Australian Government

Australian Communications and Media Authority

FREQUENCY ASSIGNMENT REQUIREMENTS FOR THE LAND MOBILE SERVICE

Radiocommunications Assignment and Licensing Instruction

RALI: LM 08

DATE OF EFFECT: 17 MAY 2024

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Amendment history

Date	Comments
2 April 1997	New RALI
3 July 1997	Updated to incorporate requirements for 800 MHz trunked land mobile radio systems and digitally modulated land mobile radio systems.
6 April 1998	Updated to incorporate requirements for 400 MHz land mobile radio systems including low powered land mobile radio systems.
4 December 2000	Updated to clarify existing policy on assignment of high power (83 W EIRP) and low power (8.3 W EIRP) single frequency land mobile radio systems.
11 June 2015	Annex C: Frequency-distance constraints update following public consultation. See IFC 42/2014.
September 2015	Arrangements for supplementary transmitter (section 5.3), height/power restriction base stations (5.6), intermodulation (section 6.5) and local environment (section 6.8) updated as part of completion of IFC42/2014 process.
1 July 2016	Sections 6.9 and 6.10 added to accommodate Harmonised Government Spectrum Area licensing arrangements.
11 Jul 2016	Simplified and clarified the process for Harmonised Government Spectrum Area licensing
21 October 2019	Introduction of new arrangements for enclosed and short-range digital low power services. See IFC 35/2018.
1 July 2020	Update to arrangements for 800 MHz band trunking. See IFC 12/2020.
17 May 2024	Updates to remove arrangements for the legacy land mobile segment (820-825/865-870 MHz) and to include additional criteria and guidance for coordination with spectrum licensed services.

Suggestions for improvements to Radiocommunications Assignment and Licensing Instruction LM 08 may be addressed to:

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

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

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

Contents

1 Introduction

1.0 Purpose

The purpose of this Radiocommunications Assignment and Licensing Instruction (RALI) is to provide advice on frequency assignment policy and coordination procedures for single and two frequency land mobile systems employing angle and digital modulation methods.

This RALI replaces RALI LM 8, dated 1 July 2020.

The information in this document reflects the Australian Communications and Media Authority's statement of current policy in relation to frequency assignment requirements for the land mobile service in the VHF, 400 MHz and 800 MHz bands. In making decisions, the Australian Communications and Media Authority (ACMA) and accredited frequency assigners should take all relevant factors into account and decide each case on its merits.

Issues relating to this document that appear to fall outside the enunciated policy should be referred to:

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

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

2 Scope

This RALI currently applies to angle and digital modulated:

> single and two frequency systems in the 400 MHz band[1] and the VHF Mid and High bands[2] using 6.25[3], 12.5 and 25 kHz[4] channelling; and
> 800 MHz trunked systems[5] using 12.5 and 25 kHz channelling.

[1] The 400 MHz band (403 to 520 MHz) is defined in RALI MS 22 [4].

[2] These frequency bands are defined in RALI MS 42 “Frequency Plan for the VHF Bands (70-87.5 MHz and 148-174 MHz)”.

[3] 6.25 kHz channelling is applicable in the 400 MHz and VHF High bands.

[4] When assigning 25 kHz systems in the 400 MHz band all transitional arrangements and limitation set out in RALI MS 22 [4] must be adhered to.

[5] The frequency band for the 800 MHz trunked land mobile service is defined in RALI MS 40 “Frequency Plan for Services in the 800 MHz Band (803–890 MHz)”.

3 Service Description

Radiocommunications systems operating in the land-mobile service (LMS) are typically used to communicate information between a controlling station and vehicular mobile or personal stations often for, but not limited to, the purposes of dispatch activities related to the performance of a business or other organisational activity.

In the case of two frequency systems, communication usually occurs between a remote control station (RCS) and mobile stations via a centrally located land station (often referred to as a ‘base’ station or repeater) which is located at a high site in order to serve the surrounding area. The base station receives transmissions on its ‘base receive’ frequency from the RCS or any mobile within the notional service area and subsequently repeats those transmissions on its ‘base transmit’ frequency for reception by any other mobile (or the RCS) within the notional service area.

In single frequency systems, the controlling station typically is the ‘base’ station and is at the centre of the notional service area, although in some cases the controlling station is linked (sometimes by land line) to a ‘base’ station at a high site. All communications occur on the one frequency.

Trunked land mobile systems (TLMS) are functionally similar to the two frequency non-trunked systems described above. However, in a trunked system, a group of channels at the base station site is time-shared between a large number of users so that the channels can be used more efficiently.

Low-power land mobile radio systems (LPMRS) are functionally similar to the systems described above but have a much smaller coverage area. They are located primarily in high-density areas and have greater frequency re-use. LPMRS are typically used to service small areas and can also be used in crane assistance and ambulatory applications.

Enclosed and short-range digital land mobile systems utilise low powers and are intended for use within either an enclosed site (such as a stadium or building) or use digital radio technology to cover a very localised area. They have greater frequency reuse than LPMRS due to their lower maximum EIRP, shielding provided by the enclosed environment they operate within or the additional interference protection provided by a digital system. However, interference protection is not provided to the same base station sensitivity level as LMRS and LPMRS due to the variability of site shielding, local clutter impacts and antenna limitations.

From an interference management perspective, an LMS has the following characteristics:

> it has a central fixed land station (generally referred to as a base station); in practice this is the controlling station in a single frequency system and the repeater in a two frequency system, and is commonly located at a high site;
> the base station serves a number of mobile/personal mobile stations, distributed randomly throughout the service area;
> in the case of a two frequency system, the controlling station (RCS) is treated as a ‘fixed mobile’ in the service area; and
> communication occurs mostly between mobiles and the controlling station (via a repeater in a two frequency system) although, in some cases, direct mobile-to-mobile or personal mobile-to-personal mobile communication may occur.

4 Service Model

The purpose of the service model is to define a set of characteristics for the LMS that will result in a specified ‘target’ grade of service for land mobile systems. There are three service models defined; one for large coverage applications (LMRS), one for small coverage applications (LPMRS) and one for localised coverage applications (enclosed and short-range digital).

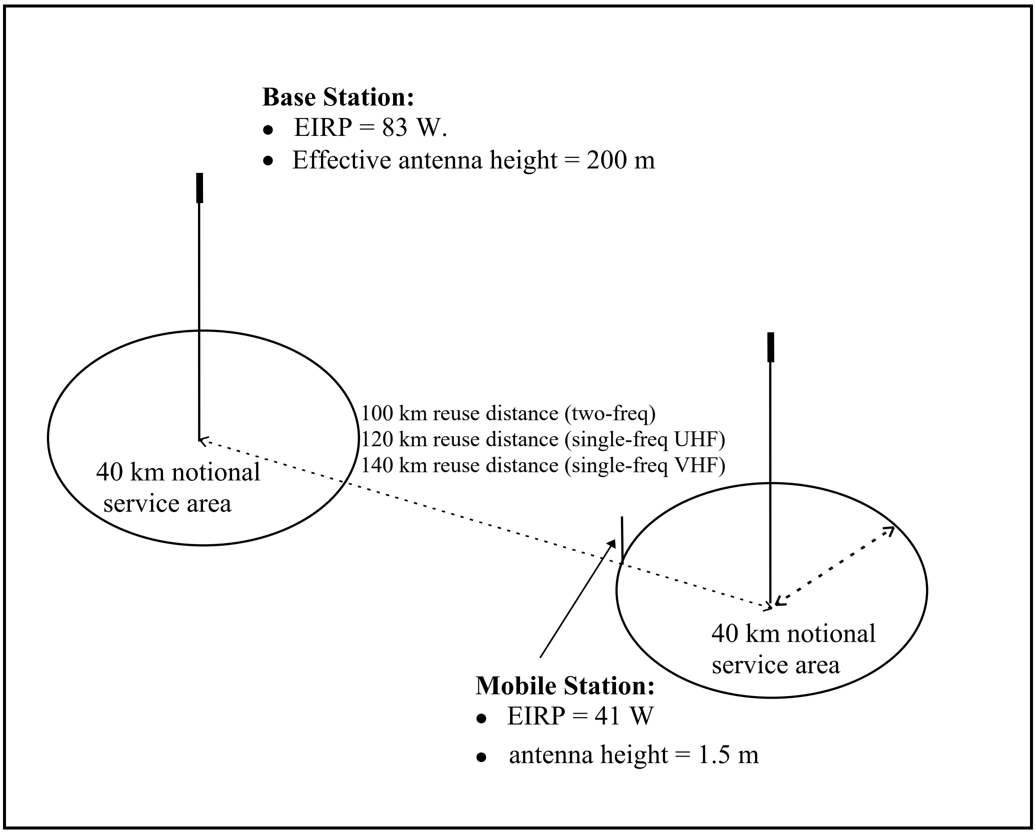
The target grade of service (TGS) is defined as a signal quality of 12 dB SINAD[6] for voice systems or a bit error rate of 10^{-2} for data systems at the receiver output for a 5 dB ratio of wanted to unwanted signals at the receiver RF input terminal. The model defines values for a set of parameters (at the inter-system, intra-system and equipment levels) that, when satisfied, will on average achieve the TGS for LMS receivers at 90% of locations within the notional service area of a land mobile system. The TGS is consider aspirational as LM 8 is based on a generic model and that whilst it references these performance parameters, due to simplification made to cater for the different technologies, availability parameters of 50% are used (in determining path loss in frequency distance constraints).

Sections 5 and 6 of this RALI detail the frequency assignment policy and coordination procedures for land mobile systems which use, as their basis, the service model as described in this section.

[6] SINAD - the ratio of (signal + noise + distortion) to (noise + distortion).

4.1 LMRS Service Model Description

Figure 1 LMRS Service Model



Key features of the service model are:

> the radiated power is limited to an equivalent isotropically radiated power (EIRP) for all stations as follows;
  > 83 watts (W) for base stations (e.g. 50 W into a 2.15 dBi dipole antenna);
  > 41 W for mobile stations (e.g. 25 W into a 2.15 dBi $\lambda/4$ monopole antenna);
  > 41 W for supplementary transmitters (e.g. 25 W into a 2.15 dBi $\lambda/4$ monopole antenna);
  > 20 W for RCSs (e.g. 1 W into a 13 dBi yagi antenna);
  > 8.3 W for personal mobile stations (e.g. 5 W into a 2.15 dBi $\lambda/4$ monopole antenna);

> an assumed base station effective antenna height of 200 metres above surrounding terrain and a mobile antenna height of 1.5 metres above ground level[7];

> assumed receiver usable sensitivity levels (refer to Annex D, Table D4, of this RALI);

> the use of a modified Longley-Rice model (base-to-base) and the modified Hata model (base-to-mobile) for propagation loss calculations associated with frequency-distance constraints (refer to Annex A of this RALI);

> the use of free space loss plus 10 dB for intermodulation propagation loss calculations associated with cull distances for intermodulation checks;

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[7] Base station antenna height is height above ground, which may include building height and tower height if the antenna is mounted atop a building.

> a notional service area radius of 40 km;
> a notional antenna for base station receivers, assumed to be a vertically polarised dipole array with a maximum antenna gain in any direction of 2 dBi at VHF and 6 dBi at UHF (Note that these figures include cable and combiner loss, but exclude cavity filter loss);
> a co-channel re-use distance of 140 km between VHF single frequency base stations, 120 km between UHF single frequency base stations and 100 km between two-frequency base stations;
> frequency coordination that is performed for base and supplementary stations only (specific levels of protection for mobiles and RCSs are intrinsic to the service model);
> assumed maximum levels of spurious emissions, including broadband noise radiated from a transmitter;
> an assumed receiver blocking performance of 90 dB above the receiver usable sensitivity levels specified in Annex D, Table D3, of this RALI;
> an assumption that additional RF selectivity, equivalent to that achieved by two 6-inch cavity filters, is installed on base station receivers, to reduce their susceptibility to interference from site-based intermodulation products (refer to Annex D, Table D3, of this RALI)[8];
> a limit on RCS transmitter output power to a maximum of 1 watt, which requires that a directional antenna be used to achieve the EIRP limit referred to above. The model presumes that the EIRP is limited to the minimum necessary to achieve a signal level 15 dB above the base station receiver's minimum usable sensitivity level at its input terminal. These limits minimise the potential for interference between the RCS and adjacent services;
> specific requirements for RCSs to minimise their potential for causing intermodulation interference in areas having a relatively high concentration of transmitters and receivers. The model presumes the following requirements for RCSs located in central business districts:
  > the height of an RCS antenna does not exceed 30 metres above ground level; and
  > a 20 dB in-line attenuator[9] is fitted between the output of an RCS transmitter and its associated antenna;
> the assumption that services are co-sited when they are located within 200 metres of each other;
> the inclusion of co-channelled transmitters (supplementary transmitters) to improve the service reliability within, but not outside, the notional service area; and
> the assumption that 800 MHz trunked equipment is approved to Federal Communications Commission (FCC) Rules Part 90.

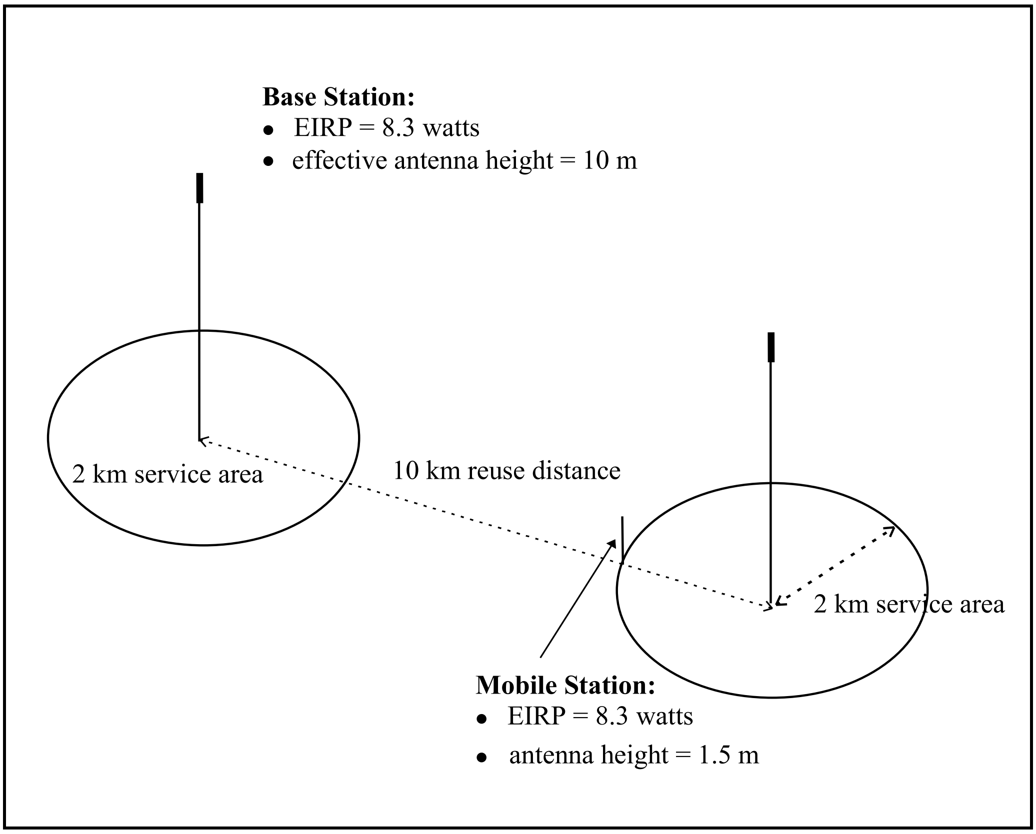
Note that during an interference investigation, one of the factors the ACMA may take into account is whether equipment is being operated in accordance with these parameters. Services that are not consistent with these models may not be afforded protection from interference from licenced radiocommunications and might be required to take interference remediation measures (for example adjust antenna height). See Annex C for more details

[8] Cavity loss is assumed to be 2 dB

[9] The model allows for the use of other devices such as isolators or feed-forward amplifiers which give intermodulation performance equivalent to or better than that achieved by a 20 dB in-line attenuator.

4.2 LPMRS Service Model Description

Figure 2 LPMRS Service Model



Key features of the LPMRS service model are:

- the radiated power is limited to an EIRP for all stations as follows;
  - 8.3 W for base stations (e.g. 5 W into a 2.15 dBi dipole antenna);
  - 8.3 W for mobile stations (e.g. 5 W into a 2.15 dBi $\lambda/4$ monopole antenna);
  - 8.3 W for personal mobile stations (e.g. 5 W into a 2.15 dBi $\lambda/4$ monopole antenna);
- base station effective antenna height of 10 metres above surrounding terrain (includes any building height) and a mobile antenna height of 1.5 metres above ground level. Interference protection cannot be provided for systems deviating significantly from this effective height assumption;
- assumed receiver usable sensitivity levels (refer to Annex D, Table D4, of this RALI);
- the use of the modified Hata model for base-to-base and base-to-mobile propagation loss calculations associated with frequency-distance constraints (refer to Annex A of this RALI);
- the use of free space loss plus 10 dB for intermodulation propagation loss calculations associated with cull distances for intermodulation checks;
- a notional service area radius of 2 km;
- a notional antenna for base station receivers, assumed to be a vertically polarised dipole array with a maximum antenna gain in any direction of 2 dBi at VHF or 6 dBi at UHF (Note that these figures include cable and combiner loss, but exclude cavity filter loss);
- a co-channel re-use distance of 10 km between base stations;

- frequency coordination that is performed for base stations only (specific levels of protection for mobiles and RCSs are intrinsic to the service model);
- assumed maximum levels of spurious emissions, including broadband noise radiated from a transmitter;
- an assumed receiver blocking performance of 90 dB above the receiver sensitivity levels specified in Annex D, Table D3, of this RALI;
- an assumption that additional RF selectivity, equivalent to that achieved by two 6 inch cavity filters, is installed on base station receivers to reduce their susceptibility to interference from site-based intermodulation products;
- the assumption that services are co-sited when they are located within 200 metres of each other; and
- specific requirements for tower crane control applications using LPMRS. The transmitter output power is assumed to be a maximum of 1 watt. The crane antenna is assumed to have a maximum beam width of 80 degrees with down tilt.

