WRC-19 limits will offer more protection to passive EESS than the previously proposed limits.

Some initial ACMA considerations on the impact of *not* adopting the WRC-19 limits (i.e. adopting a more stringent limit) follow:

* Before September 2027:
* As the previously proposed limits are stricter than the WRC-19 limits, there is a risk that internationally harmonised equipment would be unable to be deployed in Australia without modification, or that operators might need to operate at reduced power levels which may impact coverage and/or throughput.
* On the other hand, the minimum 1.1 GHz separation between spectrum licensed services and the passive band means that unwanted emissions in the passive band from standard equipment might potentially still meet the stricter, previously proposed limits below 24 GHz. This means the original limits could, in theory, be applied without precluding the use of internationally-manufactured equipment, resulting in minimal impact to spectrum licensees.
* After September 2027, there is expected to be no impact given available equipment would comply with both the previously proposed limits and the stricter WRC-19 limits.

On balance, the optimal solution would be one which would allow both the use of internationally harmonised equipment while also providing a high level of protection to the passive EESS band.

For example, if it is assumed that internationally harmonised devices in spectrum licensed band, due to the 1.1 GHz separation from the passive band, would meet the previously proposed limits, then a potential solution could be to adopt the WRC-19 limits.

The ACMA sees merit in the above proposal as it both allows the deployment of internationally harmonised equipment while continuing to meet our objective of protecting passive EESS. Therefore, based on the evidence currently available, it is proposed that:

* Spectrum licensed devices deployed before 1 September 2027 are to meet the following unwanted emission limits in the 23.6-24 GHz band:
* For base stations, a TRP limit of -33 dBW/200 MHz
* For mobile stations, a TRP limit of -29 dBW/200 MHz
* Spectrum licensed devices deployed on or after 1 September 2027 are to meet the following unwanted emission limits in the 23.6-24 GHz band:
* For base stations, a TRP limit of -39 dBW/200 MHz
* For mobile stations, a TRP limit of -33 dBW/200 MHz
* Require spectrum licensees to adhere to resolves 2.1 and 2.2 of ITU-R Resolution COM4/8 (WRC-19) for deployments in the ranges 25.1-27.5 GHz.

It is proposed that the stage-1 (i.e. before 1 September 2027) and stage-2 (i.e. on or after 1 September 2027) unwanted emission limits detailed above will apply depending on the date the transmitter is first operated under a spectrum licence. I.e. if a base station is licensed and registered in the RRL before 1 September 2027 but is upgraded with a new transmitter unit after 1 September 2027, then the transmitter must meet the stage-2 emission limit – also see the *Unwanted emission limits* section and Appendix A.

## Point-to-point services

As detailed in the [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), 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).

It is proposed that during this 7 year period, 26 GHz band spectrum licensed services will need to coexist with existing point-to-point services in the adjacent 28 GHz band. The risk of interference is low (given there will be a frequency separation of at least 600 MHz between spectrum licensed and fixed services), however including coexistence arrangements will provide a level of certainly for legacy fixed services.

Coordination procedures for protecting point-to-point services from area-wide apparatus licensed services are proposed to be included in a new RALI (RALI[new] – a draft is available on the 26/28 GHz band TLG SharePoint site). It is proposed that 26 GHz band spectrum licensed transmitters will need to be coordinated with legacy point-to-point services using the provisions in RALI[new].

It is further proposed that 26 GHz band spectrum licensed receivers will not be afforded protection from existing point-to-point links. In planning deployments under a 26 GHz band spectrum licence the licensee should take account of existing point-to-point transmitters and plan their services accordingly.

Further guidance is provided in *Managing interference from spectrum-licensed transmitters* section.

Some TLG submissions suggested that existing point-to-point services should vacate the 28 GHz band at the end of the 7 year period and there should be no possibility of allowing these services to remain in the band after this date.

Given their low deployment numbers, it is expected that 28 GHz band point-to-point services will have a minimal impact on wireless broadband services in the 26 and 28 GHz bands. This level of impact will be better understood at the end of the 7 year period and will inform a decision on whether it is appropriate for point-to-point services to remain in the band. With this in mind it is appropriate to allow the possibility of an extension for the time being.

## Devices operating under existing class licences

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

* Aviation security body scanning devices operated 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), 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 paper, the ACMA is of the view that these class licensed devices can coexist with 26 GHz band spectrum licensed service 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 ensure 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 GHz band spectrum licences — this requirement is consistent with spectrum licences issued in other bands (see the *Other conditions on the licence* section) — and would also be effective in limiting the (already unlikely) potential for instances of interference between body scanners and spectrum 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 spectrum licensed devices (in either direction) it is proposed the spectrum licensee will be responsible for resolving any such issues.

Guidance on coexistence with class-licensed services is proposed to be included in the RAG Tx and RAG Rx — see the *Radiocommunications advisory guidelines* chapter.

Some TLG submissions raised concerns that it is inappropriate that class licensed body scanners are provided a higher status than spectrum licensed services and it is contrary to the ‘no-interference/no-protection’ condition placed on body scanners by the [Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018](https://www.legislation.gov.au/Details/F2018L01583).

As detailed in the decision paper, the risk of interference between body scanners and spectrum licensed wireless broadband services is expected to be very low and would only occur if services were deployed in very close proximity. In addition, the class licence places significant restrictions on who is permitted to operate a body scanner, which will limit their proliferation and further reduce the risk that interference will occur. The ACMA therefore remains of the view that the proposed arrangements are appropriate.

## Coexistence with earth station protection zones

RALI MS 44 details the requirements for coordination with defined earth station protection zones (ESPZs). RALI MS 44 places coordination requirements on terrestrial services planned to be deployed within specified distances of the ESPZs. In bands above 12 GHz, terrestrial services within 160 km of locations within each ESPZ (as listed in Appendix B of RALI MS 44) need to be coordinated.

Some of the areas defined in the 26 GHz band reallocation declaration are less the 160 km for the locations defined in Appendix B of RALI MS 44. However, as the minimum distance is approximately 100 km, the risk of interference from an earth station transmitter inside an ESPZ to a spectrum licensed receiver is negligible. Therefore, it is proposed that 26 GHz spectrum licensed services will not need to coordinate with ESPZs.

# Discussion of proposed technical framework

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

* The conditions specified on the spectrum licence—in particular, the core conditions that define the spectrum space (both frequency and geographical area) and the level of emissions permitted inside and across the frequency boundaries of the licence (section 66 of the Act). The draft spectrum licence is contained in Appendix A
* A determination of unacceptable interference for the purpose of device registration in each band (section 145 of the Act). This defines permissible levels of emissions across geographical licence boundaries and can also define various deployment constraints. The draft *Radiocommunications (Unacceptable Levels of Interference – 26 GHz Band) Determination 2020* (the s.145 determination) is contained in Appendix B.
* Radiocommunications advisory guidelines (RAGs) that provide assistance and advice for coordination with stations in other services when and where required (section 262 of the Act). This includes detailing interference management criteria with incumbent apparatus and other spectrum licences. Draft *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 26 GHz Band) 2020* (RAG Tx) and *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020* (RAG Rx) are contained in Appendix C and D respectively.

A more comprehensive explanation of spectrum licence technical frameworks is provided in the document [*Know your obligations—Spectrum licensees*](https://www.acma.gov.au/sites/default/files/2019-08/know_your_obligations-pdf.pdf).

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

## International Developments

There has been extensive work undertaken internationally relevant to the introduction of wireless broadband services into the 26 GHz band. This section provides an outline of this work. The documents listed below have been consulted when developing the proposed spectrum licence technical framework for the 26 GHz band.

### ITU-R studies

The 26 GHz band is one of a number of bands that was considered by the ITU-R for IMT-2020 under agenda item 1.13. 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 of 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 to 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 to 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 of Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en): Characteristics for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz.

### WRC-19 outcomes

WRC-19 was held in Sharm el-Sheikh, Egypt from 28 October to 22 November 2019 – the [Provisional Final Acts](https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf) are available on the ITU-R website. Consideration of IMT in the 26 GHz band was included under agenda item 1.13. The following outcomes are relevant to the 26 GHz band:

* A new footnote (currently 5.A113) which identifies the 24.25-27.5 GHz band for administrations wishing to implement the terrestrial component for IMT. The new Resolution COM4/8 (WRC-19) applies to this identification.
* Resolution COM4/8 (WRC-19) was made to support the implementation of IMT in the 26 GHz band and includes a number of provisions for coexistence with incumbent space services (including FSS, EESS (passive) and inter-satellite services).

Resolution 750 was updated to include unwanted emission limits in the passive EESS band 23.6-24 GHz (these were discussed in the *Passive EESS satellite receivers operating in the 23.6-24 GHz band* section).

### 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

In late December 2019, the European Commission (EC) wrote to the ECC identifying the need to amend the Commission Decision 2019/784 in light of different emission limits agreed at WRC-19.[[19]](#footnote-20) The ECC developed a response at the 52nd meeting of the ECC.[[20]](#footnote-21) On 24 April 2020, the European Commission amended [EU decision 2019/784](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019D0784) to implement the WRC-19 unwanted emission limits (with the stage-2 limits coming into force at 1 January 2024. Further detail is in the *Passive EESS satellite receivers operating in the 23.6-24 GHz band* section.

### 3GPP standards

Bands n257 (comprising the frequency range 26.5-29.5 GHz) and n258 (comprising the frequency range 24.25-27.5 GHz) are standardised by 3GPP for New Radio (NR) technologies (also referred to as 5G). 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 GHz band spectrum licence technical framework.

Given the international developments outlined in the previous section, the 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.

The specific technology being considered in the development of the new technical framework is 3GPP NR (3GPP 38-series). TLG submissions indicated that this is the only technology that is expected to be used under a 26 GHz band spectrum licence.

It is proposed that the technical framework is optimised for TDD operation, which aligns with 3GPP standards and ECC decisions[[21]](#footnote-22).

Based on TLG submissions, a broad range of deployment types are expected in the band, ranging from dense ‘hot-spot’ deployments proving high capacity services in highly populated areas to macro deployments (fixed and mobile) providing high capacity broadband access over a wide area.

The following two deployment models are assumed as the ‘deployment extremes’ and are used to help define aspects of the technical framework (this does not restrict other deployment types under a 26 GHz spectrum licence):

* ‘Hot-spot’ type deployments to provide high capacity in highly populated areas.
* Typical maximum coverage per base station approx. 100-200 m.
* Typically (but not limited to) low base station antenna heights (e.g. light pole mounted) at heights below 6 m above ground level and typically (but not always) immersed in local clutter.
* UE antenna height typically around 1.5 m above ground (but could be higher is some cases).
* Macro deployment
* Could be either a mobile or fixed (point-to-multipoint) wireless broadband network
* Base station antenna heights positioned to get above local clutter and maximise coverage, typically 15m above ground level (but could be higher in the range 30-50m).
* In a fixed network:
* the 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.
* In a mobile network:
* Clutter loss is expected along some paths between base station and user terminal
* UE antenna height typically around 1.5m above ground (but could be higher in some cases).

It is proposed that the system model detailed in Table 1 be used in the development of the 26 GHz band spectrum licence technical framework.

1. System model

|  |  |  |
| --- | --- | --- |
|  | Base station | User station |
| Channel bandwidth | Standard channel sizes 50, 100, 200, 400 MHz. Carrier aggregation is possible | |
| Duplex method | TDD | |
| TRP | Minimum (based on indoor base station)[[22]](#footnote-23): 20 dBm/200 MHz  Maximum: TBD | Max. 23 dBm (mobile)  Max. 35 dBm (fixed) |
| Antenna gain | 23 dBi (8x8 array) | 17 dBi (4x4 array) possibly higher gain (parabolic) antenna in fixed deployments |
| Antenna height | 6-50 m | 1.5 m (typical for mobile)  5 m (typical for fixed) |
| Noise Figure | 10 dB | |
| Reference sensitivity (note 1) | -117 dBm/50 MHz | - |
| Minimum wanted level (note 1) | -111 dBm/50 MHz | - |
| ACS @ 50 MHz | 21.7 dB | - |
| In-band blocking (at >50 MHz offset and within 22.75-29 GHz) | 27 dB | - |
| Intermodulation rejection (dBm/occupied bandwidth) | 19 dB | - |

Note 1: These values are at the input of the receive antenna and are based on a medium-area base station as detailed in 3GPP TS 38.104. See the *Managing interference to spectrum-licensed receivers* section for further details.

