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Technical Framework Development 700 MHz Spectrum Licence Band

**TLG-Discussion Paper No. 3  
Design Requirements for the Technical Framework  
Radiocommunications Advisory Guidelines**

Document Release Information

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## 

## 1. Background

This discussion paper deals with the parts of the technical framework that provide planning guidance in respect to coordination with other services.

Typically spectrum licensees are provided planning guidance in respect to other services under Part 5.3 of the *Radiocommunications Act 1992,* (the Act). Sub-section (1) of section 262 of the Act authorises the ACMA to make written advisory guidelines about any aspect of radiocommunication or radio emissions. These guidelines are not mandatory requirements (unless the requirements are to support a licence condition) and the ACMA will consider suggested alternative interference management arrangements.

These guidelines aim to provide flexibility for licensees to manage the risk of interference between services. Should licensees be unable to resolve interference issues they may expect the ACMA to have regard to the guidelines in dealing with any such dispute.

Due to the unique protection requirements of radio astronomy facilities, the ACMA plans to also include a condition in the licence to protect the Mid West Radio Quiet Zone.

These guidelines are created in accordance with Section 262 of the Act for the purpose of:

* Managing interference from spectrum licensed transmitters into adjacent apparatus licensed receivers in adjacent frequency bands or adjacent geographic areas;
* Managing interference from apparatus licensed transmitters in adjacent frequency bands or adjacent geographic areas;
* Providing information for use by apparatus licensees who may need to coordinate with registered spectrum licensed receivers;
* Providing guidance on managing coexistence between spectrum licensed services and class licensed services;
* Providing information on coordination arrangements that apply for broadcast services in the 694-820 MHz frequency range.

ACMA seeks comment from members of the Technical Liaison Group on the arrangements for the Radiocommunications Advisory Guidelines (RAGs).

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## 2. Spectrum Licence Arrangements

Australia plans to implement the regionally harmonised arrangement for the digital dividend spectrum developed by the APT Wireless Group (AWG). It consists of two paired segments of 45 MHz for downlink and uplink with a 10 MHz duplex band between them. A 9 MHz of band exists below 703 MHz providing a buffer to the topmost television broadcast channel. These arrangements are depicted in the diagram below.

|  |
| --- |
| Figure APT FDD 700 MHz band arrangements |
| *700Mhz Band Plan1.emf* |
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## 3. Proposed New Section 262 Guidelines

The new section 262 guidelines to be developed for the 700 MHz band follow along the lines of those developed for other spectrum licensed bands. Typically a spectrum licence framework will contain two sets of section 262 guidelines specific to the band of operation.

The first set of guidelines deals with management of interference to receivers operated under apparatus, other spectrum or class licences. Typically these receivers operate in bands adjacent to the spectrum licence but the guidelines can also address interference to receivers operating in the spectrum licence band.

The second set of guidelines deals with the management of interference caused by transmitters operated under apparatus, other spectrum or class licences to registered spectrum licence receivers in the band. The guidelines will therefore outline the inter-band coordination requirements relevant to the 700 MHz spectrum licence band.

## 4. Mid Western Radio Quiet Zone

The Mid-Western Radio Quiet Zone (RQZ) is an area centred on the coordinates of the Boolardy Station site in WA which has been specially designated as an area of ‘radio quietness’ for the development of and use by Radioastronomy Services.

The *Radiocommunications (Mid-West Radio Quiet Zone) Frequency Band Plan 2011* defines the RQZ in terms of frequency band and geographic area, whilst *Radiocommunications Assignment and Licensing Instruction (RALI) MS32 (2007)* sets out coordination arrangements and protection requirements for apparatus licensed services deployed near the RQZ. The procedures in RALI MS32 consist of determination of a received interference power from the transmitting service at the centre point coordinates of the RQZ and comparison with a protection threshold.

It is proposed that a licence condition be attached to spectrum licences in the 700 MHz band stating the licensee’s obligation to follow the procedures of RALI MS32 when deploying devices around the RQZ.