Note that during an interference investigation, one of the factors the ACMA may take into account is whether equipment is being operated in accordance with these parameters. Services that are not consistent with these models may not be afforded protection from interference from licenced radiocommunications and might be required to take interference remediation measures (for example adjust antenna height). See Annex C for more details.

4.3 Enclosed and Short-range Digital Service Model Description

The enclosed and short-range digital low power models have characteristics that are common to both applications and characteristics that are unique to each model.

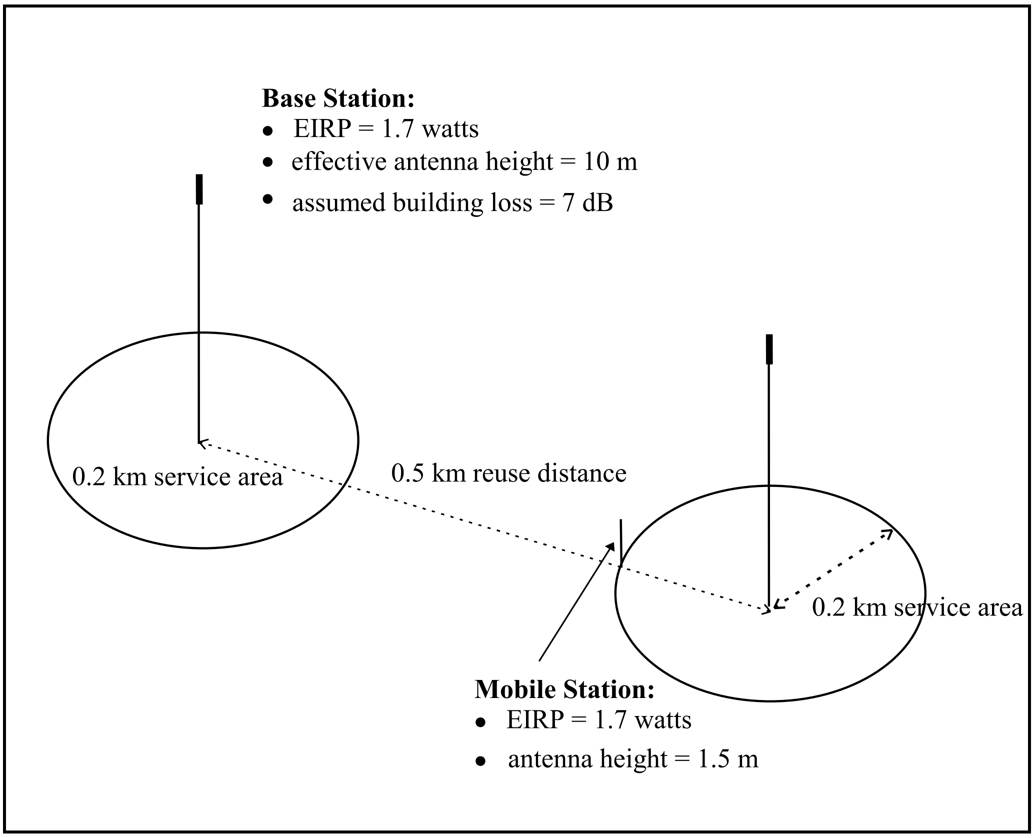
Common features of the enclosed and short-range digital low power model are:

- the radiated power is limited to a maximum EIRP for all stations as follows;
  - 1.7 W for base stations (e.g. 1 W into a 2.15 dBi dipole antenna)
  - 1.7 W for personal mobile stations (e.g. 1 W into a 2.15 dBi $\lambda/4$ monopole antenna);
- base station effective antenna height of 10 metres above surrounding terrain (includes any building height) and a mobile antenna height of 1.5 metres above ground level. Interference protection cannot be provided for systems deviating significantly from this effective height assumption;
- intermodulation checks are not carried out;
- frequency coordination is limited to co-channel base station minimum separation distances (specific levels of protection are not provided);
- assumed maximum levels of spurious emissions, including broadband noise radiated from a transmitter;
- an assumed receiver blocking performance of 90 dB above the receiver sensitivity levels specified in Annex D, Table D4, of this RALI;
- these services are not suitable for crane use due to their tight geographical frequency re-use; and
- the assumption that services are co-sited when they are located within 200 metres of each other.

Enclosed specific features

> the base station antenna must be located indoors or within the roof line of an enclosure with walls all around and no higher than 10 m above ground level (eg. within a building, warehouse or fully enclosed stadium - roof optional) or leaky feeders at any height including above 10m (eg. High rise building);
> assumed building penetration loss is 7 dB or more;
> assumed interference threshold is -96 dBm;
> a notional service area radius of 0.2 km about the station coordinates;
> a co-channel reuse distance of 0.5 km applies between base stations;
> Analog systems should deploy Continuous Tone Controlled Signalling System (CTCSS), Digitally Coded Squelch Signalling (DCSS) or similar in-band signalling.
> The following special condition is to be applied to the licence:
  > LM06: This service is to be coordinated as an enclosed service.

Figure 3 Enclosed Service Model

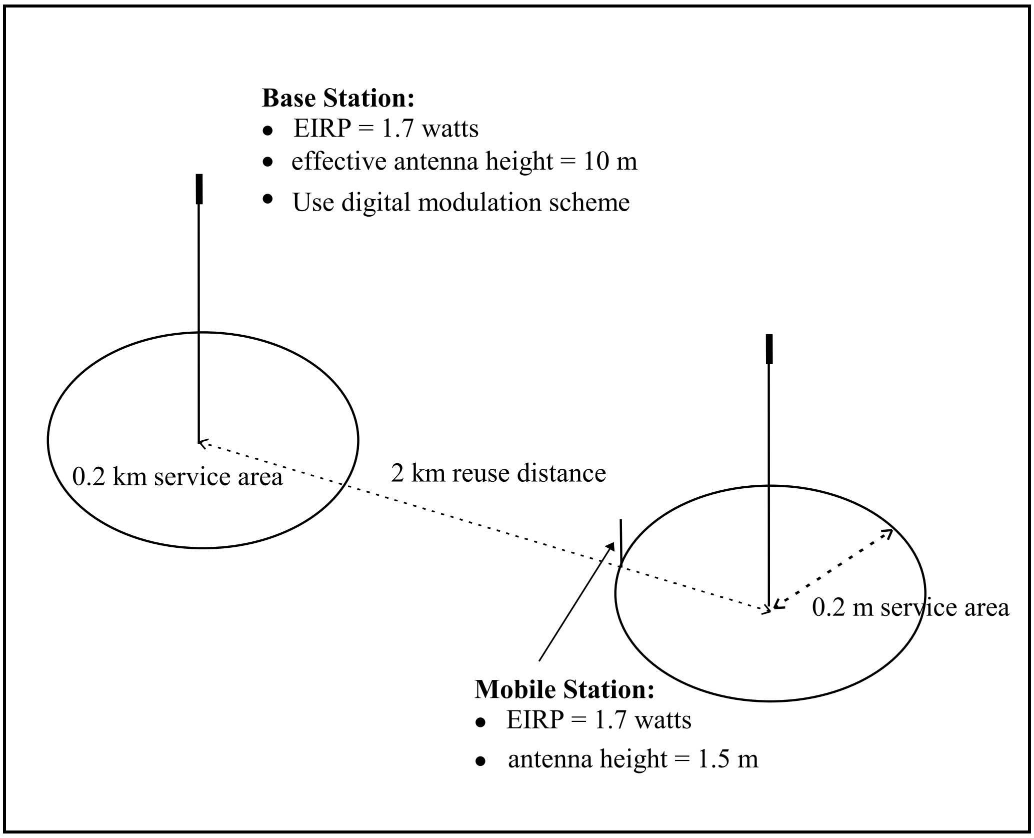


Note that during an interference investigation, one of the factors the ACMA may take into account is whether equipment is being operated in accordance with these parameters. Services that are not consistent with these parameters may not be afforded protection from interference from licenced radiocommunications and might be required to take interference remediation measures (for example adjust antenna height). See Annex C for more details.

Short-range Digital specific features

> Intend to support digital mobile radio systems such as ETSI TETRA, APCO P25, ETSI DMR or other similar digital standards;
> a notional service area radius of 200 m about the station coordinates;
> a co-channel reuse distance of 2 km applies between base stations;
> assumed interference threshold is -112 dBm;
> The following special condition is to be applied to the licence:
>> LM05: This service is to be coordinated as a Short-range Digital service

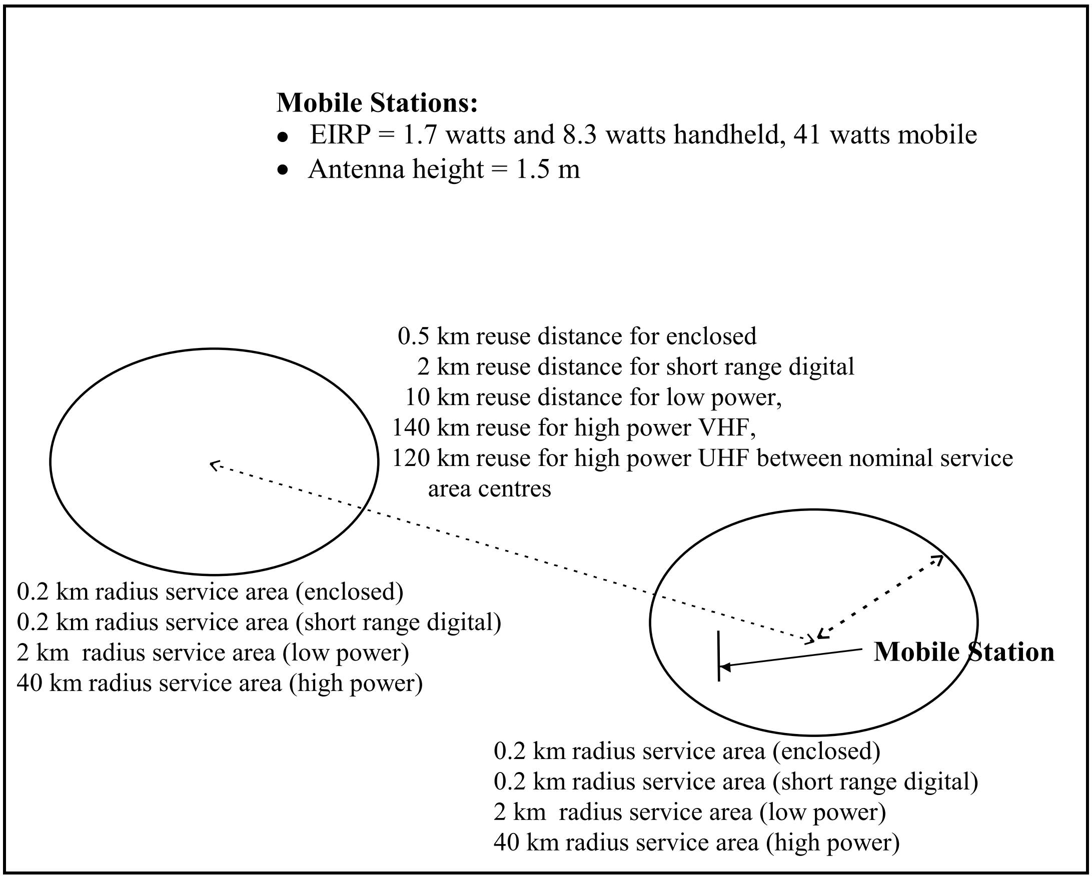
Figure 4 Short-range Digital Service Model



Note that during an interference investigation, one of the factors the ACMA may take into account is whether equipment is being operated in accordance with these parameters. Services that are not consistent with these parameters may not be afforded protection from interference from licenced radiocommunications and might be required to take interference remediation measures (for example adjust antenna height). See Annex C for more details.

4.4 Sited Ambulatory Service Model Description

Figure 5 Sited Ambulatory Service Model



Key features of the sited ambulatory service model are:

> for enclosed and short-range digital systems, the radiated power is limited to an EIRP of 1.7 W for personal mobile stations (e.g. 1 W into a 2.15 dBi λ/4monopole antenna)

> for a low power system the radiated power is limited to an EIRP of 8.3 W for personal mobile stations (e.g. 5 W into a 2.15 dBi λ/4 monopole antenna)

> for a high power system the radiated power is limited to an EIRP of 41 Watts EIRP for mobile stations (e.g. 25 W into a 2.15 dBi λ/4 monopole antenna);

> stations are assumed to be operating at or close to ground level: i.e. the effective antenna height is 1.5 metres above ground level (interference protection cannot be provided for systems deviating significantly from this effective height assumption);

> assumed receiver usable sensitivity levels (refer to Annex D, Table D4, of this RALI);

> intermodulation checks are not carried out;

> a notional service area radius of 0.2 km centred on the notional service area centre for an enclosed and short-range digital system;

> a notional service area radius of 2 km centred on the notional service area centre for a low power system;

> a notional service area radius of 40 km centred on the notional service area centre for a high power system;

- a co-channel re-use distance of 0.5 km between service areas for enclosed systems;
- a co-channel re-use distance of 2 km between service areas for short-range digital systems;
- a co-channel re-use distance of 10 km between service areas for low power systems;
- a co-channel re-use distance of 120 or 140 km (for UHF and VHF respectively) between service areas for high power systems;
- assumed maximum levels of spurious emissions, including broadband noise radiated from a transmitter;
- an assumed receiver blocking performance of 90 dB above the receiver sensitivity levels specified in Annex D, Table D3, of this RALI;

Note that during an interference investigation, one of the factors the ACMA may take into account is whether equipment is being operated in accordance with these parameters. Services that are not consistent with these models may not be afforded protection from interference from licenced radiocommunications and might be required to take interference remediation measures (for example adjust antenna height). See Annex C for more details.

5 Frequency Assignment Policy

Frequency assignment must take into consideration both *inter-service* and *intra-service* requirements consistent with the application of good engineering practice. Consideration should be given also to the issue of spectrum denial at and around popular (prime) radiocommunications sites[10].

Successful management of interference in the LMS requires that all stations operating in the service (mobile, base and RCS) comply with specific technical constraints.

Intra-service constraints form an essential element of the service model upon which frequency assignment requirements are based, and are detailed in the following paragraphs. The intra-service frequency coordination procedure is also part of this policy framework and is outlined in section 6 of this RALI.

Inter-service coordination of land-mobile services with other radiocommunications services are addressed, in some cases, by specific RALIs. Annex E lists inter-service coordination requirements prepared by the ACMA. In other cases, ITU-R Recommendations may exist. However, because of the diversity and complexity of sharing situations which may arise, it is not possible to provide rigorous and explicit procedures covering all inter-service coordination requirements. In these cases, coordination should be performed in accordance with good engineering practice based on fundamental interference mitigation principles.

For additional information on assigning services in harmonised government spectrum in the 400 MHz, please refer to Frequency assignment practice, Guideline No. 4 — assigning harmonised government spectrum (HGS) in the 400 MHz band.

5.1 Spectrum and Channelling Arrangements

Spectrum and channelling arrangements are specified in the band plans referenced at section 2 of this RALI. Trunked systems may operate in ‘non-trunked’ two-frequency spectrum; however spectrum allocated in the relevant band plans for trunking should not be assigned to non-trunked systems.

As well as complying with the channelling arrangements specified in the relevant band plans, assignments to a TLMS at any given site should be in accordance with the Block and Group arrangements tabulated at Annex B of this RALI. These arrangements have been established to minimise the occurrence of site-based intermodulation interference.

5.1.1 Implementation of the 803–960 MHz review

In November 2015, the ACMA completed its review of arrangements in the 803–960 MHz band (the Review) and released the decision paper: *The ACMA’s long-term strategy for the 803–960 MHz band* (the 803–960 MHz review decision paper). The decision paper outlines the implementation of new arrangements in the band which will be completed by June 2024.

[10] Spectrum Planning report 25/92 “Furthering Productivity of Prime Sites – Advice to Site Managers” contains useful information that is relevant to the issue of spectrum denial at and around popular radiocommunications sites.

With regard to TLMS services, the legacy allocation (820–825/865–870 MHz) was removed on 30 June 2023[11] and has been replaced by a new allocation at 806–809/851–854 MHz.

5.2 Assignment Strategy

The procedure for assigning land mobile base station frequencies is based on a strategy of horizontal loading and maximum isolation between assigned services. Under this strategy, frequencies that pass interference checks by the greatest margin are assigned. This approach maximises the isolation between systems which typically achieve a grade of service well in excess of the TGS; the actual grade of service and reliability will reduce, over time, towards the TGS as the spectrum becomes more congested.

5.3 Supplementary Transmitters

A supplementary transmitter is a transmitter intended to improve the service reliability within a 40 km radius of the 'parent' base station. A supplementary transmitter does not require frequency coordination and as such no protection is provided to the supplementary receiver. Like mobile receivers, an inherent level of protection is provided through coordination of the parent base station.

It is recommended that checks to identify and mitigate against intermodulation issues should be carried out.