## Standard Trading Unit and Minimum Contiguous Bandwidth

A spectrum licence may be traded in whole, or in part, by geographic area or frequency or both. Under section 88 of the Act, the ACMA may determine the rules that apply to trades under spectrum licensing. These rules are contained in the [*Radiocommunications (Trading Rules for Spectrum Licences) Determination 2012*](https://www.legislation.gov.au/Details/F2018C00564)(trading determination).

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

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

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

The STU that applies to all existing spectrum licence bands is defined as a parcel of spectrum space that consists of:

1. a geographic area equal to a Level 1 HCIS cell of the 2012 Australian Spectrum Map Grid (ASMG)[[23]](#footnote-24)– approximately 9×9 kilometre in size
2. a frequency band where the lower and upper frequency limits of each segment are integers when described in Hertz

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

One TLG submission suggested a STU of 1 MHz considering the larger channel bandwidths expected to be used in the band. While it is agreed that larger bandwidths are likely in the band, a STU of 1 MHz does little more to prevent fragmentation than a STU of 1 Hz would.

Given that it is likely that spectrum will only be purchased (via a trade) if the bandwidth is large enough to be usable there is low risk of spectrum fragmentation beyond practical use and a STU of 1 Hz provides maximum flexibility for spectrum trading. Therefore, the ACMA is of the view that the existing STU (described above) should also apply to the 26 GHz band, and does not propose making any changes to the STU as part of the 26 GHz band spectrum licence TLG process.

The MCB for spectrum licences is typically set at the minimum amount of spectrum needed to provide a viable service. In consideration of the technology likely to be deployed under a 26 GHz band spectrum licence, 3GPP NR (see the *System model* section), the minimum channel bandwidth 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 MCB for the 26 GHz band 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 MCB for the 26 GHz band should be set at 50 MHz. An MCB of 50 MHz also received support from some TLG members.

## Conditions on the spectrum licence

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

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

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

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

### In-band emission limits

Maximum in-band power limit

In the 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[[24]](#footnote-25) 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.[[25]](#footnote-26)

Some TLG submissions indicated that a TRP limit of 30 dBm/200 MHz may restrict future deployments and use cases, and that a TRP in the range 40-45 dBm/200 MHz would be more suitable.

Transmit power limits were also discussed at WRC-19, specifically with regard to the applicability of Article 21.5 of the ITU-R Radio Regulations, and it was agreed that more studies would be required prior to WRC-23.[[26]](#footnote-27)

While an increased TRP limit might improve flexibility it would also increase the risk of interference to other services including international satellite operations. Article 21.5 allows a maximum conducted transmit power of 40 dBm. Assuming an antenna efficiency of 50 per cent (consistent with advice from TG 5/1)[[27]](#footnote-28), this would result in a maximum TRP of 37 dBm.

It is proposed that the maximum in-band TRP limit is 37 dBm/200 MHz. This proposed limit currently complies with Article 21.5, and the ACMA will continue to monitor studies related to Article 21.5.

Note that an additional TRP restriction is proposed for transmitters operating in 27-27.5 GHz within defined areas – see the *Interference to FSS gateway satellites* subsection. Rationale for this additional TRP restriction is provided in the *Interference to FSS gateway satellites* subsection.

The ACMA acknowledges that there are still some diverging views within the TLG regarding the in-band TRP limit. The ACMA will continue to consider this issue in preparation for the public consultation phase. If we are to consider any higher TRP limits, they will need to be accompanied with additional mitigation measures to maintain coexistence with satellite services (FSS uplinks and inter-satellite services) – for example, by placing addition limitations on the radiated power above the horizon. We would expect that any additional proposals that may be brought forward after this TLG process, will reflect an agreement reached between interested/affected stakeholders (specifically, stakeholders in the terrestrial wireless broadband and satellite sectors).

Managing adjacent channel interference

As outlined in the *System mode*l section, it is proposed that the 26 GHz band 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 spectrum 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. 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 active antenna systems (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 in the 26 GHz band. 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 be free to negotiate alternative arrangements on a case-by-case basis.

The proposed requirements will require the fallback synchronisation frame structure to be pre-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 GHz band technical framework as a fallback if/when required.

Synchronisation may, depending on the 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.

Some TLG members indicated general support for a synchronisation fallback mechanism to manage adjacent band interference. However, it was also noted that due to the still evolving nature of mmWave 5G use cases, it may be too early to define a fallback frame structure. One TLG submission suggested that the ACMA should delay defining the frame structure until at least two years post-auction to allow time to gain a better understanding of the appropriate uplink-downlink configurations for different 5G use cases. Some TLG members also proposed that the frame structure should be defined in a RAG or RALI instead of as a licence condition to make it easier to update in the future if required.

The ACMA’s preliminary view is that the additional flexibility to vary the frame structure in the future would be a benefit to licensees and proposes to define the frame structure in RALI[new] – noting that the ACMA would still consult before making any future changes. It is also expected that potential changes would not be frequent. The synchronisation requirement will still be included as a licence condition.

The ACMA is of the view that the frame structure should be defined at the commencement of 26 GHz band spectrum licences to provide certainty to licensees about the relevant operating conditions for the licence. While there is a low likelihood that the synchronisation requirement is invoked in the initial years of the licence term (due to potentially low deployment numbers and the ability to negotiate other methods to resolve interference), defining the fallback frame structure before the commencement of licences will provide certainly to all affected parties should negotiations fail in the early years of the spectrum licence.

It is therefore proposed to attach the below synchronisation condition to spectrum licences in the 26 GHz band (noting that the frame structure is proposed to be defined in RALI[new]) — this proposed requirement is also included in the draft sample licence in Appendix A. The proposed synchronisation procedure would be invoked as necessary for interference management purposes with other 26 GHz band spectrum licensed services as well as with devices operated under an area-wide apparatus licence in the 26 and 28 GHz bands.

Some TLG members also suggested that synchronisation may not eliminate all cases of interference. The ACMA is of the view that the proposed synchronisation fallback requirement is a tool which would resolve the majority of interference issues, while also providing flexibility by applying it only when/where needed and allowing affected parties to negotiate other solutions where appropriate.

The ACMA will have a strong regard to the synchronisation fallback requirement when dealing with an interference resolution dispute. There are also other mechanisms to aid the resolution of interference which may still occur even though services are synchronised. These include consideration of first-in-time status and provisions provided in the Act (e.g. the conciliation process in Division 3 of the Act).

**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 26 GHz band spectrum licence or an area-wide apparatus licence in the frequency range 24.7 GHz to 29.5 GHz (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 the uplink-downlink configuration that is defined in RALI[new]; or

(ii) operating the first device using a sequence and duration of radio emissions that is consistent with that 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 device or devices registered later-in-time will generally be required to accept any interference or cease causing interference during this time.

Some TLG submissions suggested that a different frame structure may be needed in 25.1-27.5 GHz compared to 24.7-25.1 GHz and 27.5-29.5 GHz. The rationale being that different technologies and/or use cases may be operated in these different frequency ranges.

Based on TLG submissions, the only technology expected to be operated in the range 24.7-29.5 GHz, under either an area-wide apparatus licence or a spectrum licence, is 3GPP NR (3GPP 38-series). This indicates that synchronising between spectrum and apparatus licensed services (across the 25.1 GHz and 27.5 GHz boundaries) will be feasible. Of course there will be a range of different use cases and network types deployed across the 26/28 GHz bands, however the ACMA remains of the view that a single fallback frame structure (which would also apply across the 25.1 GHz and 27.5 GHz boundaries) is the best way to manage adjacent band interference – again noting that other frame structures could be bilaterally agreed.

Based on TLG submissions there is a general preference for the fallback uplink-downlink configuration to cater for a larger amount of downlink traffic. Some TLG submissions provided support for either a DDSU or DDDSU pattern as these are commonly adopted and offer reasonable latency and flexibility.[[28]](#footnote-29) One submission also recommended the FR2.120-2 pattern in table a.1.3-2 of 3GPP TS 38.101-4, (which is a DDSU pattern), while another submission suggested the FR2-1 pattern from that table (which is a DDDSU pattern).

One TLG submission noted that long-range FWA cells may require a guard period of 6 or 9 symbols (other proposed configurations only provide a guard period of 2 or 3 symbols) and that a guard band between 27.5 GHz and FWA users may be required.

It is the ACMA’s preliminary view that, given the range of deployment models possible under a 26 GHz band spectrum licence, it is not possible to prescribe a fallback uplink-downlink configuration that is optimal in all scenarios. Nor is it necessary to do so given the preferred approach is that affected parties negotiate a solution in lieu of the fallback configuration.

A prescribed guard band is also not desirable as it would unnecessarily impede the use of spectrum in situations where there is no interference issue. In scenarios where interference occurs, negotiation between affected parties fails and the fallback configuration does not provide an adequate guard period, a guard band could be implemented within the affected licensee’s spectrum holding.

It is also important that the uplink-downlink configuration is clearly articulated in the technical framework to avoid misinterpretation when it is invoked. Using a ‘pre-defined’ uplink-downlink configuration will help in this regard.

Based on feedback provided by TLG members and the above commentary, the proposed fallback uplink-downlink configuration, to be detailed in RALI[new][[29]](#footnote-30), is proposed to be either:

* An uplink-downlink configuration which is consistent with the FR2.120-2 UL-DL pattern described in Table A.1.3-2 of 3GPP TS 38.101-4 V15.4.0, where:
* The period of the slot configuration pattern is 0.5 ms;
* The period of a slot is 0.125 ms; and
* There are 14 symbols within a slot, or
* An uplink-downlink configuration which is consistent with the FR2.120-1 UL-DL pattern described in Table A.1.3-2 of 3GPP TS 38.101-4 V15.4.0, where:
* The period of the slot configuration pattern is 0.625 ms;
* The period of a slot is 0.125 ms; and
* There are 14 symbols within a slot.

The ACMA acknowledges that there are still diverging views within the TLG on what the final fallback configurate should be. The ACMA will continue to consider this issue in preparation for the public consultation phase with the aim of deciding on a single fallback uplink-downlink configuration. Any agreement reached between wireless broadband operators on the preferred fallback configuration will help the ACMA form a more definitive view on which fallback configuration should be included in the final technical framework.

### 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 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.

In consideration of the proposed registration exemption requirements (see the *Statutory conditions on the licence* section) there is potential that base stations may be exempt from registration (e.g. if they are indoors). Therefore, it is proposed to define separate unwanted emission limits depending on type of device (either base station or UE), rather than whether or not the device needs to be registered.

This is a deviation from how unwanted emission limits have traditionally been specified in spectrum licensed bands. However, the purpose of doing so is to align the technical framework more closely with international equipment standards and more accurately reflects how agreed emissions limits into the 23.4-24 GHz are defined. These definitions can also be used in the registration exemption provision for high-powered outdoor UEs (see the *Statutory conditions on the licence* subsection).

There was some support for this concept from TLG members, however it was suggested that the base station and UE definitions should be carefully defined so they include (or do not inadvertently exclude) the full range of networks and device types which may be deployed in the band (for example, base stations in private networks as well as relay only Integrated Access and Backhaul (IAB) nodes and in-band repeaters). One submission indicated a preference for continuing the traditional method of specifying unwanted emission limits based on whether or not a device needs to be registered.

The ACMA is of the view that defining base stations and user equipment and using these definitions to specify unwanted emission limits is the best way to ensure that relevant unwanted emission limits are applied to the appropriate station type. These definitions are also useful when specifying the conditions to protect FSS uplinks and the exemptions from registration.