***It is recommended that:***

***a licence condition be attached to spectrum licences in the 700 MHz band requiring the licensee to follow the procedures of RALI MS32 when deploying devices around the RQZ.***

## 5. Managing Interference to Receivers in Adjacent Bands

Section 262 guidelines are developed to inform spectrum licensees on managing interference to receivers operated under apparatus, class and spectrum licences in other bands. The principal interference mechanisms that need to be considered are:

Blocking – The in-band emission level of the transmitter at the victim receiver exceeds the blocking ability of the receiver;

Out-of-band – Emissions of the transmitter outside the band of the licence are sufficiently high to cause co-channel interference to the victim receiver; and

Intermodulation – Mixing of high level in-band emissions may give rise to an out-of-band product within the victim receiver bandwidth.

Spectrum licensees must pay attention during planning to the interference risks associated with these mechanisms, both to their own systems and to receivers operated under other licence types due to the flexibility provided within the technical framework.

### 5.1 Receivers associated with Transmitters Operated under Class Licences

Wireless microphones[[1]](#footnote-1) are permitted to operate in the 520-820 MHz band in accordance with the *Low Interference Potential Devices (LIPD) Class Licence 2000*. A user of a wireless microphone device authorised by this class licence must adhere to the stated conditions therein and must not cause interference to other radiocommunications services in the band. Wireless microphone receivers are also not afforded protection from other radiocommunications services in the band and in cases of interference users of wireless microphones are obliged to implement mitigation strategies, such as re-tuning, use of diversity systems, use of antenna isolation or otherwise to cease transmission.

Wireless microphones will not be permitted to operate in the digital dividend after the end of the reallocation period of 31 December 2014. However it is proposed that they be permitted to continue to be operated in the 520- 694 MHz frequency range under similar conditions specified in the LIPD Class Licence. The LIPD Class Licence will be updated to reflect these new arrangements.

Frequencies adjacent to the 700 MHz upper and lower bands may also be considered for use by class licence devices. Arrangements will be developed in consultation with stakeholders as necessary.

### 5.2 DTV Receivers– Area of application for the -40 dBm/MHz Out-of-Band Emission Limit below the 694 MHz boundary

In TLG Discussion Paper #1 the ACMA proposed an out-of-band emission limit of ‑40 dBm/MHz (averaged over a 7 MHz television channel bandwidth) from spectrum licensed transmitters into a broadcast channel as adequate to protect broadcast services. Given expected equipment performance, the ACMA proposed that the -40 dBm/MHz limit be met below 673 MHz[[2]](#footnote-2) by all devices and that the limit of -40 dBm/MHz be met over 673- 694 MHz frequency range by devices operating in areas where these devices coexist with broadcast services planned or licensed to operate above 673 MHz (i.e. the top three television channels 49, 50 and 51).

This approach to out-of-band emission limits minimises the need for spectrum licensed devices to meet the more stringent requirement of -40 dBm/MHz in all areas by only requiring that it be met in areas where broadcast services operate or are planned up to the 694 MHz boundary. In all other areas spectrum licensed devices only need to meet a limit of -34dBm/MHz over 673-694 MHz and -40 dBm/MHz below 673 MHz.

To assist licensees to comply with this licence condition, the ACMA will publish a series of maps (based on broadcast service planning performed by the ACMA) showing predicted coverage from digital television transmitters so that spectrum licensees can identify the areas where television channels 49, 50 and 51 are in use/planned and where the implementation of the   
–40 dBm/MHz limit is required between 673 MHz and 694 MHz.

***It is recommended that:***

***- a set of maps identifying coverage areas around DTV broadcast transmitters that are using or are planned to use television channels 49, 50 and 51 be published on the ACMA website;***

***- spectrum licensees will be required to use these maps for the implementation of the -40 dBm/MHz out-of-band emission limit in the frequency range 673-694 MHz for spectrum licensed transmitters operating in the 700 MHz lower band.***

### 5.3 Services in the Band 803-820 MHz

The Australian digital dividend extends up to 820 MHz which is 17 MHz above the upper edge of the 700 MHz upper band at 803 MHz.