Conditions of operation of supplementary base stations are contained in the *Radiocommunications Licence Conditions (Land Mobile Licence) Determination* and include that the operator:

(a) must not operate the station if its operation causes harmful interference to a service provided by another station;

(b must only operate the station to transmit using the transmit frequencies specified in the licence for the system's base station;

(c) must only operate the station to improve the service reliability within a radius of 40 kilometres of the system's base station;

(d) must not operate the station to extend the service area of the system's base station beyond 40 kilometres from the base station;

The material below is intended to provide advice about how to assess whether the service area has been extended beyond 40 km from the base station. It is not intended to be a mandatory requirement. Note that the LM 8 planning model (as used in derivation of the frequency distance constraints) assumes that the requirement has been meet.

There are two approaches that can be used to determine whether coverage has been extended beyond 40 km. One is to use the tables provided below, and the other is to use ITU-R P.526 to determine received level at and beyond 40 km service area (as in section 6.8). Under this approach, the level received by a mobile at the edge of the 40 km service area should be compared to that achieved using the methodology used for frequency distance constraints[12].

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[11] See section 3.3 of the decision paper for implementation timeframes.

[12] That is, Hata suburban propagation loss, Tx 83 watts eirp, G_r = 0dBi, H_{base} = 200m, H_{mobile} = 1.5m. Which is is -101.4 dBm at 450 MHz.

Distance/height/power tables for supplementary transmitters

Table 1 Supplementary transmitter power restrictions

Distance (d) from Base:	EIRP
$0 \le d < 10$ km	41 W
$10 \le d < 20$ km	20.5 W
$20 \le d < 30$ km	10 W
$d \ge 30$ km	Supplementary transmitters not permitted

Table 2 Height vs. power restrictions for supplementary transmitters

Height above average terrain:	EIRP Adjustment
≥ 250m	-3 dB
≥ 350 m	-6 dB
≥ 650 m	-10 dB

For example, a supplementary transmitter located 21 km from its base station and at a height of 300 metres would be permitted a maximum EIRP of 5 Watts (10 Watts minus 3 dB is 5 Watts)[13].

5.4 Bi-directional Amplifiers

Bi-directional amplifiers are used as part of a land mobile system to provide coverage within an enclosed area, within the service area of the 'parent' base station. Bi-directional amplifiers operate on a no protection/no interference basis. As defined in the *Radiocommunications Licence Conditions (Land Mobile Licence) Determination* a bi-directional amplifier system can be used with leaky feeder cable and consists of:

> one or more transmitters that transmit on frequencies used by the base station and mobile stations in the land mobile system; or

> one or more receivers that receive on frequencies used by the base station and mobile stations in the land mobile system.

[13] Height above average terrain shall be determined by the procedure defined in ITU Recommendation ITU-R P.1546. A minimum of eight equally spaced radials should be used in the calculation. The online tool at http://www.itu.int/SRTM3/index.html may be used to calculate EFFHGT. A Digital Elevation Model of 9 seconds of arc or better resolution is preferred.

Under the Radiocommunications Act all transmitters are required to be licensed[14]. A bi-directional amplifier is authorised to amplify and retransmit the 'parent' land mobile system's frequencies and bandwidth. For wideband amplifiers this could include the intended channel(s), i.e. the licensed channel of the 'parent' system to be to amplified and adjacent channels as well. In such cases additional filtering might be required to remove unauthorised transmissions, or third party authorisation from the relevant adjacent channel licensee[15].

Bi-directional amplifiers and class licensing

Underground bi-directional amplifier systems that meet the conditions for 'underground transmitters' in the Radiocommunications (Low Interference Potential Devices) Class Licence are authorised to operate under that class licence and the requirements of this RALI do not apply. Wideband amplifiers can be used for underground applications provided they meet the requirements of the Radiocommunications (Low Interference Potential Devices) Class Licence.

5.4.1 Technical requirements of bi-directional amplifiers

The following general technical requirement applies to a bi-directional amplifiers:

> The bi-directional amplifiers system must be located within the service area of the associated 'parent' base station;

> Bi-directional amplifiers can be used within the internal sub-system as part of the signal distribution provided the signals do not radiate externally from the target area. For example they can be used as 'power boosters' along the length of the leaky feeder to maintain RF signal level, provided such amplifiers are not connected to an antenna that radiates externally to the enclosure;

> An operator must not operate a bi-directional amplifier system, or a transmitter that is externally linked to the bi-directional amplifier system, using a power exceeding 1 watt pY;

> For a transmitter that is externally linked to a bi-directional amplifier system:

  > If the transmitter is located in a central business district of a city or town – an operator must fit a device between the transmitter and the antenna to the 'parent' base station that provides intermodulation performance equivalent to, or better than, the intermodulation performance achieved by a 20 dB in-line attenuator;

  > If the transmitter is used for communicating with the base station of the land mobile system – the antenna of the transmitter must be a directional antenna with a minimum gain equivalent to that of a 6 element Yagi antenna.

> Performance of a bi-directional amplifier connecting to the parent' base station must meet the same performance standards of a supplementary base station including all discrete spurious components must be below -30 dBm.

In additional to the above requirements, good engineering practices must be used in regard to the radiation of intermodulation products and noise, such that interference to licensed communications systems is avoided. In the event of harmful interference caused by any given deployment, the ACMA may require additional attenuation or filtering of the emissions and/or noise from bi-directional amplifier, as necessary to eliminate the interference or that the bi-directional amplifier cease operating. While the ACMA does not mandate equipment standards for bi-directional amplifiers, guidance on expected performance can be found in North American and European performance requirement. For example, FCC Rules and Regulations for private

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[14] Under s46 of the Radiocommunications Act it is an offence to operate a radiocommunications devices unless authorised by a spectrum, apparatus or class licence

[15] See Third-party authorisation information on the ACMA website.

land mobile services on use of signal boosters (United States Code of Federal Regulations, Title 47 §90.219) includes deployment rules and device certification requirements.

In Europe, Tetra system BDA's are required to comply with ETSI TS 101 789-1 V1.1.2:2007-04 and utilise wideband amplifiers. BDA's utilising wideband amplifiers must ensure appropriate licences covering the full transmit bandwidth.

5.4.2 Bi-directional Amplifier Licensing Requirements

Operation of a bi-directional amplifier system that meets the requirements specified in this RALI is authorised under the licence for the land mobile system of which it is a part.

The following Special Condition should be applied to the associated 'parent' base station licence:

LT: Bi-directional amplifiers authorised to operate under this licence must not cause interference to the operation of radiocommunications services and will not be afforded protection from interference cause by other radiocommunications services.

5.5 Trunked Systems

5.5.1 VHF High Band Trunking Groups and Sub-segments

The basic trunking assignment unit is the group, which consists of five channels (refer to Annex B1 of this RALI). The 120 channels in each sub-segment are arranged into 12 blocks, each consisting of two groups of five channels. Channels should be assigned at any given site in groups of five, as shown at Annex B1 of this RALI, wherever possible.

Note that the VHF High Band trunking segments are divided into two equal sub-segments, A and B (refer to Annex B1 of this RALI), in order to minimise the potential for site-based interference due to 3rd and 5th order intermodulation products. At any one site, assignments may be made from either sub-segment, A or B, but not both. Sites at which frequencies from different sub-segments are used must be separated by at least 200 metres.

5.5.2 400 MHz Trunking Groups

The basic trunking assignment unit is the group, which consists of five channels (refer to Annex B3 of this RALI). Four groups comprise a block. The 200 channels are arranged into 10 blocks, each consisting of four groups of five channels. Channels should be assigned at any given site in sets of five, as shown at Annex B3 of this RALI, wherever possible.

5.5.3 800 MHz Trunking Groups

The 800 MHz band TLMS frequency segment is 806–809/851–854 MHz.[16] The arrangements in this segment permit both 12.5 kHz and 25 kHz channel spacing. For 12.5 kHz channel spacing, 240 channels are arranged so as to comprise of twelve blocks, each consisting of four groups of five channels as shown in Table B4.1 at Annex B. Table B4.2 in Annex B4 lists the applicable 12.5 kHz channels (1-240).

For 25 kHz channel spacing, the 120 channels are arranged into 6 blocks, each consisting of four groups of five channels. Table B5.2 lists the 25 kHz channels, with channels numbered 1–120.

[16] As explained in section 5.1.1, the legacy 800 MHz TLMS frequency segment (820-825/865-870 MHz) has been removed to support the final stage of the 803–960 MHz review decision paper.

Channels should be assigned at any given site in groups of five, as shown in Tables B4.1 and B5.1 in Annex B of this RALI, wherever possible.

Note: for assignments in the 800 MHz trunking band, the minimum assignment size is one five-channel group, however it is not mandatory to assign only full groups (i.e. assignments are not confined to multiples of five channels) as was the case under previous arrangements.

5.6 Single Frequency Systems

Segments for single frequency assignments are specified in the band plans referenced at section 2 of this RALI.

As noted in the 400 MHz plan (RALI MS22), single frequency segments in the 400 MHz band are intended primarily for the assignment of low power, while not specifically stated in MS22 this includes LPMRS (8.3W EIRP), enclosed and short-range digital (1.7 W EIRP) land mobile services[17]. Assignments to single frequency high power land mobile services may, however, be made in these segments as per RALI MS22.

5.7 Height / Power Restrictions for High Power Services

In order to limit interference to adjacent services, power restrictions shall apply for high power base stations located in high spectrum density areas with heights above average terrain above 450 metres:

Table 3 Height vs. power restrictions for high power services in high density areas

Height above average terrain:	EIRP
≥ 450m	41 Watts
≥ 550 m	20.5 Watts
≥ 650 m	10 Watts

Height above average terrain shall be determined by the procedure defined in ITU Recommendation ITU-R P.1546 [14]. Note that services located at heights above average terrain above 450 metres or more are still considered to be high power services for the purposes of licensing and coordination, even though EIRP is reduced.

As an alternative to this approach the procedure and levels outlined in section 6.8 can be used to determine whether the interference threshold (as specified in section 6.8) would be exceeded, in single frequency systems the base station receiver might also require consideration.

[17] For background information see Spectrum Planning Report SP 2/00, "*Review of the ACA Policy on the Assignment of Single Frequency High Power and Low Power Mobile Services in the 400 MHz Band*".

6 Frequency Coordination Procedure

Frequency coordination is performed only for base stations and supplementary transmitters in the LMS; interference protection for mobiles and RCSs is intrinsic to the service model described in section 4 of this RALI. Ambulatory systems requiring coordination are coordinated as per the requirements of the applicable model, i.e. the LMRS, LPMRS, Enclosed or short-range digital model. short-range

The following sections detail a coordination procedure that may be applied for frequency assignment of LMS base stations.

Alternative frequency coordination procedures may be used provided that they produce equivalent results, that is, the target grade of service is achieved at 90% of locations within the notional service area (refer to section 4 of this RALI).

Note that automation of the coordination procedure (by means of an appropriate software application) is highly desirable, particularly when coordinating services in areas of high spectrum occupancy.

6.1 Overview

The general procedure for frequency coordination and assignment of land mobile base stations takes the following form:

> site selection;
> application of frequency-distance constraint checks;
> initial frequency selection;
> intermodulation checks; and
> the frequency assignment.

The following sections describe the above steps in more detail.

6.2 Site Selection

Initial site selection is likely to be based on the client's needs, but may need to be altered dependent on the outcome of the frequency coordination process outlined below.

6.3 Frequency-Distance Constraints

6.3.1 Cull for Frequency-Distance Constraints

Perform a cull (i.e. produce a list) of existing systems which due to their frequency and distance separation from the proposed system have the potential to cause or receive interference through co-channel emissions, out-of-band emissions, and transmitter broadband noise. The minimum radius and frequency range for this cull are specified at Annex C, Table C1 of this RALI.

6.3.2 Application of Frequency-Distance Constraints

Apply the frequency-distance constraints to assess the potential for interference between the proposed assignment and the systems yielded by the cull. The frequency-distance constraints for single frequency and two frequency services are detailed at Annex C of this RALI.

6.4 Initial Frequency Selection

Any channel passing the frequency-distance constraints and satisfying any particular needs of the client should be selected for subsequent intermodulation checks. Note that for two-frequency systems this will involve selection of a pair of frequencies (base transmit and base receive) that each satisfy the frequency-distance constraints.

6.5 Intermodulation Checks

The intermodulation checks listed in LM 8 are just one aspect of site management issues that should be considered as part of site management design, installation & commissioning and maintenance processes. While broader site management issues are important, they are not considered in the frequency assignment process and the licensee/site manager need to consider such matters separately. Intermodulation checks are not carried out for enclosed, short-range digital and Ambulatory systems.

6.5.1 Introduction

Intermodulation checks are performed as per below:

Transmitter Intermodulation

The proposed transmitter must be evaluated for the potential for its emissions to mix with emissions from other transmitters at the site, to produce 3rd or 5th order intermodulation products that have the potential to cause interference to the proposed or existing receivers. Mixing of transmitter emissions can occur in passive components (eg, site hardware such as couplers, isolators or mechanical/structural joints) as well as in non-linear transmitter output stages, and can result in intermodulation products that are co-channel with the proposed or existing receivers. As the characteristics of the components in which the mixing occurs cannot be known under these circumstances, the criterion for harmful interference caused by transmitter intermodulation is simply the occurrence of a 'hit' between co-sited systems, unless other evidence can be cited to demonstrate that the intermodulation interference is acceptable or is unlikely to cause interference.

Receiver Intermodulation

The proposed receiver, and existing receivers within specified frequency ranges and distances of the proposed system, must also be evaluated for their potential to receive interference due to intermodulation products caused by the mixing of transmitter emissions in proposed and existing receivers. Intermodulation products can be generated in the RF input stages of receivers if sufficient signal power is applied to drive a stage into a non-linear condition. Because of this input level dependency, the 'quality' of a hit can be quantified and either noted as having the potential to cause harmful interference, or discarded because it does not have a sufficient level to cause harmful interference.

6.5.2 Cull for Intermodulation Checks

Perform a cull of existing systems for which the potential for intermodulation interference must be considered. The cull identifies all such systems within defined frequency and distance limits from the proposed system. The radius and frequency range for each required cull is specified in Annex D, Table D1, of this RALI. Ambulatory services are excluded from consideration when performing intermodulation checks.

6.5.3 Performance of Intermodulation Checks

Perform checks for intermodulation interference between the selected assignment frequency (both transmit and receive, if they are different) and existing systems yielded by the cull, in the manner described below.

Transmitter Intermodulation

If the operating frequencies of any two co-sited transmitters (including the proposed transmitter) are contained in the relevant frequency range (See Annex D Table D1) and can be algebraically combined in the form shown in Table 4 to produce a 3rd or 5th order intermodulation product within the ‘hit’ range of a co-sited receiver (as defined in Annex D, Table D2, of this RALI) the proposed frequency should not be assigned, unless other evidence can be cited to demonstrate that the level of intermodulation interference is acceptable.

Table 4 Algebraic expressions for 3rd and 5th order intermodulation product frequencies

Frequencies of 3rd Order Products	Frequencies of 5th Order Products
$2f_1 - f_2$	$3f_1 - 2f_2$
$2f_2 - f_1$	$3f_2 - 2f_1$

f_1 = centre frequency of first co-sited transmitter

f_2 = centre frequency of second co-sited transmitter

Receiver Intermodulation

All systems falling within the cull limits specified in Annex D, Table D1, of this RALI are first evaluated for the occurrence of 3rd and 5th order intermodulation product ‘hits’ as per Table 4. A ‘hit’ is deemed to occur when an intermodulation product falls within the frequency ranges from a receiver specified in Annex D, Table D2, of this RALI.

Once the existence of a ‘hit’ has been confirmed, mathematical expressions (1) and (2) shown at Annex D3 of this RALI are evaluated to determine whether unacceptable interference would be caused due to receiver intermodulation by assignment of the proposed frequency.

When equations (1) and (2) at Annex D3 of this RALI are satisfied, the level of intermodulation interference is permissible; conversely, when the equations are not satisfied the level of interference is considered harmful, and the proposed frequency should not be assigned, unless appropriate justification can be provided to indicate that the level of intermodulation interference is acceptable.

If either receiver or transmitter intermodulation checks fail against the selected frequency, select another frequency that passed the frequency-distance constraints and perform intermodulation checks on that frequency.

Continue to perform intermodulation checks on frequencies passing the frequency-distance constraints until an acceptable frequency is found.

In cases where the prospective licensee of the new assignment is also the only victim of any harmful intermodulation products, the licensee may elect to accept any interference and proceed with the assignment.

6.5.4 Inter-Service Intermodulation Checks

Intermodulation resulting from interaction with other radiocommunication services such as television and FM radio broadcasting and paging systems may need to be considered at some sites, e.g. sites occupied by broadcasting transmitters. If inter-service intermodulation checks fail, find another acceptable frequency as per the procedure in section 6.5.3 in this RALI and perform inter-service intermodulation checks on that frequency until an acceptable frequency is found.

6.6 The Frequency Assignment

Assign to the proposed system the channel that passes the intermodulation checks and satisfies the frequency-distance constraints, consistent with meeting the client's operating frequency requirements as far as practicable.

6.7 Frequency Assignment Procedure - Trunked Systems

The procedure for frequency coordination and assignment of trunked systems is identical to that for conventional two frequency systems; however frequency-distance constraints and intermodulation requirements must be met for all frequencies in the proposed trunking block or group at the proposed site (refer to Annex B of this RALI).

Note that intra-service intermodulation checks are not required for 800 MHz trunking assignments due to the homogeneous nature of the trunking segment and the 45 MHz base transmit/receive split.