The proposed definitions of base station and user equipment station are below (noting that these definitions are yet to be legally reviewed):

* Base station means a radiocommunications device which supplies a service to one or more other stations

User equipment station means a radiocommunications device which is not a base station.

The above base station definition has been modified to capture base stations in a private network which may not connect to a telecommunications network. The change will also capture relay only IAB nodes and in-band transmitters as these devices will “*provide a service to only or more other stations”.*

***Base station unwanted emission limits***

Figure 4 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 3 includes 3GPP limits applicable to the smallest (50 MHz) and largest (400 MHz) channels. The WP 5D[[30]](#footnote-31) and 3GPP limits are dependent on the transmit power level. A transmit power level of 37 dBm (equal to the proposed in-band limit) is used to derive the limits shown in Figure 3.

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 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.

Feedback from the TLG suggests that unwanted emission limits should be based on 3GPP limits and not the WP 5D limits, so as to ensure equipment is readily available.

The frequency offset break-point for unwanted emission limits for base stations in 3GPP TS 38.104 (Table 9.7.4.3.2-1) is specified as: , where BWcontiguous is defined as the contiguous transmission bandwidth (i.e. the bandwidth from the lowest frequency edge of the lowest transmitted channel to the highest frequency edge of the highest transmitted channel).

Some TLG submissions indicated an interest in being able to operate contiguous bandwidth of up to 800 MHz (2x400 MHz channels). It is proposed to align this frequency offset break-point definition with 3GPP. This means the unwanted emission limits will vary depending on transmitter bandwidth which will allow 3GPP compliant equipment wider than 400 MHz to be deployed without modification or additional filtering. This will also provide stricter limits for channel bandwidths less than 400 MHz which would better ensure coexistence with adjacent services.

The proposed unwanted emission limits for registered devices are shown in Tables 3 and 4 (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 3 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 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 0.1 x BWoccupied[[31]](#footnote-32) from the licence frequency boundary – base stations.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 0 MHz ≤ foffset ≤ 0.1 x BWoccupied | -5 | 1 MHz |

1. Transmitter unwanted emission limits at frequencies offsets greater than 0.1 x BWoccupied from the licence frequency boundary (excluding the 23.6-24 GHz band) – base stations.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 30 MHz ≤ f < 1 GHz | -13 | 100 kHz |
| 1 GHz ≤ f ≤ 55 GHz | -13 | 1 MHz |

As discussed in the *Coexistence with other services* chapter, additional unwanted emission limits are proposed into the range 23.6-24 GHz to protect passive EESS. These limits are consistent with the outcomes of WRC-19.

The proposed limits for base stations into the 23.4-245 GHz band are provided in Table 5 – for consistency with other emission limits the TRP value has been converted from dBW to dBm.

1. Proposed transmitter unwanted emission limit within the 23.6-24 GHz frequency band – base stations.

|  |  |  |
| --- | --- | --- |
|  | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| For base stations first operated under the spectrum licence before 1 September 2027 | -3 | 200 MHz |
| For base stations first operated under the spectrum licence on or after 1 September 2027 | -9 | 200 MHz |

***User equipment unwanted emission limits***

UE unwanted emission limits from 3GPP TS 38.101-2 are shown in Table 5. The unwanted emission limits specified by WP 5D[[32]](#footnote-33) reflect the 3GPP limits for a 200 MHz channel shown in Table 6.

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 channel sizes can be deployed under the 26 GHz band spectrum licence framework, it is proposed that the unwanted emission limits for user equipment align with the 400 MHz channel emission limits shown in Table 6.

The proposed unwanted emission limits are shown in Tables 7 and 8 (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 – user equipment.

|  |  |  |
| --- | --- | --- |
| **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 — user equipment.

|  |  |  |
| --- | --- | --- |
| **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 ≤ 55 GHz | -13 | 1 MHz |

As discussed in the *Coexistence with other services* chapter, additional unwanted emission limits for spectrum licensed user equipment are proposed in the range 23.6-24 GHz to protect passive EESS.

The proposed unwanted emission limits in the range 23.6-24 GHz for user equipment are provided in Table 9. For consistency, the TRP values has been converted from dBW to dBm. These limits are consistent with the outcomes of WRC-19.

1. Transmitter unwanted emission limits into the range 23.6-24 GHz — devices exempt from registration.

|  |  |  |
| --- | --- | --- |
|  | **Total Radiated Power (dBm) per device** | **Measurement Bandwidth** |
| For user equipment first operated under the spectrum licence before 1 September 2027 | 1 | 200 MHz |
| For user equipment first operated under the spectrum licence on or after 1 September 2027 | -3 | 200 MHz |

The proposed receiver unwanted emission limits are shown in Table 10 and are based on the limits specified in 3GPP TS 38.104.

1. Receiver unwanted emission limits.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm) per device** | **Measurement Bandwidth** |
| 30 MHz ≤ f < 1 GHz | -57 | 100 kHz |
| 1 GHz ≤ f < 12.75 GHz | -47 | 1 MHz |
| 12.75 GHz ≤ f ≤ 55 GHz | -36 | 1 MHz |

### Statutory conditions on the licence

Each licence contains a number of statutory conditions which are applicable under requirements defined in sections 67-69A of the Act. These include obligations on payments, third party use, device registration (and exemption) and residency requirements.

Standard text describing these requirements is included on all spectrum licences – refer to Licence Schedule 3 of the Draft Licence at Appendix A. The main statutory requirements that differ from band-to-band relate to the devices that are exempt from registration.

Notionally, device registration and certification are a precondition for operating a radiocommunications device under a spectrum licence. The primary purpose of device registration is to enforce the requirements of devices operating under a spectrum licence, so they do not cause unacceptable interference (as defined by the subsection 145(4) determination).

In accordance with section 69(2) of the Act, specific devices may be exempt from registration.

The registration exempt requirements are designed to facilitate the use of devices in the band by exempting those that operate in a particular way and meet the core conditions of the licence.

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 11 lists the maximum TRP and EIRP limits from WP 5D and 3GPP.

1. User equipment output power limits.

|  |  |  |  |
| --- | --- | --- | --- |
| **User terminal type** | **Max TRP (dBm)** | **Max EIRP (dBm)** | **Source** |
| Handheld UE | 22 | 39[[33]](#footnote-34) | 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) |

It is proposed that any device operating with an 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, 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.

There was support within the TLG for the registration exemption limit to be set at 23 dBm per occupied bandwidth in some TLG submissions, however it was also indicated that class 1 CPE (TRP up to 35 dBm) are also likely to be deployed. This led to concerns that requiring customer equipment to be registered may result in additional regulatory burden, increased costs and potential privacy issues. There were also suggestions that high powered fixed CPE posed a low risk of interference as it wasn’t moving.

The ACMA remains of the view there is an increased interference risk from high powered UEs however acknowledges that there may be an additional regulatory burden in requiring these devices to be registered. To strike a suitable balance, it is proposed that fixed outdoor UE with a TRP in the range 23-35 dBm per occupied bandwidth is:

* exempt from registration
* operates on a no-interference / no-protection basis

if they operate in the range 25.5-27 GHz, they must be coordinated with existing SRS earth stations as defined in the *Coexistence with SRS earth stations in 25.5-27 GHz* section (as the exclusion zones where developed assuming only UEs with a TRP ≤ 23 dBm).

In addition, licensees must keep records relating to these devices (including details such as location and operating parameters) which must be provided to the ACMA on request – it is proposed to use similar record keeping provisions currently required for transmitters located at communal sites – see condition 7 of Licence Schedule 4 of the draft sample licence in Appendix A.

The above arrangements mean that high-powered fixed UE will not be required to comply with the DBC which may raise the risk adjacent-area interference. Should adjacent-area interference occur, the no-interference / no-protection status for high-powered fixed UE will provide an avenue to resolve interference disputes. Licensees also have the option to still register high-powered UEs to receive a higher level of protection (e.g. they may be afforded a first-in-time status), noting that these devices will still need to comply with the normal registration requirements (e.g. compliance with the s.145 determination).

It should be noted that the additional conditions for coexistence with FSS uplinks (see the *Interference to FSS gateway satellites* section) will limit the TRP of UEs, operating in 27-27.5 GHz (in defined areas), to 25 dBm/200 MHz.

It is also proposed to exempt all indoor devices from registration (base stations and UEs). The high building entry loss at 26 GHz is expected to reduce the risk of interference from indoor devices and negate the need for these devices to be registered.

Some TLG submissions suggested that the proposed ‘indoor’ definition (i.e. 2 metres from an external surface) would be difficult to manage and enforce, and it is not practical for self-installed CPE. Other suggested definitions included specifying a pfd limit or a minimum building penetration loss. A required building loss value is difficult to specify as it will depend on the transmit power (i.e. a high power transmitter will require more building loss to ensure the same external signal level as a lower powered transmitter).

A potential pfd limit, based on the interference risk from an outdoor UE with a TRP of 23 dBm, is:

* Pfd limit at 2 metres for the external surface of the enclosed space, modelled on a notional UE with: TRP = 23 dBm, antenna gain = 17 dBi, path loss at 2m (for f=24.7 GHz) = 66 dB

= = -7 dBW/m²/occupied bandwidth[[34]](#footnote-35)

The ACMA’s view is that exempting all indoor transmitters which have the same interference potential as a transmitter with a TRP ≤ 23 dBm, reduces regulatory burden with minimal increase in interference risk. Therefore, the above pfd limit is proposed to replace the previous indoor definition.

A TLG submission suggested that the indoor pfd limit should take into account the antenna pointing restrictions to protect FSS uplinks, considering that indoor devices are proposed to be exempt from these restrictions.

In consideration of the above, it is proposed that the indoor pfd limit is:

* -7 dBW/m²/occupied bandwidth for transmitters operating in the ranges:
* 25.1-27 GHz or
* 27-27.5 GHz and located outside the areas listed in Appendix C
* For transmitters operating in the range 27-27.5 GHz and inside the areas listed in Appendix C:
* the antenna gain of a notional UE is reduced by 3 dB to account from the minimum GSO separation angles from the GSO. This results in a pfd limit of: -9 dBW/m²/occupied bandwidth,

While two pfd limits for the indoor transmitter definition may add complexity to the technical framework (and increase the risk of inadvertent non-compliance as noted in some TLG submissions) it is the ACMA’s preliminary view that the increased coexistence certainty provided by using two limits will outweigh the regulatory burden.

Some TLG submissions suggested that all devices should be registered to help manage coexistence with FSS satellites. In particular, knowledge of transmitter details will aid in the resolution of interference issues as well as helping to ensure compliance with licence conditions. In addition, it was proposed that indoor devices should not be exempt from the additional conditions to protect FSS uplinks.

The ACMA is of the view that there is a low risk if interference from indoor devices due to the high building losses at frequencies above 27 GHz (average loss of 22 dB at an elevation angle of 11°).[[35]](#footnote-36) Therefore it is appropriate that indoor devices remain exempt from registration.

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

**Exemption from registration requirements**

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

1. a transmitter that operates in the 26 GHz band with a maximum total radiated power of less than or equal to 23 dBm per occupied bandwidth;
2. an indoor transmitter; or
3. a fixed transmitter which:
   1. is a user equipment station; and
   2. operates in the 26 GHz band with a maximum total radiated power of greater than 23 dBm per occupied bandwidth and less than or equal to 35 dBm per occupied bandwidth.

***Indoor transmitter*** means a transmitter located in an enclosed space where the power flux density from the transmitter and measured at 2 metres from the outside surface of the enclosed space is less than or equal to:

* -9 dBW/m² per occupied bandwidth for transmitters operating in the frequency range 27-27.5 GHz and located inside an area subject to additional conditions;
* -7 dBW/m² per occupied bandwidth for transmitters operating in the frequency range:
  + 25.1-27 GHz; or
  + 27-27.5 GHz and located outside an area subject to additional conditions.