There are some considerations regarding interference scenarios for any future services that may be introduced into the range 803-820 MHz. Australia is participating in discussions within the Asia-Pacific Telecommunity Wireless Group (AWG), on potential uses of the spectrum above 803 MHz; however, as yet there have been no decisions on the use of this spectrum in Australia. It is therefore not possible to devise specific coordination criteria to deal with potential interference. To preserve future planning options, an out-of-band emission limit was given in TLG Discussion Paper #1 specifying that emissions falling above 806 MHz should be below – 6 dBm/MHz, and above 813 MHz the emissions should be below a limit of – 15 dBm/MHz. These limits are broadly in line with the limits proposed in the 800 MHz TLG discussions to protect receivers from adjacent band transmitters. These limits should therefore be sufficient to allow other mobile-type services to operate and still provide protection to any other new services allowing for more efficient use of spectrum without the need to apply additional constraints upon existing spectrum licensees.

Any future coordination requirements for services above the 803 MHz boundary will be developed in consultation with stakeholders as necessary.

### 5.4 Land Mobile Base Receivers in the 820-825 MHz Range

Land Mobile Base Receivers operate in the 820-825 MHz paired with Land Mobile Base Transmitters that use the 865-870 MHz range as authorised via apparatus licensing.

In this situation there is a potential for out-of-band interference from spectrum licensed transmitters operating in the 758-803 MHz band. The Land Mobile service uses narrowband 25 kHz channelling where small frequency offsets to an interfering signal will result in significant adjacent frequency attenuation due to the sharp selectivity of the land mobile receiver.

Coordination requirements for the Land Mobile Service are described in *Radiocommunications Assignment and Licensing Instruction LM8* (RALI LM8). It is recommended that Land Mobile Base receivers in the 820-825 MHz band are to be coordinated on a first-in-time basis from spectrum licensed transmitters operating in the 758-803 MHz range in accordance with the RALI LM8 requirements. Any existing Land Mobile Base station receiver licensed prior to the registration of a spectrum licensed transmitter should be coordinated in accordance with the RALI LM8 requirements.

This mode of interference from spectrum licensed transmitter to Land Mobile Base station receiver is in most cases a high-site to high-site radiofrequency path over which there will be minimal diffraction and clutter loss.

***It is recommended that:***

***spectrum licensed transmitters operating in the 758-803 MHz band coordinate with Land Mobile Base Receivers operating in the 820-825 MHz band in accordance with RALI LM 8 on a first-in-time basis.***

### 5.5 Digital Television Receivers Operating in the 700 MHz Band

The ACMA is undertaking planning to restack digital television services to frequencies below 694 MHz. Part of this process involves the preparation of Television Licence Area Plans (TLAPs) that are directed at clearing the digital dividend band by the designated restack date (31 December 2014).

The ACMA may vary a TLAP, including the date specified for a service to be moved to a new frequency, where it considers it appropriate to do so – for example, if significant technical or engineering issues arose that prevented the restack being completed by broadcasters by 31 December 2014 in a particular area. If this occurred, the ACMA would need to balance the rights of parties who have acquired spectrum licences in the band, with the need to provide broadcasting services to the Australian public in the affected location. Potential interference to incumbent broadcasting receivers would need to be mitigated until these broadcast services are “re-stacked” to channels below 694 MHz.

To allow for a situation in which a TLAP variation is required to enable broadcasting services to continue in a particular location for a specified period, the ACMA proposes that:

* Where a broadcasting service continues to operate in the 694-820 MHz frequency range for a short time after the end of the re-allocation period, deployment of spectrum licensed transmitters will be subject to exclusion zones around the broadcast transmitter where spectrum licensed services cannot be deployed. This will have the effect of separating the spectrum licensed transmitter from broadcast service coverage areas.
* The exclusion zones will be based on the predicted coverage area of a particular broadcast transmitter plus a buffer distance to mitigate interference to a digital television receiver in the coverage area. The ACMA will publish a set of maps identifying the exclusion zones. Spectrum licensees will then need to refer to and comply with these maps when planning the deployment of their services. The number of digital television transmitters operating in the 694 - 820 MHz range will reduce over time as the “restack” progresses and the set of exclusion zone maps would be periodically updated (i.e. reduced) as services are restacked.
* Spectrum licences issued in the band will include a condition preventing the operation of devices other than in accordance with these restrictions.