6.8 Local Environment

There may be circumstances where the channel selected using the above mentioned procedure is not the optimal channel to be assigned due to the local environment. Examples are: a large mountain range offering additional propagation loss to/from a service in an adjacent area; a transmitter located on a site at a height much greater or lower than the planning model assumes; or an anomalous propagation mode occurring due to a path over water.

Under such circumstances, modified frequency/distance constraints may be applied provided that interference to adjacent services is maintained to levels prescribed in the service model, and that service areas do not overlap (i.e. a minimum of 80 km separation is maintained for high power services). Mobile receivers in at least 90% of the area of any adjacent cells using the same frequency shall be protected (on channel) to a level as given in Table 5. In single frequency systems the base station receiver might also need consideration depending on terrain topography.

Table 5 Required on-channel protection levels for mobile receivers

	6.25 kHz bandwidth	12.5 / 25 kHz bandwidth
400 MHz Band	−124 dBm	−121 dBm
VHF Band	−115 dBm	−112 dBm

Propagation path loss may be determined by use of any appropriate method described in section 4 of ITU-R P.526 (versions 4 through 9). Other methods for determining the propagation path loss may also be used pending ACMA agreement. A 9 second digital elevation model or better should be used.

6.9 Additional requirements for use of Harmonised Government Spectrum and coordination against Harmonised Government Spectrum Area licenses

The coordination methodology in this section applies to all Harmonised Government Spectrum (HGS) use, including when such use is authorised by a Harmonised Government Spectrum Area (HGSA) licence. The HGS frequency bands are listed in RALI MS22 – 400 MHz Plan (i.e. they exclude the rail segments and parts of 420-430 MHz used for defence purposes).

Area wide systems operating under HGSA arrangements have no coordination requirements and operate on a no interference – no protection basis.

6.9.1 Geographic boundary power spectral density (PSD) limitations

For proposed sited transmitters located within 120 km of a neighbouring jurisdiction, the PSD thresholds specified in Table 5 apply at any point within the geographical area of any neighbouring jurisdiction(s), unless otherwise agreed between HGSA licensee(s) of the affected jurisdiction(s).

Table 6 In-band PSD threshold value at a jurisdictional boundary

Emission Bandwidth	In-Band interference Threshold
6.25 kHz	-124 dBm
12.5 kHz	-121 dBm
25 kHz	-121 dBm

The following procedure should be used to determine if a transmitter meets the in-band jurisdictional PSD threshold described above:

Step 1: Calculate the coverage area of the proposed station using:

$$P_b = EIRP + G_r - L_{path}$$

Where;

P_b : *Interfering power (dBm)*

$EIRP$: *Equivalent Isotropically Radiated Power of interfering transmitter (dBm)*

G_r : *Receiver Antenna Gain (6 dBi)*

L_{path}[18] : *Propagation path loss (dB) is calculated using the most recent revision of propagation model ITU-R P.526*[19]

Step 2: Using the resultant coverage area plot of the interfering signal, ensure that the interference power does not exceed the maximum acceptable interference level (values in Table 5) anywhere within a neighbouring jurisdiction[20].

6.10 Additional provisions for HGSA licensees

The purpose of this section is to provide additional advice on frequency assignment policy for single and two frequency land mobile systems that will operate in Harmonised Government Spectrum (HGS) segments within the 400 MHz band. The HGS comprises frequency segments that are designated for use exclusively for Commonwealth, State and Territory Government purposes. The 400 MHz plan (RALI MS22) details allocation and channelling arrangements for HGS and non-HGS segments. Note the spectrum set aside for rail use and parts of 420 – 430 MHz used for defence purposes are not included in the HGSA licence frequency ranges.

The document *Harmonised government spectrum area licences in the 400 MHz band* outlines the licensee requirements and application process for HGSA licences. HGSA licensees will be responsible for coordinating frequency access to HGS segments inside their jurisdictional geographical area. This will include coordination between users within their own jurisdiction as well as coordination with neighbouring jurisdictions and non-HGS users operating within their jurisdiction boundaries.

The intent is to afford a degree of flexibility to HGSA licensees in such a way that they are not (in all cases) constrained by the frequency reuse distances prescribed in this RALI. This will allow ‘denser’ network topologies to be deployed to better service areas where demand for channels is high. Conversely, there is an expectation that coordinator rights are used to ensure that networks are deployed in a spectrally efficient manner so as to make the best use of the spectrum available for exclusive government use.

While this means that the constraints of RALI LM8 will largely be relaxed for services operating under the same HGSA licence, there remain some components of the RALI where the service model and coordination procedures must necessarily continue to apply to HGS users. These include Section 4, which defines a service model for LMRS and LPMRS systems and gives operational characteristics of Land Mobile Systems (LMS) that are used to achieve a target grade of service; and Sections 5 and 6, which detail the frequency assignment policy and coordination procedures for LMS including the methodology behind intermodulation checks which are still applicable to the HGS.

The provisions listed in this Section may be invoked by an entity that holds an HGSA licence. The interference protection methodologies and coordination criteria detailed in this section are based on those detailed in the service models described in this RALI.

6.10.1 Buffer Zone

A “buffer zone” has been defined in both the geographical and frequency domain. HGSA licensees will be required to observe this buffer zone in order to avoid interference into non-HGS frequency segments (adjacent band operation) and into adjacent jurisdictions (co-

[18] To be calculated using version 3 of the 9s Geoscience Australia DEM.

[19] Propagation by diffraction, see http://www.itu.int/rec/R-REC-P.526/en. Assumptions: K factor 4/3, mobile height 1.5 metres, base antenna height 30m.

[20] E.g. for an assignment in NSW near the Queensland border, if the threshold level is exceeded anywhere in Queensland the PSD test fails.

frequency operation). Within these buffer zones, the provisions listed below in Section 6.10.2 cannot be invoked.

The geographic and frequency limits of the buffer zone are as follows:

> Within 120 km of the geographical limit of a jurisdictional boundary; and
> Within 200 kHz of the edge of an HGSA frequency segment that borders a segment not covered by the HGSA licence.

HGS services proposed to operate within a buffer zone are subject to all LM08 coordination requirements and power restrictions.

6.10.2 Larger service areas in regional and remote areas

Some deployments in Low and Remote density area21 in the HGS may operate with a higher EIRP than is permitted in Section 4.0 of the RALI, in order to achieve larger service areas. In these areas, the transmitter power and EIRP of base stations operating under an HGSA licence is specified as follows:

> Transmitter power (at the antenna input) not to exceed 125W; and
> EIRP not to exceed 400W in any direction.

However, the EIRP limit for mobile stations has not changed.

Operations under the above conditions are limited by:

> Geographic and frequency range radiated power spectral density limitations (as specified in 6.9.1 and 6.10.3 respectively) must be adhered to; and
> Base station location, i.e. power is limited to the ordinary conditions of Section 4 of this RALI within a buffer zone;
> Equipment standards: equipment must adhere to applicable standards specified in the RALI. Equipment meeting the Australian radiocommunications equipment standard(s) relevant to operation in the Land Mobile Service (LMS) will also meet those stated in the LMRS and LPMRS service model for adjacent channel isolation, receiver sensitivity, and transmitter spurious and out-of-band emissions;
> Intermodulation requirements described in Section 6.10.4 of this RALI must be adhered to.

Deployment of LMS systems (LMRS and LPMRS) in the 400 MHz band in High and Medium density areas, or within a buffer zone, is required to comply with all coordination criteria and all ordinary service model parameters specified in Section 4 of the RALI.

6.10.3 Frequency boundary power spectral density (PSD) limitations

The power spectral density (PSD) of the *maximum* radiated power (i.e. the EIRP) limits that must be achieved at the segment boundary frequency (HGSA/non-HGSA) are shown in Table 6[22].

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[21] http://www.acma.gov.au/theACMA/About/Making-payments/Apparatus-licence-fees/apparatus-licence-fees-acma#schedule

[22] These figures have been derived from applicable standards that specify transmitter emission masks, as shown in Spectrum Planning Report SPP 08/14 (*Derivation of 400 MHz band land mobile frequency-distance constraints used in RALI LM8*).

Table 7 Out-of-band radiated power limits (into carrying channel bandwidths

Emission Bandwidth	Out-of-Band Interference Threshold
6.25 kHz	-16 dBm
12.5 kHz	-20 dBm
25 kHz	-13 dBm

6.10.4 Coordination Methodologies

The provisions listed in this RALI afford HGSA licensees the requisite flexibility to manage access to HGS segments. The geographic area and frequency band-edge constraints specified are intended to help coordinate with other jurisdictions (in-band) and between HGS segments and non-HGS segments (out-of-band).

6.10.4.1 Intra-Jurisdictional Coordination

Coordination between users within segments in a jurisdiction covered by an HGSA licence is a matter for the HGSA licensee. The coordination methodologies set out in RALI LM8 may be used to guide this process.

Coordination between users in a segment in a jurisdiction covered by an HGSA licence and users in a segment not covered by the licence, is to follow the coordination methodologies set out in RALI LM8.

6.10.4.2 Inter-Jurisdictional Coordination

Assignments within HGS must meet the coordination requirements detailed in this RALI with respect to HGS registrations in adjacent jurisdictions. Additionally, the in-band PSD thresholds shown in Table 5 in this RALI must be met within neighbouring jurisdictions. If cross-jurisdiction coordination cannot be achieved and/or the above mentioned boundary PSD thresholds cannot be met, an assignment can only be made if an agreement can be reached between the respective HGSA licensees. If one of the affected jurisdictions does not have an HGSA licence, agreement must be reached with the jurisdiction’s National Coordinating Committee for Government Radiocommunications (NCCGR) representative.

6.10.4.3 Coordination between HGS users and non-HGS users

Assignments within the HGS must meet the coordination requirements detailed in this RALI with respect to non-HGS services, operating in adjacent non-HGS segments. Additionally, the out-of-band radiated PSD limits into adjacent non-HGS segments as shown in Table 6 in this RALI must be met.

6.10.4.4 Intermodulation checks

The coordination requirements detailed above are intended to ensure that no harmful interference is caused to licensed services outside the jurisdiction (frequency or geography-wise) of the band coordinator. This also extends to interference that might arise from intermodulation. In all cases, the intermodulation requirements specified in Section 6.5 of RALI LM8 must be adhered to when making an assignment in the HGS. This extends to operation under the provisions of 6.10.2 of this RALI (use of higher EIRP to achieve larger coverage areas in Low and Remote density areas).

Furthermore, given the provisions of 6.10.2, there are further conditions placed on HGS assignments operating under these provisions with respect to intermodulation checks with future non-HGS assignment requests within the intermodulation cull radius of the HGS station. That is, if a prospective non-HGS assignment cannot be made due to intermodulation interference resulting from a station currently operating in the HGS as a result of the additional EIRP, the HGS operator has obligations to work through the process set out below to assist with accommodating the prospective non-HGS assignee (this does not apply when the HGS user is operating in accordance with the normal power limits set out in Section 4 of this RALI). This process is as follows:

- When assessing a prospective non-HGS assignment against a high EIRP station operating in HGS and within the intermodulation cull radius, checks should be carried out using both the actual (higher) EIRP of the HGS station (check 1) and an EIRP of 83W (check 2).
- If both check 1 and check 2 fail, then the prospective assignment cannot be made, as the intermodulation check would have failed regardless of whether or not the HGS assignment was operating under the provisions of 6.10.2.
- If check 1 fails, but check 2 passes, and it can be shown that an alternative channel is not available for the non-HGS user in the requested location, then it is the responsibility of the HGS assignee to accommodate the new proposed assignment. The prospective assignment can proceed as long as the HGS assignee has been contacted in writing to:
    - Reduce EIRP to be compliant with Section 4 of this RALI; or
    - Move to a different HGS channel for which intermodulation checks would pass for the higher EIRP limit.
- Once initial contact has been made by the prospective non-HGS assignee, the HGS assignee has 20 business days to comply with the request.

While this means that the usual “first in time” provisions for frequency assignments only apply to HGS assignments that comply with normal EIRP limits, it is expected to be mitigated by the (usually) high availability of alternative channels (both HGS and non-HGS) in the Low and Remote density areas where the provisions of 6.10.2 may be invoked.

7 Exceptions

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

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

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

8 RALI Authorisation

Approved 17/MAY/2024

Daniel Gocentas
Manager a/g
Spectrum Planning Section
Spectrum Planning and Engineering Branch

Communications Infrastructure Division
Australian Communications and Media Authority

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Annex A: Propagation Loss Models

A1. Modified Longley-Rice Model

A modified version of the Longley-Rice propagation loss model [11] has been used in the calculation of propagation loss for the determination of frequency-distance constraints appearing in Annex C when the interference path is between two high sites having effective antenna heights of 200 metres above surrounding terrain. The model has also been used for the determination of intermodulation parameters appearing in Annex D. For information, parameter values used in the model are detailed in Table A1 below.

Table A1: Parameter Values used in the Modified Longley-Rice Propagation Loss Model

Band	Frequency Limits (MHz)	Distance (km)	Path Loss (dB)
VHF Mid and High Bands	70 to 87.5 148 to 174	0 < distance <= 0.006 0.006 < distance <= 40 distance > 40	41 FSL + 10 96 + (0.55 x distance)
400 MHz Band	403 to 520	0 < distance <= 0.003 0.003 < distance <= 40 distance > 40	45 FSL + 10 104 + (0.55 x distance)
800 MHz Trunking Band	806 to 854	0 < distance <= 0.003 0.003 < distance <= 55 distance > 55	50 FSL + 10 107 + (0.55 x distance)

Notes: 1. distance = spatial separation between antennas

2. FSL = Free Space Loss [in dB]
   = 32.5 + 20 log (distance [in km]) + 20 log (frequency [in MHz])

3. The model estimates propagation loss to a 90 % confidence level and assumes a terrain irregularity factor of 90 metres [11].

A2. Modified Hata Model

The modified Hata propagation loss model [7] for suburban environment has been used in the calculation of propagation loss for the determination of frequency-distance constraints appearing in Annex C for two frequency LMRS systems, when the interference path is between a high site and a low site (base to mobile). The modified Hata urban model has been used in the calculations for all cases involving enclosed, digital short-range and LPMRS systems, including coordination of LMRS with LPMRS.

The modified Hata model estimates mean propagation loss (50% of locations for 50% of the time).

The modified Hata equations are as follows:

$$L_{suburban} = L_{urban} - 2\log\left(\frac{f}{28}\right)^2 - 5.4$$

where:

$$L_{urban} = 69.55 + 26.16\log(f) - 13.82\log(h_b) - a(h_m) + [44.9 - 6.55\log(h_b)](\log(d))^{\alpha}$$

L = median path loss (dB)

$a(h_m) = (1.1\log(f) - 0.7)h_m - (1.56\log(f) - 0.8)$

$$\alpha = \begin{cases} \alpha = 1 & for\ d \le 20km \\ \alpha = 1 + (0.14 + 0.000187f + 0.00107h_b)(\log\left(\frac{d}{20}\right))^{0.8} & for\ 20km < d \end{cases}$$

d = distance (km)

f = frequency (MHz)

h_b, h_m = base and mobile antenna heights respectively (m)

Modified Hata Model for LPMRS

The modified Hata propagation loss model for urban environment used for LPMRS has been adjusted for the base station antenna height lower than 30 m, based on ERC Report 68 [12] as follows:

$\underline{for\quad d \ge 0.1km}$

$30MHz < f \le 150MHz$

$$L = 69.6 + 26.2\log(150) - 20\log(150/f) - 13.82\log(\max\{30, h_b\}) + [44.9 - 6.55\log(\max\{30, h_b\})](\log(d))^{\alpha} - a(h_m) - b(h_b)$$

$150MHz < f \leq 1500MHz$

$$L = 69.6 + 26.2\log(f) - 13.82\log(\max\{30, h_b\}) + [44.9 - 6.55\log(\max\{30, h_b\})](\log(d))^{\alpha} - a(h_m) - b(h_b)$$

where:

L = median path loss (dB)

$a(h_m) = (1.1\log(f) - 0.7)\min\{10, h_m\} - (1.56\log(f) - 0.8) + \max\{0, 20\log(h_m/10)\}$

$b(h_b) = \min\{0, 20\log(h_b/30)\}$

$$\alpha = \begin{cases} \alpha = 1 & for \quad d \leq 20km \\ \alpha = 1 + (0.14 + 0.000187f + 0.00107h_b)(\log\left(\frac{d}{20}\right))^{0.8} & for \quad 20km < d \end{cases}$$

d = distance (km)

f = frequency (MHz)

h_b, h_m = base and mobile antenna heights respectively (m)

$\underline{for \quad d \leq 0.04km}$

L = 32.4 + 20log(f) + 10log(d^2 + ($h_b - h_m)^2 /10^6$)

$\underline{for \quad 0.04 < d < 0.1km}$

$$L = L(0.04) + \left(\frac{\log(d) - \log(0.04)}{\log(0.1) - \log(0.04)}\right)[L(0.1) - L(0.04)]$$

When L is below the free space attenuation for the same distance, the free space attenuation should be used instead.