There is no requirement to register receivers operated under a spectrum licence. However, in order to gain protection (which is often provided on a first-in-time registered basis), it is recommended that these devices be registered. The ACMA does not intend to change this option or require the registration of receivers.

### Other conditions on the licence

Spectrum licences typically contain a number of additional licence conditions – standard text describing these requirements is included on all spectrum licences, refer to Licence Schedule 4 of the Draft Licence at Appendix A. The main conditions which may differ from band-to-band relate to:

* The distance between devices which are considered co-sited (for interference management purposes)
* Coexistence requirements with specific services
* Managing interference from devices exempt from registration
* Managing coexistence with incumbent apparatus licences during the reallocation period
* Synchronisation requirements (as discussed earlier in the *In-band emission limits* section).

As discussed in the *Statutory conditions on the licence* section, it is also proposed to expand the record keeping requirements in condition 7 of Licence Schedule 4 to include high-powered fixed UEs (TRP of >23 dBm and ≤35 dBm) which are proposed to be exempt from registration.

***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, the ACMA includes 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. This clause is common to all spectrum licensed bands with only the specified distance varying.

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 GHz band 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-site 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.

A few TLG submissions suggested that the proposed co-site distance needs further consideration, noting:

* The possibility of macro-site deployments in the band (suggesting that a larger distance may be needed), and

small-cell base stations which are expected to be located much closer to each other (e.g. 25-50m), suggesting that a smaller distance may be needed.

A distance needs to be determined that is appropriate for the broad range of deployment types expected in the band. However, as this provision is intended to aid the resolution of site based out-of-band interference issues (e.g. cause by blocking, intermods, harmonics etc), it should be more heavily weighted towards base stations that are more likely to cause, or receive, these types of interference.

It is anticipated that macro base stations will have a higher risk for causing/receiving site-base interference due to having higher transmit power and lower sensitivity levels. Therefore, it is the ACMAs view that a co-site distance should be based on macro deployments, which historically have been set in the range 200m-500m. Although these distances are likely to include many small-cell base stations, the impact is expected to be minimal given this provision is only triggered as needed (i.e. when all devices are operating within their licence conditions and site-based interference is still occurring).

Given the proposed maximum in-band TRP in the 26 GHz band is lower than that of the 3.4 GHz band (37 dBm/200 MHz in the 26 GHz band compared to 48 dBm/5 MHz in the 3.4 GHz band), and taking into account the higher propagation loss at 26 GHz, the risk of out-of-band interference caused by a 26 GHz transmitter is likely to be limited to a smaller area than would typically be the case in the 3.4 GHz band. Considering the above, the ACMA is of the view that a co-site distance set at the lower end of the 200m-500m range is appropriate.

Based on the above, it is proposed that the co-site distance is set to 200 metres.

***Coexistence requirements with specific services***

As described in the *Coexistence with other services* chapter, it is proposed that:

* additional limitations on the operation of spectrum licensed transmitters (operating in 27-27.5 GHz and located within the areas specified in Appendix E) to safeguard coexistence with FSS uplinks be contained in the RAG Tx (see *Managing interference from spectrum-licensed transmitters*). It is proposed to include a licence condition requiring compliance with this provision in the RAG Tx.
* A condition restricting the operation of all transmitters (including user equipment) in specified HCIS cells be included on spectrum licences to protect the SRS earth station at Tidbinbilla.

The proposed conditions are shown below and in the draft sample licence in Appendix A.

|  |
| --- |
| **Coexistence with fixed satellite gateway uplinks**  The licensee must ensure that the operation of radiocommunications transmitters complies with the protection requirements specified in Part 4 of the Radiocommunications Advisory Guidelines *(Managing Interference from Spectrum Licensed Transmitters — 26 GHz Band) 2020*, as in force from time to time.  **Coexistence with space research earth stations**  The licensee must not operate a radiocommunications transmitter in the frequency range 25.5 GHz to 27 GHz if it is located in any of the following HCIS: MW4H3, MW4H9, MW4L3, MW5I1. |

No other coexistence requirements are proposed to be included as a condition on 26 GHz band spectrum licences.

***Managing interference from devices exempt from registration***

The risk of interference from devices exempt from registration (see theStatutory conditions on the licencesection) 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 on 26 GHz band spectrum licences:

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| The licensee must ensure that the operation of a radiocommunications transmitter that exempt from registration under Statutory Condition 4 of Licence Schedule 3 does not cause harmful interference to other radiocommunications devices operated under a different spectrum or apparatus licence. |

***Managing coexistence with incumbent apparatus licences during the reallocation period***

In accordance with relevant provisions of the Act, incumbent apparatus licences may continue to operate within the frequency/areas subject to a spectrum reallocation declaration until the end of the reallocation period.

It is proposed to include the following condition on 26 GHz band spectrum licences to manage potential interference to/from incumbent apparatus licensed services during the re-allocation period:

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| --- |
| The licensee must provide protection to, and will not be afforded protection from, any radiocommunications devices authorised under an apparatus licence and operating in a re-allocation area in the 26 GHz band until the end of the re-allocation period.[[36]](#footnote-37) |

As of 3 February 2020, there are only two apparatus licences authorising operation in the frequency/areas subject to the 26 GHz reallocation declaration. One is a scientific licence authorising a trial of new technologies at 6 locations, and the other is a radiodetermination licence for the operation of a body scanner at the WA police complex in Perth.

Given that scientific licences are typically issued on a non-renewable basis, it is expected that the above condition will only apply to devices operated under the radiodetermination licence.

## Unacceptable levels of interference

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

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

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

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

A few TLG submissions indicated general concern about whether the DBC concept (applied in all spectrum licensed bands) is fit for purpose and suggested that this issue requires further consideration in the TLG. Some more specific concerns with regard to the proposed 26 GHz band DBC were also raised (these are discussed in the following sections).

The ACMA is aware that the DBC concept does not completely predict interference levels into an adjacent area, and that in some cases it can create dead-zones at area boundaries. However, the DBC allows operating rights to be clearly defined and helps ensure that compliance with boundary conditions can be achieved with a high level of certainty. DBC calculations are also repeatable which is aids in the resolution of interference disputes.

The ACMA is of the view that the benefits provided by the DBC concept are important and should be included in the 26 GHz band spectrum licence technical framework. It is also noted that devices can be registered by using ‘guard-space’ instead of the DBC which provides additional flexibility. [[37]](#footnote-38)

Several changes to improve the accuracy of the DBC, in response to specific issues raised in the TLG, are proposed in the following sections.

### 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. a stringent LOP will provide more protection but may mean transmitters need to be located further from the area-boundary, while a relaxed LOP means transmitters can be located closer to the boundary however receiver will be afforded less protection). This benchmark level is necessary for the calculation of the device boundary criterion.

For this reason, it should be made clear that the LOP is not necessarily the same as the protection required for adjacent band services. The main distinction being that the LOP (and device boundary criteria) are aimed at managing emissions across a geographical licence area (not coordinating with a specific receiver) and adjacent channel protection is performed directly with the affected receiver.

One TLG submission suggested that a higher LOP (e.g. higher level of interference and hence reduced protection) could be specified when a transmitter is using beam steering, to account for the reduced probability of direct antenna beam alignment. A beam alignment probability gain of 8 dB was proposed to be added to LOP when a transmitter is using beam steering. This addition would result in two LOP values.

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.[[38]](#footnote-39) Using a noise figure (NF) of 10dB[[39]](#footnote-40), receiver noise is calculated as:

Therefore, the proposed LOP (to be used when calculating the DBC for non-beam forming transmitters) is:

; and

For beam steering transmitters the proposed LOP to be when calculating the DBC is:

The following LOP values are proposed to be used when calculating a DBC:

* -102 dBm/MHz for transmitters with beam steering

-110 dBm/MHz for transmitters without beam steering.

This level of protection is also proposed to be used when coordinating non-spectrum licensed services (such as FSS gateway earth stations) with spectrum licence space (see section 3.1(2) of Part 3 of the draft RAG Rx in Appendix D).

### Receive antenna height and gain

As detailed earlier, it is proposed to optimise the 26 GHz band 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 5 m 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 DBC.[[40]](#footnote-41)

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:

* UE’s 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 DBC).

Some TLG submissions suggested that a receive antenna gain based on a front-to-back ratio of 25 dB (i.e. -8 dBi) may be overly optimistic considering that in some cases the antenna may be pointing parallel to the area boundary. It was further suggested that a receive antenna gain of 0 dBi may be more appropriate.

Considering the above points, it is proposed to use an antenna gain of 0 dBi. This value is also consistent with the value used in the 3.4 GHz band.

### Propagation model

A key component of the DBC is the propagation model. The propagation model chosen for the technical framework appears in the subsection 145(4) determination as part of the device boundary criterion. The propagation model selected for the technical framework needs to be:

* suitable for TDD systems
* a generic model available to all licensees/stakeholders
* can be repeated with certainty
* suitable for use in the 25.1-27.5 GHz range

The propagation model selected here does not need to be suitable for the detailed planning of services and licensees are free to use any model for their own planning needs. The selected propagation model will be the basis of the device boundary criterion on which the ACMA may decide to reject the registration of a transmitter to be operated under the spectrum licence.

There are a range of available propagation models that could be implemented, many of which are defined in recommendations created by the ITU-R. The ACMA considers in this case, the most appropriate propagation model to use is one which relaxes to a free-space or smooth-Earth model for unobstructed paths and one that considers terrain features where appropriate for obstructed paths. The ACMA proposes to use the model contained in Recommendation ITU-R P.526-14.

Clutter (from obstructions such as building, vegetation, etc.) has the ability to reduce interference, particularly in mmWave bands. Noting that the typical base station height in mobile broadband networks is 6m (based on Attachment 2 to Document 5-1/36), it is expected that in many cases that these base stations will be at or below the surrounding clutter height. Therefore, it may be prudent to also include clutter losses in the DBC calculation for certain base station antenna heights.

Recommendation ITU-R P.2108 provides equations to calculate clutter loss not exceeded for a percentage of locations. Noting that clutter loss should only be included on paths likely to have clutter (i.e. low base station antenna heights), and given that it is a generic model which won’t match actual clutter losses (i.e. it is not desirable for the DBC to overestimate clutter losses), the ACMA propose that:

* P.2108 should only be applied for base stations with antenna heights at or below 6m
* The ‘percentage of locations’ should be set to 0.0001%
* Clutter loss is applied at only one end of the interference path
* A clutter loss value of 0 dB is to be used in cases when the loss calculated using P.2108 is less than 0 dB (which for the above parameters occurs for distances less than approx. 500m).

The combination of the above will produce relatively low levels of clutter loss on interference paths which are likely to be obstructed by clutter.

A TLG submission suggested that clutter could also be present even when an antenna height is greater than 6 metres, and therefore this should be able to be included in the DBC where applicable.

The ACMA agrees that clutter may be present when an antenna is higher than 6m. However, as discussed above, the DBC is designed so that calculations are repeatable with a high degree a certainty. Including an optional component (such a including clutter on a case-by-case basis) may act contrary to providing this certainty.

In any case, devices can be registered using ‘guard-space’ instead of calculating a DBC, which allows specific circumstances to be considered (such actual clutter loss) and affords additional flexibility when desired.

It is therefore proposed that application of the clutter model in the DBC will remain limited to transmitters with an antenna height of ≤6 metres.

### Terrain data

Some TLG submissions indicated that use of a 9-second DEM together with the terrain averaging process, also used in other spectrum licensed bands, leads to an excessively smooth terrain profile. This is most evident when the propagation model incorporates terrain data, such as the propagation model described by Recommendation ITU-R P.526. However, some TLG submissions indicated that terrain should be averaged if a 3-second DEM is used as the averaging would be made over a smaller area in comparison to a 9-second DEM.