To ensure that each individual spectrum licensee is equally treated regardless of their particular spectrum allocation, where any single UHF channel in the range 52 to 69 remains in use by an incumbent broadcast service in an area defined by an exclusion zone map, no spectrum licensed service may be deployed by a spectrum licensee in any part of the 700 MHz band.

***It is recommended that:***

***- a set of maps identifying exclusion zones around DTV broadcast transmitters that operate after the end of the re-allocation period be published on the ACMA website (that set of exclusion zone maps would be periodically updated (i.e. reduced) as services are progressively restacked out of the digital dividend range);***

***- spectrum licensees will be required by a licence condition to refer to and comply with these maps when planning services in the 700 MHz band; and***

***- where any single UHF broadcast channel in the channel 52 - 69 range is in use, no service may be deployed by a spectrum licensee in any part of the 700 MHz band within an area defined by the relevant exclusion zone map for reasons of equitable access.***

\* Comment is sought on the preferred electronic format for maps or overlays.

## 6. Managing Interference to 700 MHz Spectrum Licensed Receivers

The following sections outline proposals for the management of interference to 700 MHz band receivers in the following adjacent band scenarios.

### 6.1 Wireless Microphone transmitters

Wireless microphones[[3]](#footnote-3) are permitted to operate in the 520-820 MHz band in accordance with the LIPD Class Licence. A user of a wireless microphone device authorised by this class licence must adhere to the stated conditions therein and must not cause interference to other radiocommunications services in the band.

Wireless microphones will not be permitted to operate in the digital dividend after the end of the reallocation period of 31 December 2014. However it is proposed that they be permitted to continue to be operated in the 520-694 MHz frequency range under similar conditions specified in the LIPD Class Licence. The LIPD Class Licence will be updated to reflect these new arrangements.

Frequencies adjacent to the 700 MHz upper and lower bands may also be considered for use by class licence devices. Arrangements will be developed in consultation with stakeholders as necessary.

### 6.2 Digital Television Apparatus Licensed transmitters

Digital television transmitters will operate in the 520 - 694 MHz band. There is a potential for interference from these television transmitters to spectrum licensed receivers in the 703-748 MHz lower band. The ACMA does not intend to develop coordination procedures to cater for this scenario as it considers that spectrum licensees are best placed to determine and implement appropriate mitigation techniques to address any potential interference cases. Mitigation options could include use of receive filters, adjustment of antennas including antenna tilt and siting with consideration of broadcast transmitter locations

### 6.3 Incumbent Broadcast Transmitters

As discussed in the preceding sections, some broadcast transmitters may continue to operate on television channels in the digital dividend after the end of the re-allocation period. Where a broadcasting service continues to operate in the 694 – 820 MHz frequency range, there is potential for interference from digital television transmitters to radiocommunications receivers operating in either the 700 MHz lower band or the 700 MHz upper band.

It is proposed that the ACMA publish a set of coordination maps showing exclusion zones required for the protection of digital television receivers. These maps and information on currently operating digital television transmitters will be made available on the ACMA website.

The exclusion zone maps will not however define the separation distance required to protect spectrum licensed receivers. It is expected that spectrum licensees will be able to use the data on operating digital television services to determine an appropriate separation distance to mitigate potential interference to receivers operating under their spectrum licence(s).

***It is recommended that:***

***700 MHz band spectrum licensees should undertake their own compatibility checks to determine and implement appropriate mitigation strategies to address any potential interference from digital television transmitters operating below 694 MHz or in the digital dividend after the end of the re-allocation period.***

### 6.4. Notional Receiver Performance Level

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:

* an adjacent channel selectivity;
* a wideband blocking level;
* a wideband intermodulation rejection level;
* a receiver spurious rejection level;
* a notional RF selectivity; and,
* a notional antenna characteristic.

Each of these requirements are specified in the following sections.

#### 6.4.1 Adjacent Channel Selectivity (ACS)

Adjacent channel selectivity is a measure of a receiver’s ability to receive a wanted signal on it assigned channel due to the presence of an unwanted adjacent channel signal.