Annex B - Block, Group and Channel Allocations for Trunking Channels

B1. Block and Group Allocations for VHF High Band Trunking Channels

Table B1.1: VHF High Band Sub-segment A

BLOCK	GROUP	CHANNEL NUMBER*				
1	1	**1**	**13**	**25**	**37**	**49**
	2	**61**	**73**	**85**	**97**	**109**
2	1	**2**	**14**	**26**	**38**	**50**
	2	**62**	**74**	**86**	**98**	**110**
3	1	**3**	**15**	**27**	**39**	**51**
	2	**63**	**75**	**87**	**99**	**111**
4	1	**4**	**16**	**28**	**40**	**52**
	2	**64**	**76**	**88**	**100**	**112**
5	1	**5**	**17**	**29**	**41**	**53**
	2	**65**	**77**	**89**	**101**	**113**
6	1	**6**	**18**	**30**	**42**	**54**
	2	**66**	**78**	**90**	**102**	**114**
7	1	**7**	**19**	**31**	**43**	**55**
	2	**67**	**79**	**91**	**103**	**115**
8	1	**8**	**20**	**32**	**44**	**56**
	2	**68**	**80**	**92**	**104**	**116**
9	1	**9**	**21**	**33**	**45**	**57**
	2	**69**	**81**	**93**	**105**	**117**
10	1	**10**	**22**	**34**	**46**	**58**
	2	**70**	**82**	**94**	**106**	**118**
11	1	**11**	**23**	**35**	**47**	**59**
	2	**71**	**83**	**95**	**107**	**119**
12	1	**12**	**24**	**36**	**48**	**60**
	2	**72**	**84**	**96**	**108**	**120**

* For allocations of channel numbers to frequencies, see Table B2.1

Table B1.2: VHF High Band Sub-segment B

BLOCK	GROUP	CHANNEL NUMBER*				
1	1	**121**	**133**	**145**	**157**	**169**
	2	**181**	**193**	**205**	**217**	**229**
2	1	**122**	**134**	**146**	**158**	**170**
	2	**182**	**194**	**206**	**218**	**230**
3	1	**123**	**135**	**147**	**159**	**171**
	2	**183**	**195**	**207**	**219**	**231**
4	1	**124**	**136**	**148**	**160**	**172**
	2	**184**	**196**	**208**	**220**	**232**
5	1	**125**	**137**	**149**	**161**	**173**
	2	**185**	**197**	**209**	**221**	**233**
6	1	**126**	**138**	**150**	**162**	**174**
	2	**186**	**198**	**210**	**222**	**234**
7	1	**127**	**139**	**151**	**163**	**175**
	2	**187**	**199**	**211**	**223**	**235**
8	1	**128**	**140**	**152**	**164**	**176**
	2	**188**	**200**	**212**	**224**	**236**
9	1	**129**	**141**	**153**	**165**	**177**
	2	**189**	**201**	**213**	**225**	**237**
10	1	**130**	**142**	**154**	**166**	**178**
	2	**190**	**202**	**214**	**226**	**238**
11	1	**131**	**143**	**155**	**167**	**179**
	2	**191**	**203**	**215**	**227**	**239**
12	1	**132**	**144**	**156**	**168**	**180**
	2	**192**	**204**	**216**	**228**	**240**

* For allocations of channel numbers to frequencies, see Table B2.2

B2. Channel Allocations for VHF High Band Trunking Channels

Table B2.1: VHF High Band Sub-segment A

CHAN	BASE TX	BASE RX	CHAN	BASE TX	BASE RX	CHAN	BASE TX	BASE RX
1	165.20000	169.80000	41	165.70000	170.30000	81	166.20000	170.80000
2	165.21250	169.81250	42	165.71250	170.31250	82	166.21250	170.81250
3	165.22500	169.82500	43	165.72500	170.32500	83	166.22500	170.82500
4	165.23750	169.83750	44	165.73750	170.33750	84	166.23750	170.83750
5	165.25000	169.85000	45	165.75000	170.35000	85	166.25000	170.85000
6	165.26250	169.86250	46	165.76250	170.36250	86	166.26250	170.86250
7	165.27500	169.87500	47	165.77500	170.37500	87	166.27500	170.87500
8	165.28750	169.88750	48	165.78750	170.38750	88	166.28750	170.88750
9	165.30000	169.90000	49	165.80000	170.40000	89	166.30000	170.90000
10	165.31250	169.91250	50	165.81250	170.41250	90	166.31250	170.91250
11	165.32500	169.92500	51	165.82500	170.42500	91	166.32500	170.92500
12	165.33750	169.93750	52	165.83750	170.43750	92	166.33750	170.93750
13	165.35000	169.95000	53	165.85000	170.45000	93	166.35000	170.95000
14	165.36250	169.96250	54	165.86250	170.46250	94	166.36250	170.96250
15	165.37500	169.97500	55	165.87500	170.47500	95	166.37500	170.97500
16	165.38750	169.98750	56	165.88750	170.48750	96	166.38750	170.98750
17	165.40000	170.00000	57	165.90000	170.50000	97	166.40000	171.00000
18	165.41250	170.01250	58	165.91250	170.51250	98	166.41250	171.01250
19	165.42500	170.02500	59	165.92500	170.52500	99	166.42500	171.02500
20	165.43750	170.03750	60	165.93750	170.53750	100	166.43750	171.03750
21	165.45000	170.05000	61	165.95000	170.55000	101	166.45000	171.05000
22	165.46250	170.06250	62	165.96250	170.56250	102	166.46250	171.06250
23	165.47500	170.07500	63	165.97500	170.57500	103	166.47500	171.07500
24	165.48750	170.08750	64	165.98750	170.58750	104	166.48750	171.08750
25	165.50000	170.10000	65	166.00000	170.60000	105	166.50000	171.10000
26	165.51250	170.11250	66	166.01250	170.61250	106	166.51250	171.11250
27	165.52500	170.12500	67	166.02500	170.62500	107	166.52500	171.12500
28	165.53750	170.13750	68	166.03750	170.63750	108	166.53750	171.13750
29	165.55000	170.15000	69	166.05000	170.65000	109	166.55000	171.15000
30	165.56250	170.16250	70	166.06250	170.66250	110	166.56250	171.16250
31	165.57500	170.17500	71	166.07500	170.67500	111	166.57500	171.17500
32	165.58750	170.18750	72	166.08750	170.68750	112	166.58750	171.18750
33	165.60000	170.20000	73	166.10000	170.70000	113	166.60000	171.20000
34	165.61250	170.21250	74	166.11250	170.71250	114	166.61250	171.21250
35	165.62500	170.22500	75	166.12500	170.72500	115	166.62500	171.22500
36	165.63750	170.23750	76	166.13750	170.73750	116	166.63750	171.23750
37	165.65000	170.25000	77	166.15000	170.75000	117	166.65000	171.25000
38	165.66250	170.26250	78	166.16250	170.76250	118	166.66250	171.26250
39	165.67500	170.27500	79	166.17500	170.77500	119	166.67500	171.27500
40	165.68750	170.28750	80	166.18750	170.78750	120	166.68750	171.28750

Table B2.2: VHF High Band Sub-segment B

CHAN	BASE TX	BASE RX	CHAN	BASE TX	BASE RX	CHAN	BASE TX	BASE RX
121	166.70000	171.30000	**161**	167.20000	171.80000	**201**	167.70000	172.30000
122	166.71250	171.31250	**162**	167.21250	171.81250	**202**	167.71250	172.31250
123	166.72500	171.32500	**163**	167.22500	171.82500	**203**	167.72500	172.32500
124	166.73750	171.33750	**164**	167.23750	171.83750	**204**	167.73750	172.33750
125	166.75000	171.35000	**165**	167.25000	171.85000	**205**	167.75000	172.35000
126	166.76250	171.36250	**166**	167.26250	171.86250	**206**	167.76250	172.36250
127	166.77500	171.37500	**167**	167.27500	171.87500	**207**	167.77500	172.37500
128	166.78750	171.38750	**168**	167.28750	171.88750	**208**	167.78750	172.38750
129	166.80000	171.40000	**169**	167.30000	171.90000	**209**	167.80000	172.40000
130	166.81250	171.41250	**170**	167.31250	171.91250	**210**	167.81250	172.41250
131	166.82500	171.42500	**171**	167.32500	171.92500	**211**	167.82500	172.42500
132	166.83750	171.43750	**172**	167.33750	171.93750	**212**	167.83750	172.43750
133	166.85000	171.45000	**173**	167.35000	171.95000	**213**	167.85000	172.45000
134	166.86250	171.46250	**174**	167.36250	171.96250	**214**	167.86250	172.46250
135	166.87500	171.47500	**175**	167.37500	171.97500	**215**	167.87500	172.47500
136	166.88750	171.48750	**176**	167.38750	171.98750	**216**	167.88750	172.48750
137	166.90000	171.50000	**177**	167.40000	172.00000	**217**	167.90000	172.50000
138	166.91250	171.51250	**178**	167.41250	172.01250	**218**	167.91250	172.51250
139	166.92500	171.52500	**179**	167.42500	172.02500	**219**	167.92500	172.52500
140	166.93750	171.53750	**180**	167.43750	172.03750	**220**	167.93750	172.53750
141	166.95000	171.55000	**181**	167.45000	172.05000	**221**	167.95000	172.55000
142	166.96250	171.56250	**182**	167.46250	172.06250	**222**	167.96250	172.56250
143	166.97500	171.57500	**183**	167.47500	172.07500	**223**	167.97500	172.57500
144	166.98750	171.58750	**184**	167.48750	172.08750	**224**	167.98750	172.58750
145	167.00000	171.60000	**185**	167.50000	172.10000	**225**	168.00000	172.60000
146	167.01250	171.61250	**186**	167.51250	172.11250	**226**	168.01250	172.61250
147	167.02500	171.62500	**187**	167.52500	172.12500	**227**	168.02500	172.62500
148	167.03750	171.63750	**188**	167.53750	172.13750	**228**	168.03750	172.63750
149	167.05000	171.65000	**189**	167.55000	172.15000	**229**	168.05000	172.65000
150	167.06250	171.66250	**190**	167.56250	172.16250	**230**	168.06250	172.66250
151	167.07500	171.67500	**191**	167.57500	172.17500	**231**	168.07500	172.67500
152	167.08750	171.68750	**192**	167.58750	172.18750	**232**	168.08750	172.68750
153	167.10000	171.70000	**193**	167.60000	172.20000	**233**	168.10000	172.70000
154	167.11250	171.71250	**194**	167.61250	172.21250	**234**	168.11250	172.71250
155	167.12500	171.72500	**195**	167.62500	172.22500	**235**	168.12500	172.72500
156	167.13750	171.73750	**196**	167.63750	172.23750	**236**	168.13750	172.73750
157	167.15000	171.75000	**197**	167.65000	172.25000	**237**	168.15000	172.75000
158	167.16250	171.76250	**198**	167.66250	172.26250	**238**	168.16250	172.76250
159	167.17500	171.77500	**199**	167.67500	172.27500	**239**	168.17500	172.77500
160	167.18750	171.78750	**200**	167.68750	172.28750	**240**	168.18750	172.78750

B3. Block, Group and Channel Structure for the 400 MHz Trunking Band

Table B3.1: Block and Group Structure for the 400 MHz Trunking Band

BLOCK	GROUP	CHANNEL NUMBER*				
1	1	**1**	**41**	**81**	**121**	**161**
	2	**21**	**61**	**101**	**141**	**181**
	3	**11**	**51**	**91**	**131**	**171**
	4	**31**	**71**	**111**	**151**	**191**
2	1	**2**	**42**	**82**	**122**	**162**
	2	**22**	**62**	**102**	**142**	**182**
	3	**12**	**52**	**92**	**132**	**172**
	4	**32**	**72**	**112**	**152**	**192**
3	1	**3**	**43**	**83**	**123**	**163**
	2	**23**	**63**	**103**	**143**	**183**
	3	**13**	**53**	**93**	**133**	**173**
	4	**33**	**73**	**113**	**153**	**193**
4	1	**4**	**44**	**84**	**124**	**164**
	2	**24**	**64**	**104**	**144**	**184**
	3	**14**	**54**	**94**	**134**	**174**
	4	**34**	**74**	**114**	**154**	**194**
5	1	**5**	**45**	**85**	**125**	**165**
	2	**25**	**65**	**105**	**145**	**185**
	3	**15**	**55**	**95**	**135**	**175**
	4	**35**	**75**	**115**	**155**	**195**
6	1	**6**	**46**	**86**	**126**	**166**
	2	**26**	**66**	**106**	**146**	**186**
	3	**16**	**56**	**96**	**136**	**176**
	4	**36**	**76**	**116**	**156**	**196**
7	1	**7**	**47**	**87**	**127**	**167**
	2	**27**	**67**	**107**	**147**	**187**
	3	**17**	**57**	**97**	**137**	**177**
	4	**37**	**77**	**117**	**157**	**197**
8	1	**8**	**48**	**88**	**128**	**168**
	2	**28**	**68**	**108**	**148**	**188**
	3	**18**	**58**	**98**	**138**	**178**
	4	**38**	**78**	**118**	**158**	**198**
9	1	**9**	**49**	**89**	**129**	**169**
	2	**29**	**69**	**109**	**149**	**189**
	3	**19**	**59**	**99**	**139**	**179**
	4	**39**	**79**	**119**	**159**	**199**
10	1	**10**	**50**	**90**	**130**	**170**
	2	**30**	**70**	**110**	**150**	**190**
	3	**20**	**60**	**100**	**140**	**180**
	4	**40**	**80**	**120**	**160**	**200**

* For allocations of channel numbers to frequencies, see Table B3.2

Table B3.2: Channel Allocations for the 400 MHz Trunking Band

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
1	415.5750	406.1250	**51**	416.2000	406.7500	**101**	416.8250	407.3750	**151**	417.4500	408.0000
2	415.5875	406.1375	**52**	416.2125	406.7625	**102**	416.8375	407.3875	**152**	417.4625	408.0125
3	415.6000	406.1500	**53**	416.2250	406.7750	**103**	416.8500	407.4000	**153**	417.4750	408.0250
4	415.6125	406.1625	**54**	416.2375	406.7875	**104**	416.8625	407.4125	**154**	417.4875	408.0375
5	415.6250	406.1750	**55**	416.2500	406.8000	**105**	416.8750	407.4250	**155**	417.5000	408.0500
6	415.6375	406.1875	**56**	416.2625	406.8125	**106**	416.8875	407.4375	**156**	417.5125	408.0625
7	415.6500	406.2000	**57**	416.2750	406.8250	**107**	416.9000	407.4500	**157**	417.5250	408.0750
8	415.6625	406.2125	**58**	416.2875	406.8375	**108**	416.9125	407.4625	**158**	417.5375	408.0875
9	415.6750	406.2250	**59**	416.3000	406.8500	**109**	416.9250	407.4750	**159**	417.5500	408.1000
10	415.6875	406.2375	**60**	416.3125	406.8625	**110**	416.9375	407.4875	**160**	417.5625	408.1125
11	415.7000	406.2500	**61**	416.3250	406.8750	**111**	416.9500	407.5000	**161**	417.5750	408.1250
12	415.7125	406.2625	**62**	416.3375	406.8875	**112**	416.9625	407.5125	**162**	417.5875	408.1375
13	415.7250	406.2750	**63**	416.3500	406.9000	**113**	416.9750	407.5250	**163**	417.6000	408.1500
14	415.7375	406.2875	**64**	416.3625	406.9125	**114**	416.9875	407.5375	**164**	417.6125	408.1625
15	415.7500	406.3000	**65**	416.3750	406.9250	**115**	417.0000	407.5500	**165**	417.6250	408.1750
16	415.7625	406.3125	**66**	416.3875	406.9375	**116**	417.0125	407.5625	**166**	417.6375	408.1875
17	415.7750	406.3250	**67**	416.4000	406.9500	**117**	417.0250	407.5750	**167**	417.6500	408.2000
18	415.7875	406.3375	**68**	416.4125	406.9625	**118**	417.0375	407.5875	**168**	417.6625	408.2125
19	415.8000	406.3500	**69**	416.4250	406.9750	**119**	417.0500	407.6000	**169**	417.6750	408.2250
20	415.8125	406.3625	**70**	416.4375	406.9875	**120**	417.0625	407.6125	**170**	417.6875	408.2375
21	415.8250	406.3750	**71**	416.4500	407.0000	**121**	417.0750	407.6250	**171**	417.7000	408.2500
22	415.8375	406.3875	**72**	416.4625	407.0125	**122**	417.0875	407.6375	**172**	417.7125	408.2625
23	415.8500	406.4000	**73**	416.4750	407.0250	**123**	417.1000	407.6500	**173**	417.7250	408.2750
24	415.8625	406.4125	**74**	416.4875	407.0375	**124**	417.1125	407.6625	**174**	417.7375	408.2875
25	415.8750	406.4250	**75**	416.5000	407.0500	**125**	417.1250	407.6750	**175**	417.7500	408.3000
26	415.8875	406.4375	**76**	416.5125	407.0625	**126**	417.1375	407.6875	**176**	417.7625	408.3125
27	415.9000	406.4500	**77**	416.5250	407.0750	**127**	417.1500	407.7000	**177**	417.7750	408.3250
28	415.9125	406.4625	**78**	416.5375	407.0875	**128**	417.1625	407.7125	**178**	417.7875	408.3375
29	415.9250	406.4750	**79**	416.5500	407.1000	**129**	417.1750	407.7250	**179**	417.8000	408.3500
30	415.9375	406.4875	**80**	416.5625	407.1125	**130**	417.1875	407.7375	**180**	417.8125	408.3625
31	415.9500	406.5000	**81**	416.5750	407.1250	**131**	417.2000	407.7500	**181**	417.8250	408.3750
32	415.9625	406.5125	**82**	416.5875	407.1375	**132**	417.2125	407.7625	**182**	417.8375	408.3875
33	415.9750	406.5250	**83**	416.6000	407.1500	**133**	417.2250	407.7750	**183**	417.8500	408.4000
34	415.9875	406.5375	**84**	416.6125	407.1625	**134**	417.2375	407.7875	**184**	417.8625	408.4125
35	416.0000	406.5500	**85**	416.6250	407.1750	**135**	417.2500	407.8000	**185**	417.8750	408.4250
36	416.0125	406.5625	**86**	416.6375	407.1875	**136**	417.2625	407.8125	**186**	417.8875	408.4375
37	416.0250	406.5750	**87**	416.6500	407.2000	**137**	417.2750	407.8250	**187**	417.9000	408.4500
38	416.0375	406.5875	**88**	416.6625	407.2125	**138**	417.2875	407.8375	**188**	417.9125	408.4625
39	416.0500	406.6000	**89**	416.6750	407.2250	**139**	417.3000	407.8500	**189**	417.9250	408.4750
40	416.0625	406.6125	**90**	416.6875	407.2375	**140**	417.3125	407.8625	**190**	417.9375	408.4875
41	416.0750	406.6250	**91**	416.7000	407.2500	**141**	417.3250	407.8750	**191**	417.9500	408.5000
42	416.0875	406.6375	**92**	416.7125	407.2625	**142**	417.3375	407.8875	**192**	417.9625	408.5125
43	416.1000	406.6500	**93**	416.7250	407.2750	**143**	417.3500	407.9000	**193**	417.9750	408.5250
44	416.1125	406.6625	**94**	416.7375	407.2875	**144**	417.3625	407.9125	**194**	417.9875	408.5375
45	416.1250	406.6750	**95**	416.7500	407.3000	**145**	417.3750	407.9250	**195**	418.0000	408.5500
46	416.1375	406.6875	**96**	416.7625	407.3125	**146**	417.3875	407.9375	**196**	418.0125	408.5625
47	416.1500	406.7000	**97**	416.7750	407.3250	**147**	417.4000	407.9500	**197**	418.0250	408.5750
48	416.1625	406.7125	**98**	416.7875	407.3375	**148**	417.4125	407.9625	**198**	418.0375	408.5875
49	416.1750	406.7250	**99**	416.8000	407.3500	**149**	417.4250	407.9750	**199**	418.0500	408.6000