The ACMA agrees that this averaging process, when used with 9-second DEM, can lead to unrealistic results in some cases, and it may be less relevant in bands where the device boundaries will be small. It is also noted that the use of a 3-second DEM can improve the accuracy of results. Therefore, to improve the accuracy of the DBC, it is proposed to:

* Use a 3-second DEM instead of a 9-second DEM.
* Maintain the terrain averaging process when determining the terrain profile along a radial and when determining the terrain height at the receiver.

These changes would also require the guidance in the document ‘[Digital Elevation Model Interpretation](https://www.acma.gov.au/publications/2019-11/publication/digital-elevation-model-interpretation-2013)’ to be updated. These updates will be made at a later time.

### Device boundary criteria

In consideration of the above, the proposed device boundary criteria consists of:

* A defined level of protection of -110 dBm/MHz (for non-beam steering transmitters) or -102 dBm/MHz (for beam steering transmitters) to a receiver with a gain of 0 dBi at a height of 5m above the ground
* Use of Recommendations ITU-R P.526-14 as the propagation model. For base stations at or below 6m above ground level, additional clutter loss is included using Recommendation ITU-R P.2108 (set at the transmitter end only, *p*=0.0001% with a minimum loss cap of 0 dB)
* 1 degree radial increments
* Step size of 100m, with a maximum 300 steps per radial (subject to change depending a decision on max in-band TRP and LOP)[[41]](#footnote-42).
* A calculation procedure similar to that implemented in other spectrum licence bands, other than the terrain date changes discussed above (see the draft s.145 determination at Appendix B).

Conditions for application of the DBC

In most cases, a device is deemed to cause unacceptable interference if any part of the DBC falls outside the geographic area of the spectrum licence. However, there are some cases where higher levels of interference across a geographical area would not impact other users. Three relevant scenarios are when part of the DBC falls:

* Outside the ASMG
* Outside the licence area and only crosses sea or ocean (and no land) outside the licence area
* Outside the licence area and inside HCIS cell MW4H6 (this cell contains the Canberra Deep Space Communications Complex earth receive station). The protection provided by the DBC 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, allowing the DBC to fail within this cell will not impact coexistence between SRS and spectrum licensed devices.

The ACMA proposes to add clauses to the s.145 determination which deems these scenarios as not causing unacceptable interference. Similar arrangements are included in the 3.6 GHz band technical framework.

### Unacceptable levels of interference

Under subsection 145(4) of the Act, the ACMA can determine what is considered unacceptable levels of interference. This has the effect of constraining how transmitters can be operated under a spectrum licence, as if a transmitter is operated in a manner that is deemed to cause unacceptable interference (as determined by the ACMA) then the ACMA has the power (under subsection 145(1) of the Act) to refuse to register it.

Based on the discussions in the previous sections, it is proposed that interference caused by a radiocommunications transmitter is unacceptable if:

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| --- |
| (1) A level ofinterference caused by a radiocommunications transmitter operated under a spectrum licence issued for the 26 GHz band is unacceptable if:  (a) the operation of the transmitter in the 26 GHz band results in a breach of a core condition of the licence relating to the maximum permitted level of radio emission from the transmitter:  (i) outside the parts of the spectrum the use of which is authorised under the licence; or  (ii) outside the geographic area of the licence; or  (b) subject to subsections (2), (3) and (4) any part of the device boundary of the transmitter lies outside of the geographic area of the licence; or  (c) the device boundary of the transmitter cannot be calculated in accordance with Part 1 of Schedule 2.  (2) A level of interference mentioned in paragraph (1)(b) is not unacceptable in relation to a part of the device boundary that:  (a) lies outside the boundary of the ASMG; and  (b) is connected to a radial that:  (i) is mentioned in Part 1 of Schedule 2; and   1. does not cross the geographic area of another spectrum licence in the 26 GHz band.   (3) A level of interference mentioned in paragraph (1)(b) is not unacceptable in relation to a part of the device boundary that:  (a) lies outside the geographic area of the licence; and  (b) lies inside the following HCIS: MW4H6; and  (c) is connected to a radial that:  (i) is mentioned in Part 1 of Schedule 2; and  (ii) does not cross the geographic area of another spectrum licence in the 26 GHz band.  (4) A level of interference mentioned in paragraph (1)(b) is not unacceptable in relation to a part of the device boundary that:  (a) lies outside the geographic area of the licence; and  (b) is connected to a radial that:  (i) is mentioned in Part 1 of Schedule 2; and  (ii) does not cross over land outside the geographical area of the licence that is permanently above the Australian territorial sea baseline as defined by Geoscience Australia. |

### Groups of transmitters and receivers

Group registration arrangements provide additional flexibility to licensees when deploying systems within the band.

In the TLG’s for the 800 MHz, 1800 MHz, 700 MHz, 2.3 GHz and 2.5 GHz bands, the consensus was for group registration to primarily support the registration of systems that have their antenna phase centres located within a defined proximity (20 metres in this case). Additionally, the parameters of the equipment being considered in the group should be essentially identical, and that a transmitter or receiver can only belong to one group.

It is proposed to adopt the same arrangements for groups of transmitters and receivers in the 26 GHz band. See the draft s.145 determination for proposed wording.

## Radiocommunications advisory guidelines

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

Generally, RAGs include provisions to help assess the possible interference between spectrum-licensed devices and services operating under spectrum, apparatus or class licences. Potentially affected services are identified in the RAGs to enable licensees to assess and mitigate the risk of interference between these services. Typically, a minimum of two RAGs are developed for each spectrum licence band. These include:

* A RAG to manage interference to spectrum licence receivers; and
* A RAG to manage interference from spectrum licence transmitters.

It is important to note that where a case of interference arises between a spectrum-licensed device and another licensed device, the ACMA will refer to the provisions of the RAGs in resolving the matter. In general, affected licensees also have the ability to negotiate their own arrangements in order to manage interference. Such arrangements will also be taken into account when resolving any interference disputes. In some cases, a spectrum licence may also contain a condition with requires that certain parts of a RAG must be adhered to. For example, it is proposed that a condition is included on 26 GHz band spectrum licences which requires compliance with the FSS gateway uplink coexistence provisions detailed in RAG Tx.

### Managing interference from spectrum-licensed transmitters

The protection requirements for the following services are proposed to be outlined in *Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 26 GHz Band) 2020* (RAG Tx)– the full draft RAG Tx is contained in Appendix C*:*

* Area-wide apparatus licensed devices operating:
* In the frequency ranges 24.7-25.1 GHz and 27.5-29.5 GHz Australia wide
* In the frequency range 25.1-27.5 GHz is areas adjacent to 26 GHz band spectrum licensed areas
* Space station receivers operating in the range 25.1-27.5 GHz
* SRS earth stations operating in the frequency range 25.5-27 GHz
* FSS gateway uplinks operating in the frequency range 27-27.5 GHz
* Passive 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 25.1-27.5 GHz.

Area-wide apparatus licensed services operating in and adjacent to the 25.1-27.5 GHz range

The ACMA is considering new arrangements for area-wide apparatus licensed services which authorise operation in the 24.7-25.1 GHz and 27.5-29.5 GHz bands Australia wide and 25.1-27.5 GHz in geographic areas not subject to 26 GHz band reallocation declaration.

Radiocommunications transmitters operated under a spectrum licence in the 26 GHz band have the potential to cause interference to area-wide apparatus licensed receivers operating in adjacent frequencies and areas.

The device boundary criterion, as defined in the s.145 determination, is the primary mechanism for managing interference across geographical boundaries. However, at times it may be necessary for licensees operating transmitters under a 26 GHz band spectrum licence to negotiate with other area-wide apparatus licensees when deploying services in order to avoid harmful interference.

The primary mechanism for managing interference across frequency boundaries is the unwanted emissions limits defined in the 26 GHz band spectrum licence. However, as services operated under 26 GHz band spectrum licences and area-wide apparatus licences will be in TDD mode, there is potential for interference even when devices comply with the defined unwanted emission limits. Therefore, at times it may be necessary for licensees operating transmitters under a 26 GHz band spectrum licence to negotiate with area-wide apparatus licensees (and vice versa) when deploying services in order to avoid harmful interference.

It is proposed that the following protection requirements are included in the RAG Tx (an equivalent requirement is proposed to be included in RALI[new] which would be applicable to area-wide apparatus licensed services)*:*

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| --- |
| Spectrum licensees planning to deploy radiocommunications transmitters in the 26 GHz band should have regard to radiocommunications receivers recorded in the Register operating under area-wide apparats licences operating in and adjacent to the 26 GHz band.  In planning for the operation of fixed transmitters under a spectrum licence in the 26 GHz band, spectrum licensees should coordinate with any radiocommunications receivers recorded in the Register. The coordination performed should:   * use the parameters of the radiocommunications receivers as recorded in the Register; * use the compatibility requirement set out in Schedule 2 of the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band)* 2020 as in force from time to time; * Although there are no receiver performance requirements, the notional receiver performance level set out in Schedule 1 of the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band)* 2020 as in force from time to time, is to be used for coordination purposes; * make use of a suitable propagation model to model path loss between the fixed transmitters and radiocommunications receivers; and * take into account terrain and any other relevant factors.   *Note*: An example of a suitable propagation model is that set out in section 4.5.2 of ITU-R Recommendation P.526-14 *Propagation by diffraction*.  In the event that coordination performed as outlined above indicates harmful interference may occur, spectrum licensees should consider:   * replanning the deployment of the fixed transmitters to avoid causing harmful interference; or * negotiating with the licensee of the affected area-wide licence to find a resolution.   In the event a solution under the above provisions is not possible, interference is managed in accordance with any synchronisation requirementcondition included in the spectrum licence, unless other arrangements are agreed to by the affected licensees.  *Note:* For a device with an active antenna system, the radiated power in the direction of a receiver operated under another licence, is defined as the sum of the gain of the antenna towards in the direction of the receiver (accounting for azimuth and elevation) and the Total Radiated Power (dBm). This allowance is based on the assumption that beam pointing angles and/or power can be controlled dynamically to ensure a defined level of radiated power in a specific direction is not exceeded. |

Coexistence with space station receivers

Article 5 of the ITU-R Radio Regulations details allocations for various space services in the range 24.7-27.5 MHz on a co-primary basis with terrestrial services (including IMT). Resolves 2.1 and 2.2 of ITU-R Resolution COM4/8 (WRC-19) requires administrations to apply conditions on IMT base station deployments in 24.25-27.5 GHz to protect space station receivers.

To provide consistency with ITU-R Resolution COM4/8 (WRC-19), the following provisions are proposed to be included in RAG Tx:

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| * Licensees of a 26 GHz band spectrum licence are to adhere to the provisions detailed in resolves 2.1 and 2.2 of ITU-R Resolution COM4/8 (WRC-19) for deployments in the range 24.7-27.5 GHz. |

Regarding the abovementioned mechanical pointing restrictions, these are already included in proposed additional conditions on IMT services in the frequency range 27-27.5 GHz in certain areas.

Coexistence with SRS earth stations in 25.5-27 GHz

Earth receive stations support space research activities in the range 25.5-27 GHz and are currently located at New Norcia, WA, and Tidbinbilla, ACT. As detailed in the *Coexistence with other services* chapter, the ACMA proposes that spectrum licensed transmitters which are not exempt from registration and high-powered fixed UEs, which operate in the range 25.5-27 GHz, must be coordinated with these earth station with a protection level of -156 dBW/MHz.

A TLG submission indicated that the minimum elevation angles should be reconsidered. In consideration that near-earth SRS missions require earth stations to point down to elevation angles of 5° and that local terrain may limit elevation angles in some directions, the elevation angles to be used in coordination have been revised.

The ACMA is currently considering updating RALI MS 43 to include coexistence arrangements with the Tidbinbilla SRS earth station. If RALI MS 43 is updated within a suitable timeframe (e.g. before the 26 GHz band spectrum auction), the ACMA may consider aligning some of the earth stations parameters to be used when coordinating spectrum licensed transmitters (such as the notional antenna pattern) with those currently (for New Norcia) and potentially (for Tidbinbilla) included in RALI MS 43. The potential alignment with RALI MS 43 (and the potential updates to RALI MS 43 itself) will be subject to further public consultation.