Recommended ACS values for 700 MHz band receivers are given in Table A. These requirements have been derived on the basis of protecting adjacent channels.

|  |  |
| --- | --- |
| **Table A Adjacent Channel Selectivity Requirements #** | |
| **Channel Bandwidth (MHz)** | **Relative ACS (dB)** |
| 5 | 46.0 |
| >5 | 42.0 |
|  | |

# These ACS values are defined at the antenna connector port of the receiver, or in the case where additional devices such as filters and amplifiers are installed in the signal path ahead of the receiver, then the values are defined at the outermost antenna connector port.

***It is recommended that:***

***the adjacent channel selectivity performance for a receiver operating in the 703-748 MHz band be equal to or better than that set out in Table A.***

#### 6.4.2 Receiver Blocking

Receiver blocking is a measure of the ability of a receiver to receive wanted signal in the presence of a high level unwanted interferer on frequencies other than those of the adjacent channels. Receiver blocking attenuation varies to some degree depending on the frequency offset of the unwanted signal and the type of unwanted signal.

Recommended receiver blocking requirements for 700 MHz band receivers specified for a wideband 5 MHz channel are given in Table B.

|  |  |
| --- | --- |
| **Table B Receiver Blocking Levels #** | |
| **For interfering signals within this range** | **Relative Blocking Requirements (dB)** |
| 1 MHz to 683 MHz | 85.0 |
| 683 MHz to 768 MHz | 55.0 |
| 768 MHz to 12750 MHz | 85.0 |
|  | |

# These Receiver Blocking values are defined at the antenna connector port of the receiver, or in the case of additional devices such as filters and amplifiers installed in the signal path ahead of the receiver, then the values are defined at the outermost antenna connector port.

***It is recommended that:***

***the wideband receiver blocking performance for a receiver operating in the 703-748 MHz band be equal to or better than that set out in Table B.***

#### 6.4.3 Receiver Intermodulation Rejection

Receiver intermodulation rejection is a measure of a receiver’s ability to receive a wanted signal on its assigned channel frequency in the presence of interference due to the intermodulation products of two or more unwanted signals at frequency offsets and amplitudes that form a specific relationship to the wanted signal.

The intermodulation rejection requirement for spectrum licensed receivers in the 700 MHz band has been determined by considering, firstly;

* unwanted signals from out-of-band base station transmitters that arrive at the base station receiver in question and generate intermodulation products located at near offsets to the wanted base station receiver passband; and secondly,
* unwanted signals from in-band mobile station transmitters that arrive at the base station receiver in question and generate intermodulation products located at near offsets to the wanted base station receiver passband.

Intermodulation rejection requirements for 700 MHz band licensed receivers are given in Table C. The blocking or interfering signal in this case is assumed to a wideband carrier.

|  |  |
| --- | --- |
| **Table C Intermodulation Rejection Requirements for 700 MHz Receivers #** | |
| **Frequency Offset outside the Wanted Channel Edge (MHz)** | **Intermodulation Rejection Requirement (dB)** |
| 2.5 | 50.0 |
| 7.5 | 50.0 |
| 12.5 | 54.0 |
| 17.5 | 54.0 |
| 22.5 | 80.0 |
|  | |

# The intermodulation products most likely to affect a receiver are the third-order intermodulation products 2\*f1-f2 and 2\*f2-f1, so the frequency offsets have been set to account for these intermodulation products.

***It is recommended that:***

***the wideband intermodulation rejection requirements for a receiver operating in the 703-748 MHz band be equal to or better than that set out in Table C.***

#### 6.4.4 Spurious Rejection Response

Spurious rejection response of a receiver is the ability of a receiver to receive its assigned wanted channel frequency in the presence of unwanted signals that form intermodulation products, mixing signals within the receiver and have the potential to degrade receiver performance by appearing in the IF passband.

There are multiple potential combinations of signals that could mix with the local oscillator within a receiver to produce spurious interferers within the intermediate frequency passband. These combinations include unwanted signals that appear at the front-end of the receiver as either an image frequency of the wanted channel, a transmit leakage signal or any other unwanted frequency signal such as adjacent channel signals and blocking signals.