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
50	416.1875	406.7375	**100**	416.8125	407.3625	**150**	417.4375	407.9875	**200**	418.0625	408.6125

* For allocations of channel numbers to frequencies, see Table B4.2

B4 Block, Group and Channel Structure for the 800 MHz Trunking Band (12.5 kHz channel spacing)

Table B4.1: Block and Group Structure for the 800 MHz Trunking Band (12.5 kHz channel spacing)

BLOCK	GROUP	CHANNEL NUMBER*				
1	1	1	49	97	145	193
	2	25	73	121	169	217
	3	13	61	109	157	205
	4	37	85	133	181	229
2	1	2	50	98	146	194
	2	26	74	122	170	218
	3	14	62	110	158	206
	4	38	86	134	182	230
3	1	3	51	99	147	195
	2	27	75	123	171	219
	3	15	63	111	159	207
	4	39	87	135	183	231
4	1	4	52	100	148	196
	2	28	76	124	172	220
	3	16	64	112	160	208
	4	40	88	136	184	232
5	1	5	53	101	149	197
	2	29	77	125	173	221
	3	17	65	113	161	209
	4	41	89	137	185	233
6	1	6	54	102	150	198
	2	30	78	126	174	222
	3	18	66	114	162	210
	4	42	90	138	186	234
7	1	7	55	103	151	199
	2	31	79	127	175	223
	3	19	67	115	163	211
	4	43	91	139	187	235
8	1	8	56	104	152	200
	2	32	80	128	176	224
	3	20	68	116	164	212
	4	44	92	140	188	236
9	1	9	57	105	153	201
	2	33	81	129	177	225
	3	21	69	117	165	213
	4	45	93	141	189	237
10	1	10	58	106	154	202
	2	34	82	130	178	226
	3	22	70	118	166	214
	4	46	94	142	190	238

BLOCK	GROUP	CHANNEL NUMBER*				
11	1	11	59	107	155	203
	2	35	83	131	179	227
	3	23	71	119	167	215
	4	47	95	143	191	239
12	1	12	60	108	156	204
	2	36	84	132	180	228
	3	24	72	120	168	216
	4	48	96	144	192	240

* For allocations of channel numbers to frequencies, see Table B4.2

Table B4.2: Channel Allocations for the 800 MHz Trunking Band (12.5 kHz channel spacing)

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
1	851.00625	806.00625	81	852.00625	807.00625	161	853.00625	808.00625
2	851.01875	806.01875	82	852.01875	807.01875	162	853.01875	808.01875
3	851.03125	806.03125	83	852.03125	807.03125	163	853.03125	808.03125
4	851.04375	806.04375	84	852.04375	807.04375	164	853.04375	808.04375
5	851.05625	806.05625	85	852.05625	807.05625	165	853.05625	808.05625
6	851.06875	806.06875	86	852.06875	807.06875	166	853.06875	808.06875
7	851.08125	806.08125	87	852.08125	807.08125	167	853.08125	808.08125
8	851.09375	806.09375	88	852.09375	807.09375	168	853.09375	808.09375
9	851.10625	806.10625	89	852.10625	807.10625	169	853.10625	808.10625
10	851.11875	806.11875	90	852.11875	807.11875	170	853.11875	808.11875
11	851.13125	806.13125	91	852.13125	807.13125	171	853.13125	808.13125
12	851.14375	806.14375	92	852.14375	807.14375	172	853.14375	808.14375
13	851.15625	806.15625	93	852.15625	807.15625	173	853.15625	808.15625
14	851.16875	806.16875	94	852.16875	807.16875	174	853.16875	808.16875
15	851.18125	806.18125	95	852.18125	807.18125	175	853.18125	808.18125
16	851.19375	806.19375	96	852.19375	807.19375	176	853.19375	808.19375
17	851.20625	806.20625	97	852.20625	807.20625	177	853.20625	808.20625
18	851.21875	806.21875	98	852.21875	807.21875	178	853.21875	808.21875
19	851.23125	806.23125	99	852.23125	807.23125	179	853.23125	808.23125
20	851.24375	806.24375	100	852.24375	807.24375	180	853.24375	808.24375
21	851.25625	806.25625	101	852.25625	807.25625	181	853.25625	808.25625
22	851.26875	806.26875	102	852.26875	807.26875	182	853.26875	808.26875
23	851.28125	806.28125	103	852.28125	807.28125	183	853.28125	808.28125
24	851.29375	806.29375	104	852.29375	807.29375	184	853.29375	808.29375
25	851.30625	806.30625	105	852.30625	807.30625	185	853.30625	808.30625
26	851.31875	806.31875	106	852.31875	807.31875	186	853.31875	808.31875
27	851.33125	806.33125	107	852.33125	807.33125	187	853.33125	808.33125
28	851.34375	806.34375	108	852.34375	807.34375	188	853.34375	808.34375
29	851.35625	806.35625	109	852.35625	807.35625	189	853.35625	808.35625
30	851.36875	806.36875	110	852.36875	807.36875	190	853.36875	808.36875
31	851.38125	806.38125	111	852.38125	807.38125	191	853.38125	808.38125
32	851.39375	806.39375	112	852.39375	807.39375	192	853.39375	808.39375
33	851.40625	806.40625	113	852.40625	807.40625	193	853.40625	808.40625
34	851.41875	806.41875	114	852.41875	807.41875	194	853.41875	808.41875

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
35	851.43125	806.43125	115	852.43125	807.43125	195	853.43125	808.43125
36	851.44375	806.44375	116	852.44375	807.44375	196	853.44375	808.44375
37	851.45625	806.45625	117	852.45625	807.45625	197	853.45625	808.45625
38	851.46875	806.46875	118	852.46875	807.46875	198	853.46875	808.46875
39	851.48125	806.48125	119	852.48125	807.48125	199	853.48125	808.48125
40	851.49375	806.49375	120	852.49375	807.49375	200	853.49375	808.49375
41	851.50625	806.50625	121	852.50625	807.50625	201	853.50625	808.50625
42	851.51875	806.51875	122	852.51875	807.51875	202	853.51875	808.51875
43	851.53125	806.53125	123	852.53125	807.53125	203	853.53125	808.53125
44	851.54375	806.54375	124	852.54375	807.54375	204	853.54375	808.54375
45	851.55625	806.55625	125	852.55625	807.55625	205	853.55625	808.55625
46	851.56875	806.56875	126	852.56875	807.56875	206	853.56875	808.56875
47	851.58125	806.58125	127	852.58125	807.58125	207	853.58125	808.58125
48	851.59375	806.59375	128	852.59375	807.59375	208	853.59375	808.59375
49	851.60625	806.60625	129	852.60625	807.60625	209	853.60625	808.60625
50	851.61875	806.61875	130	852.61875	807.61875	210	853.61875	808.61875
51	851.63125	806.63125	131	852.63125	807.63125	211	853.63125	808.63125
52	851.64375	806.64375	132	852.64375	807.64375	212	853.64375	808.64375
53	851.65625	806.65625	133	852.65625	807.65625	213	853.65625	808.65625
54	851.66875	806.66875	134	852.66875	807.66875	214	853.66875	808.66875
55	851.68125	806.68125	135	852.68125	807.68125	215	853.68125	808.68125
56	851.69375	806.69375	136	852.69375	807.69375	216	853.69375	808.69375
57	851.70625	806.70625	137	852.70625	807.70625	217	853.70625	808.70625
58	851.71875	806.71875	138	852.71875	807.71875	218	853.71875	808.71875
59	851.73125	806.73125	139	852.73125	807.73125	219	853.73125	808.73125
60	851.74375	806.74375	140	852.74375	807.74375	220	853.74375	808.74375
61	851.75625	806.75625	141	852.75625	807.75625	221	853.75625	808.75625
62	851.76875	806.76875	142	852.76875	807.76875	222	853.76875	808.76875
63	851.78125	806.78125	143	852.78125	807.78125	223	853.78125	808.78125
64	851.79375	806.79375	144	852.79375	807.79375	224	853.79375	808.79375
65	851.80625	806.80625	145	852.80625	807.80625	225	853.80625	808.80625
66	851.81875	806.81875	146	852.81875	807.81875	226	853.81875	808.81875
67	851.83125	806.83125	147	852.83125	807.83125	227	853.83125	808.83125
68	851.84375	806.84375	148	852.84375	807.84375	228	853.84375	808.84375
69	851.85625	806.85625	149	852.85625	807.85625	229	853.85625	808.85625
70	851.86875	806.86875	150	852.86875	807.86875	230	853.86875	808.86875
71	851.88125	806.88125	151	852.88125	807.88125	231	853.88125	808.88125
72	851.89375	806.89375	152	852.89375	807.89375	232	853.89375	808.89375
73	851.90625	806.90625	153	852.90625	807.90625	233	853.90625	808.90625
74	851.91875	806.91875	154	852.91875	807.91875	234	853.91875	808.91875
75	851.93125	806.93125	155	852.93125	807.93125	235	853.93125	808.93125
76	851.94375	806.94375	156	852.94375	807.94375	236	853.94375	808.94375
77	851.95625	806.95625	157	852.95625	807.95625	237	853.95625	808.95625
78	851.96875	806.96875	158	852.96875	807.96875	238	853.96875	808.96875
79	851.98125	806.98125	159	852.98125	807.98125	239	853.98125	808.98125
80	851.99375	806.99375	160	852.99375	807.99375	240	853.99375	808.99375

B5 Block, Group and Channel Structure for the 800 MHz Trunking Band (25 kHz channel spacing)

Table B5.1: Block and Group Structure for the 800 MHz Trunking Band (25 kHz channel spacing)

BLOCK	GROUP	CHANNEL NUMBER*				
1	1	**1**	**25**	**49**	**73**	**97**
	2	**13**	**37**	**61**	**85**	**109**
	3	**7**	**31**	**55**	**79**	**103**
	4	**19**	**43**	**67**	**91**	**115**
2	1	**2**	**26**	**50**	**74**	**98**
	2	**14**	**38**	**62**	**86**	**110**
	3	**8**	**32**	**56**	**80**	**104**
	4	**20**	**44**	**68**	**92**	**116**
3	1	**3**	**27**	**51**	**75**	**99**
	2	**15**	**39**	**63**	**87**	**111**
	3	**9**	**33**	**57**	**81**	**105**
	4	**21**	**45**	**69**	**93**	**117**
4	1	**4**	**28**	**52**	**76**	**100**
	2	**16**	**40**	**64**	**88**	**112**
	3	**10**	**34**	**58**	**82**	**106**
	4	**22**	**46**	**70**	**94**	**118**
5	1	**5**	**29**	**53**	**77**	**101**
	2	**17**	**41**	**65**	**89**	**113**
	3	**11**	**35**	**59**	**83**	**107**
	4	**23**	**47**	**71**	**95**	**119**
6	1	**6**	**30**	**54**	**78**	**102**
	2	**18**	**42**	**66**	**90**	**114**
	3	**12**	**36**	**60**	**84**	**108**
	4	**24**	**48**	**72**	**96**	**120**

* For allocations of channel numbers to frequencies, see Table B5.2

Table B5.2: Channel Allocations for the 800 MHz Trunking Band (25 kHz channel spacing)

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
1	851.0125	806.0125	61	852.5125	807.5125
2	851.0375	806.0375	62	852.5375	807.5375
3	851.0625	806.0625	63	852.5625	807.5625
4	851.0875	806.0875	64	852.5875	807.5875
5	851.1125	806.1125	65	852.6125	807.6125
6	851.1375	806.1375	66	852.6375	807.6375
7	851.1625	806.1625	67	852.6625	807.6625
8	851.1875	806.1875	68	852.6875	807.6875
9	851.2125	806.2125	69	852.7125	807.7125
10	851.2375	806.2375	70	852.7375	807.7375
11	851.2625	806.2625	71	852.7625	807.7625
12	851.2875	806.2875	72	852.7875	807.7875

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
13	851.3125	806.3125	73	852.8125	807.8125
14	851.3375	806.3375	74	852.8375	807.8375
15	851.3625	806.3625	75	852.8625	807.8625
16	851.3875	806.3875	76	852.8875	807.8875
17	851.4125	806.4125	77	852.9125	807.9125
18	851.4375	806.4375	78	852.9375	807.9375
19	851.4625	806.4625	79	852.9625	807.9625
20	851.4875	806.4875	80	852.9875	807.9875
21	851.5125	806.5125	81	853.0125	808.0125
22	851.5375	806.5375	82	853.0375	808.0375
23	851.5625	806.5625	83	853.0625	808.0625
24	851.5875	806.5875	84	853.0875	808.0875
25	851.6125	806.6125	85	853.1125	808.1125
26	851.6375	806.6375	86	853.1375	808.1375
27	851.6625	806.6625	87	853.1625	808.1625
28	851.6875	806.6875	88	853.1875	808.1875
29	851.7125	806.7125	89	853.2125	808.2125
30	851.7375	806.7375	90	853.2375	808.2375
31	851.7625	806.7625	91	853.2625	808.2625
32	851.7875	806.7875	92	853.2875	808.2875
33	851.8125	806.8125	93	853.3125	808.3125
34	851.8375	806.8375	94	853.3375	808.3375
35	851.8625	806.8625	95	853.3625	808.3625
36	851.8875	806.8875	96	853.3875	808.3875
37	851.9125	806.9125	97	853.4125	808.4125
38	851.9375	806.9375	98	853.4375	808.4375
39	851.9625	806.9625	99	853.4625	808.4625
40	851.9875	806.9875	100	853.4875	808.4875
41	852.0125	807.0125	101	853.5125	808.5125
42	852.0375	807.0375	102	853.5375	808.5375
43	852.0625	807.0625	103	853.5625	808.5625
44	852.0875	807.0875	104	853.5875	808.5875
45	852.1125	807.1125	105	853.6125	808.6125
46	852.1375	807.1375	106	853.6375	808.6375
47	852.1625	807.1625	107	853.6625	808.6625
48	852.1875	807.1875	108	853.6875	808.6875
49	852.2125	807.2125	109	853.7125	808.7125
50	852.2375	807.2375	110	853.7375	808.7375
51	852.2625	807.2625	111	853.7625	808.7625
52	852.2875	807.2875	112	853.7875	808.7875
53	852.3125	807.3125	113	853.8125	808.8125
54	852.3375	807.3375	114	853.8375	808.8375
55	852.3625	807.3625	115	853.8625	808.8625
56	852.3875	807.3875	116	853.8875	808.8875
57	852.4125	807.4125	117	853.9125	808.9125
58	852.4375	807.4375	118	853.9375	808.9375

CH #	BASE TX	BASE RX	CH #	BASE TX	BASE RX
59	852.4625	807.4625	119	853.9625	808.9625
60	852.4875	807.4875	120	853.9875	808.9875

Annex C - Frequency-Distance Constraints

Overview of frequency-distance constraints

The frequency-distance constraints are intended to support technology flexible networks (that apply equally to both digital and analog systems) and provide a frequency coordination framework that balances the risk of interference with spectrum efficiency.

The frequency-distance constraints are based on a notional equipment configuration using statistical propagation models.

The methodology used for calculation of the frequency-distance constraints is outlined in Spectrum Planning Report SPP 08/14 (Derivation of 400 MHz band land mobile frequency-distance constraints used in RALI LM8)). This report was released in September 2014 in support of consultation on an update to LM8. Following industry consultation, changes were made to the resulting frequency-distance constraints when LM8 was finalised in June 2015 (see section below – "Modifications from Spectrum Planning Report SPP 08/14"). The planning report documents the key equipment performance assumptions that were used in that process.

In this regard the international standards considered (as documented in the 2014 spectrum planning report) in deriving the frequency-distance constraints in LM8 included:

> Part 90 of the FCC Rules; Rule 90.210 (Emission masks) and Rule 90.221 (Adjacent channel power limits) [13]
> ETSI EN 300 392-2 [14]
> ETSI EN 300 113-1 V1.7.1 (2011-11) [15]
> ETSI EN 300 086-1 V1.4.1 (2010-06) [16]

While not specifically mentioned, the Australian analog standard AS/NZS 4295 Analog speech (angle modulated) equipment operating in land mobile and fixed services bands in the range 29.7 MHz to 1 GHz [17] was considered as it is largely based on ETSI EN 300 086 [16] and its parameters are subsumed by those of standards referenced above.