The following requirements are proposed to be included in the RAG Tx:

|  |
| --- |
| * Radiocommunications transmitters operated under a spectrum licence in the 26 GHz band in the frequency range 25.5-27 GHz, other than transmitters exempt from registration is accordance with Statutory Condition 4(a) or 4(b) of Licence Schedule 3 of the licence, must protect the Canberra Deep Space Communications Complex earth receive station located at -35.3951˚N, 148.9785˚E and the New Norcia Deep Space Ground Station earth receive station located at -31.0484˚N, 116.1914˚E. * The Canberra Deep Space Communications Complex and the New Norcia Deep Space Ground Station are to be protected from co-channel emissions to an aggregate interference level of -156 dBW/MHz at the input of the receiver.   Note: The interference level is based on Recommendation ITU-R SA.609-2.   * The earth station antenna pattern to be used in calculations is defined in ITU-R Recommendation SA.509-3 with a minimum elevation above the horizon of: * For the Canberra Deep Space Communications Complex, the maximum of: * 6 degrees, or * The angle to clear terrain in the direction of the proposed transmitter plus 0.5 degrees * For the New Norcia Deep Space Ground Station, the maximum of: * 5 degrees, or * The angle to clear terrain in the direction of the proposed transmitter plus 0.5 degrees |

FSS gateway uplinks

As detailed in the *Coexistence with other services* chapter, the ACMA proposed a range of additional conditions to safeguard coexistence of 26 GHz band spectrum licensed transmitters with FSS gateway uplinks in the range 27-27.5 GHz. These proposed conditions would apply to spectrum licensed devices operating in the range 27-27.5 GHz and within HCIS areas listed in Appendix E and consist of:

* The maximum TRP, for any outdoor transmitter, is 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 over the course of a single day
* Outdoor fixed UEs must not direct their antenna beam (via electrical or mechanical steering) to an angle from the GSO arc which is less than the minimum angles in Table 12, when the antenna beam is pointed at elevation angles of greater than or equal to 11° above the horizon.

1. Minimum separation angles

|  |  |
| --- | --- |
| Outdoor fixed UE antenna gain | Minimum separation angle from the GSO arc |
| < 34.7 dBi | 25 degrees |
| ≥ 34.7 dBi | 1.5 degrees |

It is proposed that the conditions included in the RAG Tx as detailed below*.*

|  |
| --- |
| A radiocommunications transmitter operated under a spectrum licence in the 26 GHz that is:   * is a user equipment station * is directing its antenna beam to an elevation angle greater than or equal to 11 degrees above the horizontal plane; * is a fixed transmitter; * is not an indoor transmitter; * operates in the frequency range 27-27.5 GHz; and * is located inside an area subject to additional conditions specified in Schedule 1.   Must not:   * Direct its antenna beam to within: * 1.5 degrees of the geostationary orbit if it is connected to an antenna with a gain of greater than or equal to 34.7 dBi; or * 25 degrees of the geostationary orbit if it is connected to an antenna with a gain of less than 34.7 dBi * A radiocommunications transmitter operated under a spectrum licence in the 26 GHz band which is a base station, must not: * be connected to an antenna which has its highest gain directed above the horizontal plane when the antenna is not being electrically steered; or * direct its antenna beam via electrical steering to an elevation angle greater than 5 degrees above the horizontal plane for more than 5 percent of time in any 24 hour period   If:   * the radiocommunications transmitter operates in the frequency range 27-27.5 GHz; and * the radiocommunications transmitter is located inside an area subject to additional conditions specified in Schedule 1. * A radiocommunications transmitter operated under a spectrum licence in the 26 GHz band must not operate with a total radiated power exceeding 25 dBm/200 MHz, if: * It is not an indoor transmitter; * The radiocommunications transmitter operates in the frequency range 27-27.5 GHz; and * the radiocommunications transmitter is located inside an area subject to additional conditions specified in Schedule 1. * Other than the requirements in subsections 4.2(1), 4.2(2) and 4.2(3) of Part 4, radiocommunications transmitters operated under a spectrum licence in the 26 GHz band in accordance with the conditions of the licence are not taken to cause unacceptable interference to FSS gateway uplinks. |

To provide additional regulatory certainty it is also proposed that a licence condition requiring compliance with the above provisions is included on spectrum licences *–* see the *Other conditions on the licence* subsection.

Passive EESS in the 23.6-24 GHz band

Space-borne passive sensing EESS services operate in the 23.6-24 GHz band. To manage coexistence between passive EESS and devices operating under a 26 GHz spectrum licence, the ACMA proposes the unwanted TRP limits in the range 23.6-24 GHz of:

* -33 dBW/200MHz for base stations and -29 dBW/200MHz for user equipment for devices deployed before 1 September 2027, and
* -39 dBW/200MHz for base stations and -33 dBW/200MHz for user equipment for devices deployed on or after 1 September 2027

It is proposed for these limits to be included as a core condition on 26 GHz band spectrum licences (subject to further consideration by the TLG – see the *Unwanted emission limits* subsection.

It is further proposed that the following guidance be included in the RAG Tx*:*

|  |
| --- |
| Radiocommunications transmitters operated under a spectrum licence in the 26 GHz band in accordance with the conditions of the licence are not taken to cause unacceptable interference to earth exploration satellite services (passive) operating in the 23.6-24 GHz band. |

Legacy fixed point-to-point services operating in the frequency range 27.5-28.5 GHz

As discussed in the *Coexistence with other services* chapter, it is proposed that 26 GHz spectrum licences service are coordinated with legacy point-to-point services in the adjacent 27.5-29.5 GHz band, using the provisions in RALI[new].

It is proposed that the following guidance is included in the RAG Tx:

|  |
| --- |
| In planning for the operation of radiocommunications transmitters under a spectrum licence, spectrum licensees are to provide fixed point-to-point services with a level of out-of-band and in-band protection from those transmitters, other than transmitters exempt from registration in accordance with the conditions of the licence, as would be provided from an area-wide apparatus licensed transmitter which has been coordinated in accordance with RALI[new]. |

Class licensed devices

A number of class licensed devices currently operate in the 24.25-27.5 GHz range authorised by 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). As detailed in the *Coexistence with other services* chapter, the ACMA is of the view that these class licensed devices can coexist with 26 GHz band spectrum licensed services without the need for specific licence conditions or coordination requirements.

To avoid the need for changes in operation to body scanners, in the unlikely event there is interference between body scanners and spectrum licensed devices (in either direction) it is proposed the spectrum licensee will be responsible to make change to resolve the issue.

The ACMA proposes that the following guidance be included in the RAG Tx*:*

|  |
| --- |
| * Radiocommunications transmitters operated under a spectrum licence in the 26 GHz band must not cause harmful interference to a device operated under the *Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018*, as in force from time to time. * Radiocommunications transmitters operated under a spectrum licence in the 26 GHz band in accordance with the conditions of the licence are not taken to cause unacceptable interference to services operating under a class licence other than the *Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018*. |

### Managing interference to spectrum-licensed receivers

The draft *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020* (RAG Rx) provides guidance on the management of interference to receivers operating under a 26 GHz band spectrum licence. The RAD Rx will provide coexistence arrangement with specific services, as well as detailing notional receiver parameters.

A full copy of the draft RAG Rx is contained in Appendix D.

Area-wide apparatus licensed services operating in and adjacent to the 25.1-27.5 GHz range

The ACMA is developing arrangements for area-wide apparatus licensed wireless broadband services in the 24.7-25.1 GHz and 27.5-29.5 GHz bands Australia wide and 25.1-27.5 GHz in geographic areas not subject to 26 GHz band reallocation declaration.

It is proposed that in-band interference caused to spectrum licensed receivers by transmitters operating under an area-wide apparatus licence is managed as if the transmitter is operated under a spectrum licence. The same device boundary criteria and synchronisation requirement (unless other arrangements are agreed to by the affected licensees), as applied to spectrum licensed radiocommunications transmitters at the time of registration are also applied to area-wide apparatus licensed radiocommunications transmitters. Therefore, spectrum licensed receivers are afforded the same level of in-band protection from new area-wide apparatus licensed transmitters as they are afforded from transmitters operated under adjacent spectrum licences.

Requirements for area-wide apparatus licensed transmitters to comply with the device boundary criteria and the synchronisation requirement are proposed to be included in new area-wide apparatus licence technical framework.[[42]](#footnote-43)

Coexistence with FSS gateway up-links in 27-27.5 GHz

FSS gateway uplinks operate with a frequency overlap with the upper 500 MHz of the 26 GHz band (27-27.5 GHz), with earth stations currently limited to 10 locations. The potential of interference from FSS earth stations into 26 GHz spectrum licensed devices will depend on a number of factors, in particular the geographical separation and antenna discrimination. As detailed in the *Coexistence with other services* section, the probability of interference to spectrum licensed devices is low.

The ACMA does not intend to develop coordination procedures to manage interference from existing FSS gateway earth stations as it considers that spectrum licensees are best placed to determine and implement appropriate mitigation techniques to address any potential interference cases. Therefore, it is proposed that spectrum licensees must accept any in-band interference to radiocommunications receivers caused by existing FSS earth stations.

Applications for new FSS earth stations (in frequency and area combinations not subject to the 26 GHz band reallocation declaration) after the issue of 26 GHz band spectrum licences will be coordinated with the spectrum licence space on a case by case basis. Coordination requirements will be developed in a separate consultation process.

Class licensed devices

A number of class licensed devices currently operate in the 25.1-27.5 GHz range authorised by 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). As detailed in the *Coexistence with other services* chapter, the ACMA is of the view that these class licensed devices can coexist with 26 GHz band spectrum licensed services without the need for specific licence conditions or coordination requirements.

To avoid the need for changes to body scanner operating requirements, in the unlikely event that there is interference between body scanners and spectrum licensed devices (in either direction) it is proposed the spectrum licensee will be responsible for resolving any such issues. To this effect, it is proposed that the follow text is included in the RAG Rx:

|  |
| --- |
| A Radiocommunications receiver operated under a spectrum licence in the 26 GHz band is not afforded protection from interference by a device operated under the *Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018,* as in force from time to time. |

Notional Receiver

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

The ACMA does not intend to enforce minimum receiver performance levels. However, while receiver performance will not be a mandatory requirement, a minimum notional receiver performance level will be assumed when considering and resolving interference issues that might arise. This minimum level of performance is specified so that receivers with poor performance do not deny large amounts of spectrum space to transmitters in order to protect the receiver from interference.

The minimum Notional Receiver Performance Level consists of:

a compatibility requirement;

a notional antenna characteristic;

an adjacent channel selectivity (ACS);

a blocking level; and

an intermodulation rejection level.

Each of these requirements are specified in the following sections.

Specification of the notional receiver may either be made using absolute or relative values and is usually determined by the range of technologies that are in use or planned for use in the band. Feedback from some TLG members indicated a preference to use relative terms when specifying ACS, in-band blocking and intermodulation rejection as these parameters are a ratio relative to the minimum wanted signal level. Using ratios would allow these parameters to be applicable for different wanted levels and base station types[[43]](#footnote-44),

The ACMA sees merit in using relative values considering the range of base station types which may be deployed in the 26 GHz band. However, the notional receiver and compatibility requirement are also used to coordinate apparatus licensed transmitters with existing spectrum licensed receivers. This coordination may require calculating the maximum tolerable interference level at frequencies outside the receiver’s bandwidth. This calculation would require the notional receiver to specify the minimum wanted level as well as the ACS and blocking ratios.