The spurious response rejection is specific to the architecture of a receiver and the quality of its components. For receivers with traditional superheterodyne architectures a receiver which has an improved ability to reduce spurious signal interference has the following characteristics.

* Suitable radiofrequency filtering at the front-end to attenuate unwanted signals before they reach the amplification and mixing stages. This should be combined with use of a radiofrequency image filter to attenuation image frequencies.
* Use of good quality amplifiers and mixers with minimal non-linear characteristics and leakage.
* Use of image signal rejection mixers which use phase cancellation to reduce the presence of image signal interference.
* Use of intermediate frequency (IF) filters with steep attenuation outside the IF passband.

***It is recommended that:***

***the spurious response rejection of a receiver operating in the 703-748 MHz band should be equal to or better than 65 dB.***

#### 6.4.5 Notional RF Selectivity

A notional RF selectivity is proposed for use by base station receivers in the 703-748 MHz band, to provide additional protection from adjacent channel emissions and to reduce the potential for out-of-band interference.

Some good filters available on the market can produce significant attenuation (up to 40 dB) within 1 MHz of the band edge and should not have difficulty in achieving this notional mask. Substantial attenuation is required at the mask floor to reduce emissions from higher powered transmitters that operate beyond the guard band below 694 MHz. It is considered that this floor attenuation should be achievable for the corresponding frequency offset from the band edge of a receiver in the 703 – 748 MHz range.

***It is recommended that:***

***the above notional RF selectivity be achieved or exceeded in spectrum licensed receivers.***

#### 6.4.6 Notional Antenna and Feeder Requirements

The notional antenna characteristics for base receivers operating on the 700 MHz band are a gain of 15.7 dBi and a feeder loss of 3 dB.

### 6.5 Compatibility Requirement

The compatibility requirement sets basic levels for compatibility between adjacent band transmitters and spectrum licensed receivers. This requirement protects 700 MHz base station receivers to current IMT uplink performance standards. Thus, it ensures that the presence of a registered adjacent band transmitter does not adversely affect the performance of a spectrum licensed receiver.

The compatibility requirement is stated as:

* + a wanted to unwanted ratio of 24 dB for 99.99% annual availability, and
  + a minimum wanted signal of -83 dBm/5MHz corresponding to a bit error rate of 0.001.

The W/UW ratio here provides sufficient protection for higher order modulation schemes used over the air interface of modern mobile technologies and is derived from generic bit error probability curves for these modulations. The wanted level is the minimum signal required at a spectrum licensed base station in order to receive a signal from a mobile station for the stated BER of 0.001 from standard bit error probability curves. The wanted signal level includes a 1dB noise rise (receiver threshold degradation) and results in a maximum interfering signal at –6 dB below the noise floor.

For bandwidths other than 5 MHz a correction factor of 10\*log10(BW(MHz)/5) dB should be applied.

The compatibility requirement may be applied for the protection of spectrum licensed fixed receivers that:

* + meet the Notional Receiver Performance Level,
  + have been are registered in the Register of Radiocommunications Licences (RRL),
  + operate in the lower band (703-748 MHz) with a height greater than 20 m, or operate in the upper band (758-803 MHz) with a height less than 10 m.

***It is recommended that:***

***the Compatibility Requirements for receivers operating in the 703-748 MHz band will provide a wanted to unwanted ratio of 24 dB for an annual availability of 99.99% where the minimum wanted signal level is set to -83 dBm/5MHz corresponding to a BER of 0.001.***

***The Compatibility Requirement has been based on a 5 MHz channel, although this can be scaled using a correction factor of 10\*log10(BW(MHz)/5) dB*** ***for other bandwidths.***

1. Wireless microphones are covered by the category for Wireless Audio Transmitters in the LIPD Class Licence. [↑](#footnote-ref-1)
2. This equates to three TV channels below the 694 MHz boundary, equivalent to a 30 MHz separation from the lower edge of the spectrum licence frequency boundary. [↑](#footnote-ref-2)
3. Wireless microphones are covered by the category for Wireless Audio Transmitters in the LIPD Class Licence. [↑](#footnote-ref-3)