Similarly, the parameters of the 2018 voluntary Australian digital standard AS/NZS 4768.3 Digital radio equipment operating in land mobile and fixed services bands in the range 29.7 MHz to 1 GHz [18], while it was not considered in the 2015 LM8 release, it's parameters are also subsumed by those standards referenced above including ETSI EN 300 113 [15].

Both Australian Standards (AS/NZS 4295 and AS/NZS 4768.3) provide the Australian parameters to the ETSI standards they reference and are listed above. Two examples of Australian specific parameters include extending the frequencies used from 470 MHz to 520 MHz and maximum power limits.

Subject to the consideration of local factors and employing good engineering site practices equipment meeting the above-mentioned performance requirements (or similar requirements) should be compatible with the assumptions used in the calculation of the frequency-distance constraints.

Relationship of frequency-distance constraints to interference management

As outlined above the frequency-distance constraints for the various LM8 models are based around the notional models, their equipment configuration and equipment performance assumptions. During an interference investigation, one of the factors the ACMA may take into account is whether equipment is being operated in accordance with those parameters.

For example, a radiocommunications receiver that does not meet notional equipment configuration and the level of performance of the reference standards may not be afforded protection from interference from licenced radiocommunications transmitters operating in accordance with the conditions of the associated licence. Likewise, a transmitter whose adjacent channel emission do not meet the level of performance of the reference standards and causes interference to an adjacent channel service, whose equipment meets the referenced standards, would need to take interference remediation measures.

Site management

LM8 frequency-distance constraints do not consider all interference mechanisms that potentially arise when services are located in close proximity to one another. Consequently, it is important for the radiocommunications designer to consider local factors and employ good engineering practices to ensure their radiocommunications system operates satisfactorily. For example, for single frequency systems the LM8 frequency-distance constraints do not provide protection from blocking caused by services located in close proximity to one another with a frequency separation beyond 100 kHz.

To minimise the impacts of blocking, good engineering practice could include using vertical separation on the same tower and the use of appropriate filtering in circumstances where sites need to be located close to each other.

Modifications from Spectrum Planning Report SPP 08/14

Consideration was given to feedback received as part of the consultation process (IFC 42/2014) and the following changes were made from the frequency-distance constraints as determined in the SPP 08/14:

> Frequency-distance constraints are symmetrical and based on worst case values. That is, values for new 6.25 kHz to existing 12.5 kHz are the same as new 12.5 kHz to existing 6.25 kHz with worst case values being used.

> For low powered systems, to address concerns about small separation distances in low powered systems when channel bandwidths overlap, in such circumstances distances have been set at 10 km.

> Adjusting 1st adjacent channel separation for 12.5 and 25 kHz high powered two frequency systems to be 0 km. Rationale being that either performance will be better than modelled and any degradation in adjacent channel performance will be limited to mobile receivers at edge of the 40km service area (i.e. 37-40 km) in close proximity to unwanted base station.

> Reference levels for 25/12.5 kHz systems are to be the same. For 6.25 kHz systems levels will be adjusted by 3 dB in recognition of smaller bandwidth.

> Calculating separation distances by determining a reference propagation loss at the co-channel separation distance and using the FDR values to determine what loss (and hence distances) are required at other frequency separations.

SPP 8/2014: Derivation of 400 MHz band land mobile frequency distance constraints used in RALI LM8	The spectrum planning report - Deri

LM8 frequency-distance constraint tables before and after simplifications	LM8FrequencyDistanceSpreadsheet v2.xlsx

C1. Cull Limits Applicable to Frequency-Distance Constraints

Table C.1: Cull Limits Applicable to Frequency-Distance Constraints

Band of Operation	Cull Radius	Cull Frequency Range		
		Single Frequency Segment	Two Frequency Segment	
			Tx	Rx
VHF Mid Band	140 km	± 100 kHz	± 100 kHz	± 100 kHz
VHF High Band	140 km	± 100 kHz	± 100 kHz	± 100 kHz
400 MHz Band	120 km	± 100 kHz	± 100 kHz	± 100 kHz
800 MHz Trunking Band	200 km	N/A	± 25 kHz	± 25 kHz

Note: These cull limits do not consider the impact of blocking.

C2. Frequency-Distance Constraints for Single Frequency LMRS in the VHF Mid and High Bands

The following frequency-distance constraints apply whenever two LMRS systems require coordination in the VHF Mid and High Bands, and where:

> both are single-frequency systems; or

> both are two-frequency systems and the transmit frequency of one system is with 100kHz of the receive frequency of the other; or

> one is a single-frequency system operating within 100kHz of the transmit or receive frequency of the other (two-frequency) system.

Table C2.1: Frequency-Distance Constraints for 6.25 kHz Single Frequency LMRS in the VHF Hight Band

Frequency Distance Constraints for **Single Frequency** Services			
Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**140**	**140**	**140**
< 12.5	**90**	**130**	**136**
< 18.75	**33**	**51**	**106**
< 25	**33**	**30**	**64**
< 31.25	**26**	**23**	**48**
< 62.5	**17**	**15**	**47**
< 68.75	**17**	**15**	**42**
< 75	**16**	**14**	**18**
< 93.75	**15**	**14**	**18**
< 100	**14**	**13**	**18**
≥ 100	**0**	**0**	**0**

Table C2.2: Frequency-Distance Constraints for 12.5 kHz Single Frequency LMRS in the VHF Mid and High Bands

Frequency Distance Constraints for **Single Frequency** Services			
Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**140**	**140**	**140**
< 12.5	**130**	**130**	**135**
< 18.75	**51**	**76**	**118**
< 25	**30**	**22**	**76**
< 31.25	**23**	**16**	**48**
< 62.5	**15**	**8.6**	**46**
< 68.75	**15**	**8.5**	**41**
< 75	**14**	**8**	**15**
< 81.25	**14**	**7.3**	**14**
< 87.5	**14**	**6.9**	**14**
< 93.75	**14**	**6.5**	**14**
< 100	**13**	**6.3**	**14**
≥ 100	**0**	**0**	**0**

Table C2.3: Frequency-Distance Constraints for 25 kHz Single Frequency LMRS in the VHF Mid and High Bands

Frequency Distance Constraints for **Single Frequency** Services			
Frequency Offset (kHz)	Distance Separation (km)		
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**140**	**140**	**140**
< 12.5	**136**	**135**	**135**
< 18.75	**106**	**118**	**118**
< 25	**64**	**76**	**82**
< 31.25	**48**	**48**	**56**
< 56.25	**47**	**46**	**51**
< 62.5	**47**	**46**	**50**
< 68.75	**42**	**41**	**46**
< 75	**18**	**15**	**27**
< 81.25	**18**	**14**	**19**
< 100	**18**	**14**	**18**
≥ 100	**0**	**0**	**0**

C3. Frequency-Distance Constraints for Single Frequency LMRS in the 400 MHz Band

The following frequency-distance constraints apply whenever two LMRS systems require coordination in the 400MHz Band, and where:

> both are single-frequency systems; or

> both are two-frequency systems and the transmit frequency of one system is with 100kHz of the receive frequency of the other; or
> one is a single-frequency system operating within 100kHz of the transmit or receive frequency of the other (two-frequency) system.

Table C3.1: Frequency-Distance Constraints for 6.25 kHz Single Frequency LMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**120**	**120**	**120**
< 12.5	**70**	**110**	**116**
< 18.75	**8.1**	**19**	**86**
< 25	**8.1**	**7.5**	**44**
< 31.25	**6.4**	**5.7**	**12**
< 37.5	**4.1**	**3.6**	**5.1**
< 93.75	**4.1**	**3.6**	**4.7**
< 100	**4.1**	**3.6**	**4.5**
≥ 100	**0**	**0**	**0**

Table C3.2: Frequency-Distance Constraints for 12.5 kHz Single Frequency LMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**120**	**120**	**120**
< 12.5	**110**	**110**	**115**
< 18.75	**19**	**57**	**98**
< 25	**7.5**	**5.4**	**56**
< 31.25	**5.7**	**4.1**	**13**
< 37.5	**3.6**	**2.1**	**4.6**
< 43.75	**3.6**	**2.1**	**3.6**
< 100	**3.6**	**2.1**	**2.4**
≥ 100	**0**	**0**	**0**

Table C3.3: Frequency-Distance Constraints for 25 kHz Single Frequency LMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**120**	**120**	**120**
< 12.5	**116**	**115**	**115**
< 18.75	**86**	**98**	**98**
< 25	**44**	**56**	**62**
< 31.25	**12**	**13**	**23**
< 37.5	**5.1**	**4.6**	**7.9**
< 43.75	**4.7**	**3.6**	**4.6**
< 50	**4.7**	**2.4**	**2.8**
< 87.5	**4.7**	**2.4**	**2.4**
< 93.75	**4.7**	**2.4**	**2.1**
< 100	**4.5**	**2.4**	**1.7**
≥ 100	**0**	**0**	**0**

C4. Frequency-Distance Constraints for Single Frequency LPMRS in the VHF High Band and the 400 MHz Band

The following frequency-distance constraints apply whenever two LPMRS systems require coordination, and where:

> both are single-frequency systems; or

> both are two-frequency systems and the transmit frequency of one system is with 100kHz of the receive frequency of the other; or

> one is a single-frequency system operating within 100kHz of the transmit or receive frequency of the other (two-frequency) system.

Table C4.1: Frequency-Distance Constraints for Single Frequency LPMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**10**	**10**	**10**
< 12.5	**1.9**	**10**	**10**
< 18.75	**0.3**	**0.5**	**10**
< 25	**0.3**	**0.3**	**0.8**
< 31.25	**0.3**	**0**	**0.4**
≥ 31.25	**0**	**0**	**0**
Proposed 12.5 kHz from Existing			
< 12.5	**10**	**10**	**10**
< 18.75	**0.5**	**1.2**	**10**
< 25	**0.3**	**0**	**1.2**
< 31.25	**0**	**0**	**0.4**
≥ 31.25	**0**	**0**	**0**
Proposed 25 kHz from Existing			
< 18.75	**10**	**10**	**10**
< 25	**0.8**	**1.2**	**10**
< 31.25	**0.4**	**0.4**	**0.5**
< 37.5	**0**	**0**	**0.3**
≥ 37.5	**0**	**0**	**0**

Table C4.2: Frequency-Distance Constraints for Single Frequency LPMRS in the VHF High Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**10**	**10**	**10**
< 12.5	**1.9**	**10**	**10**
< 18.75	**0.3**	**0.5**	**10**
< 25	**0.3**	**0.3**	**0.8**
< 31.25	**0.3**	**0**	**0.4**
< 62.5	**0**	**0**	**0.4**
< 68.75	**0**	**0**	**0.3**
≥ 68.75	**0**	**0**	**0**
Proposed 12.5 kHz from Existing			
< 12.5	**10**	**10**	**10**
< 18.75	**0.5**	**1.2**	**10**
< 25	**0.3**	**0**	**1.2**
< 62.5	**0**	**0**	**0.4**
< 68.75	**0**	**0**	**0.3**
≥ 68.75	**0**	**0**	**0**
Proposed 25 kHz from Existing			
< 18.75	**10**	**10**	**10**
< 25	**0.8**	**1.2**	**10**
< 31.25	**0.4**	**0.4**	**0.6**
< 62.5	**0.4**	**0.4**	**0.5**
< 68.75	**0.3**	**0.3**	**0.4**
< 75	**0**	**0**	**0.3**
≥ 75	**0**	**0**	**0**

C5. Frequency-Distance Constraints for Single Frequency LMRS and LPMRS in the VHF High Band and the 400 MHz Band

The following frequency-distance constraints apply whenever an LMRS and LPMRS system require coordination, and where:

> both are single-frequency systems; or
> both are two-frequency systems and the transmit frequency of one system is with 100kHz of the receive frequency of the other; or
> one is a single-frequency system operating within 100kHz of the transmit or receive frequency of the other (two-frequency) system.

Table C5.1: Frequency-Distance Constraints for 6.25 kHz Single Frequency LMRS vs LPMRS in the VHF High Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**116**	**111**	**111**
< 12.5	**35**	**91**	**103**
< 18.75	**4.5**	**8**	**54**
< 25	**4.5**	**4.3**	**14**
< 31.25	**3.9**	**3.5**	**7**
< 62.5	**2.9**	**2.6**	**6.7**
< 68.75	**2.9**	**2.6**	**5.4**
< 75	**2.8**	**2.6**	**3.7**
< 87.5	**2.7**	**2.5**	**3.7**
< 100	**2.6**	**2.5**	**3.6**
≥ 100	**0**	**0**	**0**

Table C5.2: Frequency-Distance Constraints for 12.5 kHz Single Frequency LMRS vs LPMRS in the VHF High Band.

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**111**	**105**	**111**
< 12.5	**91**	**92**	**102**
< 18.75	**8**	**23**	**70**
< 25	**4.3**	**3.4**	**23**
< 31.25	**3.5**	**2.8**	**7**
< 62.5	**2.6**	**1.8**	**6.4**
< 68.75	**2.6**	**1.8**	**5.2**
< 75	**2.6**	**1.7**	**3.5**

< 87.5	**2.5**	**1.6**	**3.5**
< 100	**2.5**	**1.5**	**3.5**
≥ 100	**0**	**0**	**0**

Table C5.3: Frequency-Distance Constraints for 25 kHz Single Frequency LMRS vs LPMRS in the VHF High Band

Frequency Offset (kHz)	Distance Separation (km)	Frequency Offset (kHz)	Distance Separation (km)
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**111**	**111**	**111**
< 12.5	**103**	**102**	**102**
< 18.75	**54**	**70**	**71**
< 25	**14**	**23**	**27**
< 31.25	**7**	**7**	**10**
< 37.5	**6.7**	**6.4**	**7.9**
< 56.25	**6.7**	**6.4**	**7.8**
< 62.5	**6.7**	**6.4**	**7.7**
< 68.75	**5.4**	**5.2**	**6.4**
< 75	**3.7**	**3.5**	**4**
< 87.5	**3.7**	**3.5**	**3.1**
< 100	**3.6**	**3.5**	**3.1**
≥ 100	**0**	**0**	**0**

Table C5.4: Frequency-Distance Constraints for 6.25 kHz Single Frequency LMRS vs LPMRS in the 400 MHz band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**107**	**103**	**103**
< 12.5	**34**	**85**	**96**
< 18.75	**4.5**	**8**	**52**
< 25	**4.5**	**4.3**	**14**
< 31.25	**3.9**	**3.5**	**6**
< 37.5	**2.9**	**2.6**	**3.3**
< 93.75	**2.9**	**2.6**	**3.1**
< 100	**2.9**	**2.6**	**3**
≥ 100	**0**	**0**	**0**

Table C5.5: Frequency-Distance Constraints for 12.5 kHz Single Frequency LMRS vs LPMRS in the 400 MHz band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**103**	**97**	**103**
< 12.5	**85**	**86**	**95**
< 18.75	**8**	**23**	**67**
< 25	**4.3**	**3.4**	**23**
< 31.25	**3.5**	**2.8**	**6.1**
< 37.5	**2.6**	**1.8**	**3.1**
< 43.75	**2.6**	**1.8**	**2.6**
< 100	**2.6**	**1.8**	**2**
≥ 100	**0**	**0**	**0**

Table C5.6: Frequency-Distance Constraints for 25 kHz Single Frequency LMRS vs LPMRS in the 400 MHz band

Frequency Offset (kHz)	Distance Separation (km)	Frequency Offset (kHz)	Distance Separation (km)
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**103**	**103**	**103**
< 12.5	**96**	**95**	**95**
< 18.75	**52**	**67**	**68**
< 25	**14**	**23**	**27**
< 31.25	**6**	**6.1**	**9.2**
< 37.5	**3.3**	**3.1**	**4.4**
< 43.75	**3.1**	**2.6**	**3.1**
< 50	**3.1**	**2**	**2.2**
< 87.5	**3.1**	**2**	**2**
< 93.75	**3.1**	**2**	**1.8**
< 100	**3**	**2**	**1.6**
≥ 100	**0**	**0**	**0**

C6. Frequency-Distance Constraints for Two Frequency LMRS in the 400 MHz Band and the VHF Mid and High Bands

The following frequency-distance constraints apply whenever two systems requiring coordination are both two-frequency LMRS operating with the same frequency sense.