*Compatibility requirement*

3GPP TS 38.104 specifies different receiver requirements for wide area, medium range and local area base stations. The proposed compatibility requirement is based on parameters for medium-area base stations as the proposed in-band limit of 37 dBm/200 MHz aligns with the output TRP limit for medium-area base stations of ≤47 dBm.[[44]](#footnote-45)

3GPP TS 38.104 does not set specific reference sensitivity limits for mmwave equipment, instead reference sensitivity limits are based on a value to be declared by the equipment vendor (within a specified range). The reference sensitivity (EISREFSENS) for local area NR base stations at which a throughput requirement is to be met for a specified reference measurement channel is calculated by the following equation[[45]](#footnote-46):

EISREFSENS\_50M + ΔFR2\_REFSENS

Where:

EISREFSENS\_50M is based on a 50 MHz reference measurement channel and is declared by the equipment vendor within the range -91 to -114 dBm/50MHz (for a medium-area base station) at the receive antenna.[[46]](#footnote-47)

ΔFR2\_REFSENS is -3 dB for the reference direction, and 0 dB for all other directions within the range of angles of arrival.

For the minimum EISREFSENS\_50M of -114 dBm and ΔFR2\_REFSENS equals -3 dB, the EISREFSENS is -117 dBm/50MHz at the input of the antenna array. Taking into account the range of sensitivity levels and other anomalous effects on the wanted channel (fading, body loss, etc.), the minimum wanted signal level at the antenna input is –111 dBm per 50 MHz. This also matches the wanted signal mean power (EISREFSENS + 6 dB) level defined in 3GPP standards for testing receiver compliance.

Given the integrated nature of antenna arrays in mmwave NR equipment, receiver specifications for 26 GHz band equipment in 3GPP TS 38.104 are specified as ‘over-the-air’, meaning limits are specified at the input of the receive antenna array. However, in order for the notional receiver to be used to coordinate non-spectrum licensed transmitters with spectrum licensed receivers, which will need to consider the receiver antenna gain in the direction of the interfering transmitter, the compatibility requirements should be defined at the input of the receiver.

To specify this requirement at the receiver input an assumed antenna gain of 23 dBi is added, giving the proposed wanted level of -88 dBm/50MHz at the input of the receiver. It is also proposed that this wanted level should apply for 95% of the time in a 1 hour period – which is consistent with the capability requirements in the 3.6 GHz band.

The maximum tolerable interference level is proposed to be based on an I/N of -6 dB and a NF of 10 dB (sourced from WP 5D[[47]](#footnote-48)). This equates to a maximum interference level of -93 dBm/50MHz at the input of the receiver which equals a wanted to unwanted ratio of 5 dB.

*Notional antenna*

It is proposed that the antenna gain recorded in the RRL should be used for coordination and interference management purposes. If the antenna details are not included in the RRL, then an antenna gain (including losses) of 23 dBi (based on an 8x8 array) in all directions is to be used.

*Adjacent channel selectivity*

Adjacent channel selectivity (ACS) is a measure of the receiver’s ability to receive a wanted signal at its assigned channel frequency in the presence of an adjacent channel signal with a specified centre frequency offset of the interfering signal to the band edge of a victim system. In 3GPP TS 38.104, ACS is expressed as an absolute interfering signal level in the adjacent channel. The interference level is calculated with using the following equation:

Interfering signal mean power = EISREFSENS\_50M + 27.7 + ΔFR2\_REFSENS

As evident in the above equation, the ACS limit is dependent on the reference sensitivity level. For the lowest EISREFSENS\_50M of -114 dBm and ΔFR2\_REFSENS of -3 dB, the maximum interference level is –89.3 dBm/50 MHz with a centre frequency offset of at least ± 24.29 MHz. Assuming the minimum wanted level of -111 dBm/50 MHz (at the receive antenna input), the proposed adjacent channel selectivity requirement is 21.7 dB at offsets less than 50 MHz.

*Blocking*

Receiver blocking is a measure of the ability of a receiver to receive the wanted signal in the presence of a high level unwanted signal on frequencies other than the first adjacent channel. Blocking occurs where high levels of unwanted signal outside the wanted channel changes the operating point of the RF amplifier or mixing stages reducing receiver sensitivity. This effectively blocks the reception of low level signals in the wanted channel.

In 3GPP TS 38.104, in-band blocking limits apply at frequency offsets of 50-1500 MHz from the base station RF bandwidth[[48]](#footnote-49) and are expressed as an absolute interfering signal level centred at least 75 MHz offset from the channel edge. The interference level is calculated with using the following equations:

Interfering signal mean power = EISREFSENS\_50M + 33 + ΔFR2\_REFSENS

For the lowest EISREFSENS\_50M of -114 dBm and ΔFR2\_REFSENS of -3 dB, the maximum interference level is -84 dBm/50 MHz at the input of the antenna array. Assuming the minimum wanted level of -111 dBm/50 MHz (at the receive antenna input), the proposed blocking requirement is 27 dB at offsets of 50-1500 MHz from the frequency limits of the spectrum licence.

The proposed blocking requirements at frequency offsets of greater than 1500 MHz, based on the limits in 3GPP TS 38.104, are displayed in Table 13. These proposed limits apply at the input of the receive antenna (as antenna performance is unknown at frequencies well outside the operating band). In 3GPP TS 38.104, the over-the-air out-of-band blocking requirement is based on the wanted and unwanted signals originating from the same direction. Therefore, it is proposed the that out-of-band blocking requirement of the notional receiver is limited to unwanted signals from azimuths that are consistent with the -3 dB beamwidth of the antenna in its operating band.

1. Proposed blocking requirements at offsets greater than 1500 MHz

|  |  |
| --- | --- |
| **Frequency range (GHz)** | **RMS field strength (V/m)** |
| 0.03-12.75 | 0.36 |
| 12.75-22.75 | 0.1 |
| 29-55 | 0.1 |

*Receiver intermodulation rejection*

Intermodulation response rejection is a measure of the capability of the receiver unit to receive a wanted signal on its assigned channel frequency in the presence of two interfering signals which have a specific frequency relationship to the wanted signal. In 3GPP 38.104, the intermodulation rejection interference signal is calculated using the following equation:

EISREFSENS\_50M + 25 + ΔFR2\_REFSENS dB

For the lowest EISREFSENS\_50M of -114 dBm and ΔFR2\_REFSENS of -3 dB, the maximum interference level is -92 dBm/50 MHz at the input of the antenna array. The defined offsets of the interference signals (between the channel edge and the centre of the interference signal) depend on the wanted channel bandwidth and range between 5.64 and 7.5 MHz for a continuous wave signal and 40 to 45 MHz for the 50 MHz NR signal. Assuming the minimum wanted level of -111 dBm/50 MHz (at the receive antenna input), the proposed intermodulation rejection requirement is 19 dB for offsets greater than 5 MHz.

|  |
| --- |
| The proposed compatibility requirement and notional receiver requirements are:  A compatibility requirement of:   * A minimum wanted signal level of -88 dBm per 50 MHz for 95% of the time in any 1 hour period; and * A wanted to unwanted ratio of 5 dB.   The adjacent channel selectivity requirement is 21.7 dB in the adjacent 50 MHz of the licence under which the radiocommunications receiver operates.  The receiver blocking requirement is:   * 27 dB at frequency offsets greater than 50 MHz and less than or equal to 1500 MHz from the upper and lower frequency limits of the spectrum licence under which the radiocommunications receiver is operating. * An RMS field strength at the input of the receive antenna of, from unwanted emissions within the -3 dB beamwidth of the receive antenna: * 0.36 V/m in the 0.03-12.75 GHz frequency range * 0.1 V/m in the frequency ranges 12.75-55 GHz, excluding offsets of less than or equal to 1500 MHz.   The receiver intermodulation rejection level is 19 dB for each out-of-band signal at frequency offsets greater than or equal to 5 MHz from the upper and lower frequency limit of the spectrum licence under which the radiocommunications receiver operates. |

As indicated earlier in this paper, the ACMA is currently considering how FSS earth stations should be licensed and the arrangements for managing interference from earth stations to spectrum licensed receivers. The outcome of this work may require some minor amendments to the proposed notional receiver and compatibly requirement detailed above. The ACMA will discuss potential changes (if required) with relevant stakeholders prior to public consultation on the spectrum licence technical framework.

The notional receiver is typically used when coordinating a proposed transmitter with an existing receiver (i.e. the coordination will protect the existing receiver to the level of the notional receiver). It is proposed to include notes in the RAG Rx which explain the frequency range over which the calculated maximum tolerable interference level is to apply.

One TLG submission suggested that the calculated tolerable interference level should be based on the occupied bandwidth of the transmitter being coordinated instead of using a fixed 50 MHz bandwidth from 3GPP standards.

The ACMA’s preliminary view is that a fixed reference bandwidth of 50 MHz is appropriate. This means that when coordinating transmitters with an occupied bandwidth wider than 50 MHz the transmit power spectral density should be converted to a 50 MHz reference bandwidth.

Some example calculations are provided below:

* the maximum interference level within the adjacent 50 MHz from the receiver is calculated as:

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

=-88 dBm/50 MHz +21.7 dB – 23 dBi

= –89.3 dBm/50 MHz at the receive antenna input (when coordinating a transmitter with an existing receiver, this is the maximum power level permitted within the adjacent 50 MHz).

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

Wanted signal level + in-band blocking - Rx antenna gain in the direction of the transmitter (from the RRL)

= -88 dBm/50 MHz + 27 dB - 23 dBi

= -84 dBm/50 MHz at the receive antenna input (when coordinating a transmitter with an existing receiver, this is the maximum power level permitted at frequency offsets of 50-1500 MHz)

# Appendix A – Draft spectrum licence

Refer to attachment on SharePoint

# Appendix B – Draft Radiocommunications (Unacceptable Levels of Interference - 26 GHz Band) Determination

Refer to attachment on SharePoint

# Appendix C – Draft Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters – 26 GHz Band)

Refer to attachment on SharePoint

# Appendix D – Draft Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 26 GHz Band)

Refer to attachment on SharePoint

# Appendix E – 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 14. 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 F – Coexistence with FSS uplinks

This appendix outlines the rationale for the inclusion of additional licence conditions on wireless broadband services within the -3 dB footprints of the nbn satellite network. 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 spectrum licensed devices operating in 27-27.5 GHz and within the areas detailed in Appendix E. 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.[[49]](#footnote-50) 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.[[50]](#footnote-51) 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 15 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 15, 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)[[51]](#footnote-52) | | | |
| 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 within a 3 dB nbn gateway footprint and in the range 27-27.5 GHz:

* 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 per day, 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.[[52]](#footnote-53) 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 satellites will be within the range 40°-50° above the horizon for the majority of gateway footprint areas.[[53]](#footnote-54) 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 5. 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:[[54]](#footnote-55)
* 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 16 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 16 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[[55]](#footnote-56) | -6 dB (for 0.6% of the time) | |
| Noise temp[[56]](#footnote-57) | 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 7), 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 spectrum licensed devices operating in the range 27-27.5 GHz within NBN gateway areas:

Outdoor fixed UEs must not direct their antenna beam (via electrical or mechanical steering) to an angle from the GSO arc which is less than the minimum angles in Table 17, when the antenna beam is pointed at elevation angles of greater than or equal to 11° above the horizon.

1. Minimum separation angles

|  |  |
| --- | --- |
| Outdoor fixed UE antenna gain | Minimum separation angle from the GSO arc |
| < 34.7 dBi | 25 degrees |
| ≥ 34.7 dBi | 1.5 degrees |

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

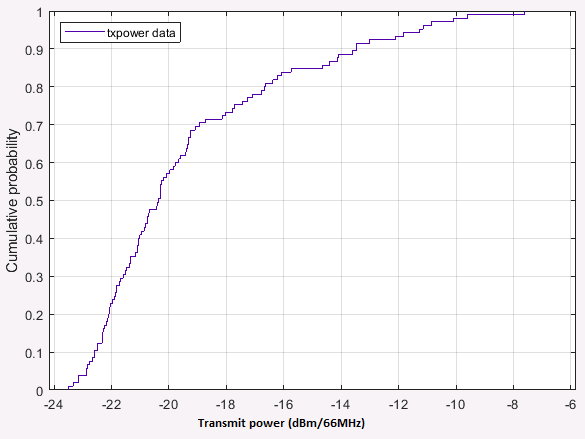
This attachment to Appendix F contains the statistical results of simulations for UE transmit powers at set distances from the base station.

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:

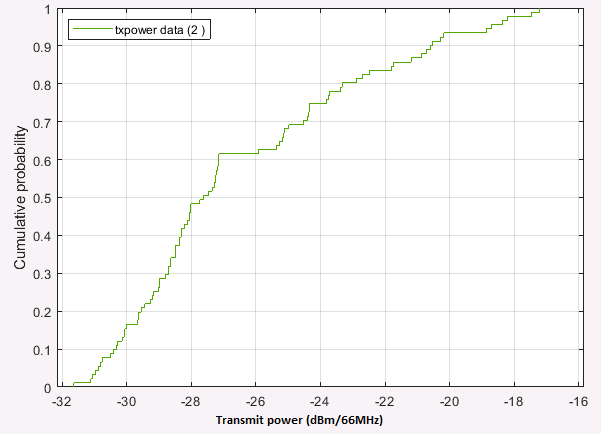
* For a 6m high base station:
* 4m for an elevation angle of 50°
* 5m for an elevation angle of 40°
* For a 30m high base station:
* 24m for an elevation angle of 50°
* 34m for an elevation angel of 40°

The following figures provide cumulative distribution function curves for UE transit powers for the above cases. Figures 6 and 8 include clutter in the signal path between UE and BS, while Figures 7 and 9 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.[[57]](#footnote-58)

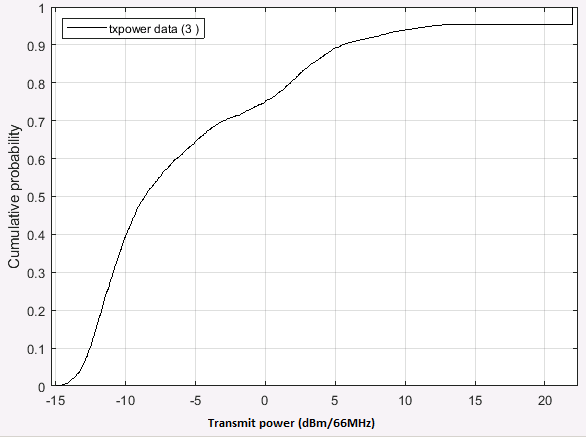
1. Transmit power for BS height = 6m, UE distance from BS = 4 to 5m, with clutter (assuming urban/suburban UE distribution model)



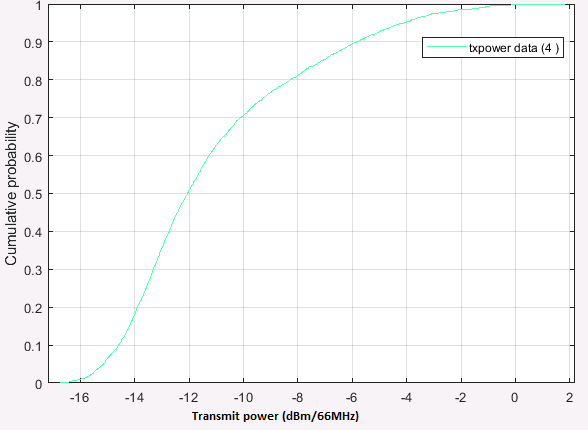
1. Transmit power for BS height = 6m, UE distance from BS = 4 to 5m, without clutter (assuming urban/suburban UE distribution model)



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. Refer to the [Radiocommunications (Spectrum Re-allocation—26 GHz Band) Declaration 2019](https://www.legislation.gov.au/Details/F2019L01374) (the 26 GHz band reallocation declaration) [↑](#footnote-ref-2)
2. See: <https://portal.acma.gov.au> [↑](#footnote-ref-3)
3. Refer to https://www.legislation.gov.au/Details/F2019L01374 [↑](#footnote-ref-4)
4. In February 2020, the former Department of Communications was merged into the new Department of Infrastructure, Transport, Regional Development and Communications. [↑](#footnote-ref-5)
5. The CSO class licence was updated in February 2020 to, among other changes, include the frequency ranges 28.3-28.5 GHz and 29.1-29.5 GHz. The ACMA also indicated that the introduction of arrangements to facilitate ubiquitous FSS services below 28.3 GHz may occur following further consideration of coexistence issues. More information is available on the [ACMA website](https://www.acma.gov.au/consultations/2019-12/improved-spectrum-access-and-pricing-satellite-services-consultation-402019). [↑](#footnote-ref-6)
6. The ACMA is developing arrangements for area-wide apparatus licensed services in the 26 and 28 GHz bands, optimised for the deployment of wireless broadband services. See the *Development of the 26/28 GHz band apparatus licence technical framework* TLG paper. [↑](#footnote-ref-7)
7. While the synchronisation requirement is proposed to be included on 26 GHz spectrum licences and in the AWL LCD, the fallback frame structure is proposed to be details in a new RALI – see the *In-band emission limits* section for more details. [↑](#footnote-ref-8)
8. The ACMA is currently considering updating RALI MS 43 to include coexistence arrangements with the Tidbinbilla SRS earth station. If RALI MS 43 is updated within a suitable timeframe (e.g. before the 26 GHz band spectrum auction), the ACMA may consider aligning some of the earth stations parameters to be used when coordinating spectrum licensed transmitters (such as the notional antenna pattern) with those currently (for New Norcia) and potentially (for Tidbinbilla) included in RALI MS 43. The potential alignment with RALI MS 43 (and the potential updates to RALI MS 43 itself) will be subject to further public consultation. [↑](#footnote-ref-9)
9. The DBC is a provision common to all current spectrum licensed bands which is used to manage interference at the geographic boundary of the licence. Generally, a spectrum licensed transmitter cannot be operated if the calculated DBC falls outside the geographic area of the licence. See the *Device boundary criteria* section for more detail on the proposed DBC in the 26 GHz band. [↑](#footnote-ref-10)
10. -3 dB beamwidth = 163 / sqrt(Glinear) = 163 / sqrt(2951.2) = 3° [↑](#footnote-ref-11)
11. Gain = , where k = efficiency (0.6 assumed), D = diameter (m), λ = wavelength (m) [↑](#footnote-ref-12)
12. Available on the Department of Infrastructure, Transport, Regional Development and Communications [website](https://www.communications.gov.au/publications/coexistence-terrestrial-and-satellite-services-26-ghz). [↑](#footnote-ref-13)
13. See studies B, C, L and O in Attachment 3 to Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en). These studies found that separation distances of up to 18km (assuming 1% clutter) may be required for gateway earth station elevation angles of 5°. [↑](#footnote-ref-14)
14. See ECC Decision (18)06 [↑](#footnote-ref-15)
15. See the [Provisional Final Acts](https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf) are available on the ITU-R website [↑](#footnote-ref-16)
16. See [Document ECC(20)001](https://www.cept.org/Documents/ecc/57047/ecc-20-001_letter-ecc-chair-26-ghz-wrc-passiveeess) [↑](#footnote-ref-17)
17. See [Document ECC(20)055 Annex 18](https://www.cept.org/Documents/ecc/57825/ecc-20-055-annex-18_ecc-response-to-the-ec-letter-on-26-ghz). [↑](#footnote-ref-18)
18. See the [Commission Implementing Decision (EU) 2020/590](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2020.138.01.0019.01.ENG&toc=OJ:L:2020:138:TOC) [↑](#footnote-ref-19)
19. See [Document ECC(20)001](https://www.cept.org/Documents/ecc/57047/ecc-20-001_letter-ecc-chair-26-ghz-wrc-passiveeess) [↑](#footnote-ref-20)
20. See [Document ECC(20)055 Annex 18](https://www.cept.org/Documents/ecc/57825/ecc-20-055-annex-18_ecc-response-to-the-ec-letter-on-26-ghz). [↑](#footnote-ref-21)
21. See [ECC Decision (18)06](https://www.erodocdb.dk/document/3361). [↑](#footnote-ref-22)
22. See Attachment 2 to Document 5-1/36 [↑](#footnote-ref-23)
23. Available on the [ACMA website](https://www.acma.gov.au/sites/default/files/2019-10/The%20Australian%20spectrum%20map%20grid%202012.PDF). [↑](#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. See [Commission Implementing Decision 2019/784](https://eur-lex.europa.eu/eli/dec_impl/2019/784/oj) [↑](#footnote-ref-26)
26. Article 21.5 provides a transmitter power limit of +10 dBW. [↑](#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. Where D = downlink slot, U = uplink slot and S = special slot. [↑](#footnote-ref-29)
29. A draft of RALI[new] is available on the 26/28 GHz band TLG SharePoint site. [↑](#footnote-ref-30)
30. See Attachment 2 to Document 5-1/36 [↑](#footnote-ref-31)
31. BWoccupied is the occupied bandwidth of the radiocommunications transmitter operated under the licence. [↑](#footnote-ref-32)
32. In Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-33)
33. Assuming a 4x4 antenna array with an element gain of 5 dBi. [↑](#footnote-ref-34)
34. Equation adapted from Recommendation ITU-R P.525 [↑](#footnote-ref-35)
35. Using ITU-R Recommendation P.2109-1 and assuming a traditional building. Losses will increase for thermally-efficient buildings and higher elevation angles. [↑](#footnote-ref-36)
36. Reallocation areas and period are detailed in the [Radiocommunications (Spectrum Re-allocation—26 GHz Band) Declaration 2019](https://www.legislation.gov.au/Details/F2019L01374) [↑](#footnote-ref-37)
37. More information on the guard-space method is available in the document ‘Spectrum Licensing Technical Frameworks – Information Paper’, available on the [ACMA website](https://www.acma.gov.au/publications/2019-11/publication/spectrum-licensing-technical-frameworks-information-paper-2009). [↑](#footnote-ref-38)
38. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-39)
39. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-40)
40. See [*Radiocommunications (Unacceptable Levels of Interference — 3.4 GHz Band) Determination 2015*](https://www.legislation.gov.au/Details/F2018C00557)*.* [↑](#footnote-ref-41)
41. Based on any assumed TRP = 40 dBm/200 MHz, transmitter antenna gain = 23 dBi and LOP = 110 dBm/MHz. Assuming free space, this results in a maximum radial length of approximately 30 km [↑](#footnote-ref-42)
42. See the *Development of the 26/28 GHz band apparatus licence technical framework* TLG paper on the SharePoint site. [↑](#footnote-ref-43)
43. The wanted levels and reference sensitivity (EISREFSENS) will depend on base station type - EISREFSENS is declared by the manufacturer from within a range specified in 3GPP TS 38.104 depending on base station type (local-area, medium-area and wide-area). [↑](#footnote-ref-44)
44. See section 9.3.1 of 3GPP TS 38.104. [↑](#footnote-ref-45)
45. This equation applies for 50, 100 and 200 MHz channels with 60 kHz sub-channel spacing, and 50 MHz channels with 120 kHz sub-channel spacing. For 100, 200 and 400 MHz channels with 120 kHz sub-channel spacing the equation is: EISREFSENS\_50M + 3+ ΔFR2\_REFSENS, which will give a higher sensitivity level for the same EISREFSENS\_50M value. [↑](#footnote-ref-46)
46. See section 10.3.3 of 3GPP TS 38.104 for equations to calculate reference sensitivity from EISREFSENS\_50M. [↑](#footnote-ref-47)
47. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-48)
48. The in-band blocking offset range has been updated to better align with 3GPP TS 38.104. [↑](#footnote-ref-49)
49. 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-50)
50. 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-51)
51. 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-52)
52. 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-53)
53. Elevation angles will be higher than 50° in the remainder of nbn gateway footprint areas. [↑](#footnote-ref-54)
54. Simulated deployment characteristics and propagation modules used were consistent with those agreed by ITU-R Task Group 5/1. [↑](#footnote-ref-55)
55. 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-56)
56. 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-57)
57. 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-58)