Table C6.1: Frequency-Distance Constraints for 6.25 kHz Two Frequency LMRS in the VHF High Bands

Frequency Distance Constraints for **Two Frequency** Services			
Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**100**	**100**	**100**
< 12.5	**52***	**86**	**94**
< 18.75	**0**	**0**	**63**
≥ 18.75	**0**	**0**	**0**

Table C6.2: Frequency-Distance Constraints for 12.5 kHz Two Frequency LMRS in the VHF Mid and High Bands

Frequency Distance Constraints for **Two Frequency** Services			
Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**100**	**100**	**100**
< 12.5	**86**	**87**	**94**
< 18.75	**0**	**0**	**74**
< 25	**0**	**0**	**47**
≥ 25	**0**	**0**	**0**

Table C6.3: Frequency-Distance Constraints for 25 kHz Two Frequency LMRS in the VHF Mid and High Bands

Frequency Distance Constraints for **Two Frequency** Services			
Frequency Offset (kHz)	Distance Separation (km)		
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**100**	**100**	**100**
< 12.5	**94**	**94**	**94**
< 18.75	**63**	**74**	**74**
< 25	**0**	**47**	**48**
≥ 25	**0**	**0**	**0**

Table C6.4: Frequency-Distance Constraints for Two Frequency LMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz LMRS from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**100**	**100**	**100**
< 12.5	**54***	**87**	**95**
< 18.75	**0**	**0**	**65**
≥ 18.75	**0**	**0**	**0**
Proposed 12.5 kHz LMRS from Existing			
< 6.25	**100**	**100**	**100**
< 12.5	**87**	**88**	**94**
< 18.75	**0**	**0**	**75**
< 25	**0**	**0**	**47**
≥ 25	**0**	**0**	**0**
Proposed 25 kHz LMRS from Existing			
< 6.25	**100**	**100**	**100**
< 12.5	**95**	**94**	**94**
< 18.75	**65**	**75**	**75**
< 25	**0**	**47**	**49**
≥ 25	**0**	**0**	**0**

* This base-to-base distance separation is not required if the services are co-sited (i.e. within 200m). This is because for the co-sited services the propagation path for the wanted and interfering signals is always the same and the receiver filtering will provide wanted-to-unwanted signal discrimination greater than the required protection ratio.

C7. Frequency-Distance Constraints for Two Frequency LPMRS in the VHF High Band and the 400 MHz Band

The following frequency-distance constraints apply whenever two systems requiring coordination are both two-frequency LPMRS operating with the same frequency sense.

Table C7.1: Frequency-Distance Constraints for Two Frequency LPMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**10**	**10**	**10**
< 12.5	**3.5**	**10**	**10**
< 18.75	**0**	**2.4**	**10**
< 25	**0**	**0**	**2.6**
< 31.25	**0**	**0**	**2.3**
≥ 31.25	**0**	**0**	**0**
Proposed 12.5 kHz from Existing			
< 12.5	**10**	**10**	**10**
< 18.75	**2.4**	**2.9**	**10**
< 25	**0**	**0**	**2.9**
< 31.25	**0**	**0**	**2.3**
≥ 31.25	**0**	**0**	**0**
Proposed 25 kHz from Existing			
< 18.75	**10**	**10**	**10**
< 25	**2.6**	**2.9**	**10**
< 31.25	**2.3**	**2.3**	**2.4**
≥ 31.25	**0**	**0**	**0**

Table C7.2: Frequency-Distance Constraints for Two Frequency LPMRS in the VHF High Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**10**	**10**	**10**
< 12.5	**3.5**	**10**	**10**
< 18.75	**0**	**2.4**	**10**
< 25	**0**	**0**	**2.6**
≥ 25	**0**	**0**	**0**
Proposed 12.5 kHz from Existing			
< 12.5	**10**	**10**	**10**
< 18.75	**2.4**	**2.9**	**10**
< 25	**0**	**0**	**2.9**
≥ 25	**0**	**0**	**0**
Proposed 25 kHz from Existing			
< 18.75	**10**	**10**	**10**
< 25	**2.6**	**2.9**	**10**
< 31.25	**0**	**0**	**2.5**
≥ 31.25	**0**	**0**	**0**

C8. Frequency-Distance Constraints for Two Frequency LMRS and LPMRS in the VHF High Band and the 400 MHz Band

The following frequency-distance constraints apply whenever an LMRS and an LPMRS system require coordination, and both are two-frequency systems operating with the same frequency sense.

Table C8.1: Frequency-Distance Constraints for 6.25 kHz Two Frequency LMRS vs LPMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**65**	**62**	**62**
< 12.5	**42**	**49**	**57**
< 18.75	**3.4**	**4.5**	**43**
< 25	**3.4**	**3.3**	**6.3**
< 31.25	**3.2**	**3.1**	**3.9**
< 93.75	**2.9**	**2.8**	**3**
< 100	**3**	**2.6**	**2.9**
≥ 100	**0**	**0**	**0**

Table C8.2: Frequency-Distance Constraints for 12.5 kHz Two Frequency LMRS vs LPMRS in the 400 MHz Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**62**	**58**	**62**
< 12.5	**49**	**50**	**56**
< 18.75	**4.5**	**9.4**	**44**
< 25	**3.3**	**3.1**	**9.4**
< 31.25	**3.1**	**2.9**	**3.9**
< 37.5	**2.8**	**2.5**	**2.9**
< 43.75	**2.8**	**2.5**	**2.8**
< 93.75	**2.8**	**2.5**	**2.6**
< 100	**2.6**	**2.5**	**2.6**
≥ 100	**0**	**0**	**0**

Table C8.3: Frequency-Distance Constraints for 25 kHz Two Frequency LMRS vs LPMRS in the 400 MHz Band.

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**62**	**62**	**62**
< 12.5	**57**	**56**	**56**
< 18.75	**43**	**44**	**44**
< 25	**6.3**	**9.4**	**41**
< 31.25	**3.9**	**3.9**	**4.9**
< 37.5	**3**	**2.9**	**3.4**
< 43.75	**3**	**2.8**	**2.9**
< 50	**3**	**2.6**	**2.7**
< 87.5	**3**	**2.6**	**2.6**
< 93.75	**3**	**2.6**	**2.5**
< 100	**2.9**	**2.6**	**2.5**
≥ 100	**0**	**0**	**0**

The following frequency-distance constraints apply whenever LMRS and LPMRS systems in the VHF High Band are to be coordinated (proposed and existing), use two frequency operation, and have the same frequency sense.

Table C8.4: Frequency-Distance Constraints for 6.25 kHz Two Frequency LMRS vs LPMRS in the VHF High Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 6.25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**65**	**62**	**62**
< 12.5	**42**	**48**	**56**
< 18.75	**3.3**	**4.3**	**43**
< 25	**3.3**	**3.2**	**5.9**
< 31.25	**3.1**	**3**	**4**
< 62.5	**2.8**	**2.7**	**3.9**
< 68.75	**2.8**	**2.7**	**3.6**
< 100	**2.8**	**2.7**	**2.9**
≥ 100	**0**	**0**	**0**

Table C8.5: Frequency-Distance Constraints for 12.5 kHz Two Frequency LMRS vs LPMRS in the VHF High Band.

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 12.5 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**62**	**58**	**62**
< 12.5	**48**	**49**	**56**
< 18.75	**4.3**	**8.9**	**44**
< 25	**3.2**	**3**	**8.8**
< 31.25	**3**	**2.8**	**4**
< 62.5	**2.7**	**2.5**	**3.8**
< 68.75	**2.7**	**2.5**	**3.5**
< 100	**2.7**	**2.5**	**2.7**
≥ 100	**0**	**0**	**0**

Table C8.6: Frequency-Distance Constraints for 25 kHz Two Frequency LMRS vs LPMRS in the VHF High Band

Frequency Offset (kHz)	Distance Separation (km)		
Proposed 25 kHz from Existing	Existing 6.25 kHz	Existing 12.5 kHz	Existing 25 kHz
< 6.25	**62**	**62**	**62**
< 12.5	**56**	**56**	**56**
< 18.75	**43**	**44**	**44**
< 25	**5.9**	**8.8**	**41**
< 31.25	**4**	**4**	**4.9**
< 56.25	**3.9**	**3.8**	**4.3**
< 62.5	**3.9**	**3.8**	**4.2**
< 68.75	**3.6**	**3.5**	**3.8**
< 75	**2.9**	**2.7**	**3.1**
< 100	**2.9**	**2.7**	**2.9**
≥ 100	**0**	**0**	**0**

C9. Frequency-Distance Constraints for Trunked Services in the 800 MHz Trunking Band

Table C9.1: Frequency-Distance Constraints for 12.5 kHz Trunked Services in the 800 MHz Band

Frequency-Distance Constraints for Trunked Services in the 800 MHz Trunking Band		
Frequency Offset (kHz)	Distance Separation (km)	
Proposed 12.5 kHz from Existing	Existing 12.5 kHz	Existing 25 kHz
< 12.5	**100**	**100**
< 25	**0**	**100**
≥ 25	**0**	**0**

Table C9.2: Frequency-Distance Constraints for 25 kHz Trunked Services in the 800 MHz Band

Frequency-Distance Constraints for Trunked Services in the 800 MHz Trunking Band		
Frequency Offset (kHz)	Distance Separation (km)	
Proposed 25 kHz from Existing	Existing 12.5 kHz	Existing 25 kHz
< 12.5	**100**	**100**
< 25	**100**	**100**
≥ 25	**0**	**0**

C10. Frequency-Distance Constraints for enclosed and short-range digital systems in the 400 MHz Band

The following frequency-distance constraints apply whenever enclosed or short-range digital system and a LMS require coordination, and both are operating with the same frequency sense.

The modified Hata urban model has been used in the calculations for enclosed and short-range digital services co-channel separation distances.

Table C10.1: Frequency Distance constraints requirements for 12.5 kHz and 25 kHz Enclosed and Short-range Digital Services in the 400 MHz Band

System 1	System 2	Distance Separation (km)							
		Two Frequency				Single Frequency			
	Offset (kHz)	Co-Ch	1st Adj	2nd Adj	<100	Co-Ch	1st Adj	2nd Adj	<100
Short-range Digital	**Short-range Digital**	**2**	**0**	**0**	**0**	**2**	**0.3**	**0**	**0**
Short-range Digital	**Enclosed**	**2**	**0**	**0**	**0**	**2**	**0. 2**	**0**	**0**
Enclosed	**Enclosed**	**0.5**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**
LPMRS (Low Power)	**Short-range Digital**	**5**	**0.3**	**0**	**0**	**7**	**0.3**	**0**	**0**

LPMRS (Low Power)	**Enclosed**	**5**	**0**	**0**	**0**	**5**	**0.2**	**0**	**0**
LMRS (High Power)	**Short-range Digital**	**45**	**0.6**	**0.4**	**0.3**	**50**	**1.7**	**0.7**	**0.4**
LMRS (High Power)	**Enclosed**	**45**	**0.5**	**0.3**	**0.3**	**45**	**0.8**	**0.4**	**0.2**

Coordination between Enclosed or Short-range Digital systems and LPMRS Crane systems (Special Condition AU) needs to be undertaken as LPMRS to LPMRS systems due to the elevated antenna height of the Crane system.

Annex D - Intermodulation Checks

Receiver and transmitter intermodulation checks are required to be performed for two-signal 3rd order and two-signal 5th order products. These intermodulation products have the potential to cause interference as a result of:

> Emissions from two existing transmitters mixing and falling within the 'hit' range of an existing (Scenario 1) or proposed receiver (Scenario 2); or

> Emissions from the proposed transmitter mixing with emissions from an existing transmitter and falling within the 'hit' range of an existing (Scenario 3) or proposed receiver (Scenario 4).

Scenarios 2, 3 and 4 are required to be assessed using the applicable frequency-distance constraints detailed in Table D1.

D1. Cull Limits Applicable to Intermodulation Checks

Table D1: Cull Limits Applicable to Intermodulation Checks

	Frequency - Distance Cull Range	
Receiver Intermodulation		
Description	Third Order Intermodulation	Fifth Order Intermodulation
Scenario 1 – *caused in existing receiver by existing transmitter*	Not applicable to assignment of new systems	
Scenario 2 - *caused in proposed receiver by existing transmitters*	Transmitters within 2 km & 2.25 MHz of proposed receiver frequency	Transmitters within 0.2 km & 0.375 MHz of proposed receiver frequency
Scenarios 3 and 4 -*caused in proposed or existing receiver by proposed transmitter as Outer*	Transmitters within 4 km & 1.125 MHz of proposed transmitter frequency Receivers within 2 km & 2.25 MHz of proposed transmitter frequency	Transmitters within 0.4 km & 0.125 MHz of proposed transmitter frequency Receivers within 0.2 km & 0.375 MHz of proposed transmitter frequency
Scenarios 3 and 4- *caused in proposed or existing receiver by proposed transmitter as Inner*	Transmitters within 4 km & 1.125 MHz of proposed transmitter frequency Receivers within 2 km & 1.125 MHz of proposed transmitter frequency	Transmitters within 0.4 km & 0.125 MHz of proposed transmitter frequency Receivers within 0.2 km & 0.25 MHz of proposed transmitter frequency
Transmitter Intermodulation		
Scenarios 2, 3 and 4 - *caused by proposed or existing transmitters*	Transmitters and receivers within 0.2 km & within the band 20 MHz above and 20 MHz below the proposed transmitter frequency	

D2. Frequency Offset from Victim Receiver Within Which an Intermodulation 'Hit' is Deemed to Occur

Table D2: Frequency Offset from Victim Receiver within which an Intermodulation 'Hit' is Deemed to Occur

Frequency offset from receiver centre frequency (± kHz)						
Interferer channel width*	Receiver channel width / Intermodulation Order					
	6.25 kHz		12.5 kHz		25 kHz	
	3rd order	5th order	3rd order	5th order	3rd order	5th order
6.25 kHz	**9.375**	**12.5**	**12.25**	**15.5**	**18.5**	**22**
12.5 kHz	**15.125**	**21.125**	**18**	**24**	**24.5**	**30.5**
25 kHz	**28**	**40**	**30.5**	**43**	**37**	**49**

* The interferer channel width is taken as the wider of the two intermodulation-producing interferers

D3. Expressions for Evaluating Intermodulation Interference

The following equations should be used to evaluate receiver generated intermodulation interference. When the equations are satisfied, the level of the intermodulation product is not high enough[1] to cause harmful interference.

The equation for two signal 3rd order receiver intermodulation is:

$$PR + 2^*(EIRP_{dBm} - L_{b\ inner} + L_c - RF_{inner}) + (EIRP_{dBm} - L_{b\ outer} + L_c - RF_{outer}) + ECR\ 2/3 \leq RS$$

The equation for two signal 5th order receiver intermodulation is:

$$PR + 3^*(EIRP_{dBm} - L_{b\ inner} + L_c - RF_{inner}) + 2^*(EIRP_{dBm} - L_{b\ outer} + L_c - RF_{outer}) + ECR\ 2/5 \leq RS$$

The parameter values applicable to the above equations are specified in Table D3.

[1] It is assumed that harmful interference will occur if the level of the intermodulation product is greater than the usable sensitivity level (RS).

D4. Parameter Values Applicable to Intermodulation Checks

Table D3: Parameter Values Applicable to Intermodulation Checks

Parameter	Assumed Value
RS (Base Receiver Usable Sensitivity[2])	-119 dBm (800 MHz Trunking Band) -116 dBm (400 MHz Band) -107 dBm (VHF High Band) -101 dBm (VHF Mid Band)
PR (Protection Ratio)	5 dB for 12 dB SINAD
$EIRP_{dBm}$ (Transmitter EIRP)	30+ 10Log($EIRP_{Watts}$) (e.g. 49.2 dBm for LMRS @ 200m HAAT) 39.2 dBm (8.3 W for LPMRS)
L_b (propagation loss: from 'inner' or 'outer' transmitter to victim receiver)	Free Space Loss + 10 dB
L_c (antenna gain and feeder loss)	2 dBi (VHF) 6 dBi (400 MHz & 800 MHz Bands)
RF (receiver front-end response: achieved by the RF selectivity of a receiver in conjunction with two cavity filters)	**For the VHF Mid and High Bands:** **2 dB** for Freq Offset <= 0.06 MHz **2 x [23.3 + 18.7*log(Freq Offset)] dB** for 0.06 < Freq Offset <= 1.5 MHz **2 x [23.3 + 18.7*log(Freq Offset) + (Freq Offset – 1.5)*18/1.5]** dB for 1.5 MHz < Freq Offset <= 4.4 MHz **140 dB** for Freq Offset > 4.4 MHz **For the 400 MHz Band:** **5 dB** for Freq Offset <=0.1 MHz **5 + 60 log [1+ (2 × (Freq Offset - 0.1)/1.5)$^{0.8}$]dB** for 0.1 < Freq Offset <= 15 MHz **70 dB** for Freq Offset > 15 MHz **For the 800 MHz Trunking Band:** **2 + 60*log[1 + (2*Freq Offset/5)$^{1.5}$] dB** for Freq Offset <= 2.5 MHz **2 + 60*log[1 + (2*Freq Offset/5)^{2}] dB** for 2.5 < Freq Offset <= 9 MHz **70 dB** for Freq Offset > 9 MHz
ECR (effective conversion ratio of intermodulation products)	2 Signal Third Order: ECR 2/3 = -9 dB 2 Signal Fifth Order: ECR 2/5 = -28 dB

[2] These are static usable sensitivity levels assumed by the service model for base receivers in built up areas and take into consideration man made noise levels. It is expected that receivers will have bench measured sensitivity levels at their rf input terminals better than those specified.

Annex E - Inter-service Coordination

The following inter-service coordination requirements have been prepared by the ACMA. Note that this list is not exhaustive. In some cases, specific ITU-R Recommendations may exist to address inter-service coordination. However, because of the diversity and complexity of sharing situations which may arise, it is not possible to provide rigorous and explicit procedures covering all inter-service coordination requirements. In these cases, coordination defaults to the identification of all non-homogeneous services in the band in question, followed by a manual assessment of their impact on the interference environment.

E1. VHF Mid and High Assignments Adjacent to Television Channels 6

In the absence of detailed coordination procedures, no assignments for new fixed or mobile services should be made in the frequency band 168–174 MHz within the frequency/distance limits specified in Table E1 from television services operating on channel 6 (177.5 MHz). These requirements are in addition to those of embargo 32.

Table E1: Frequency-Distance constraints for services operating near TV Ch6

Frequency Band	Distance Separation
168.0–172.8 MHz	3 km
172.8–173.3 MHz	10 km
173.3–174.0 MHz	60 km

E2. 400 MHz Assignments in the Vicinity of Wideband Fixed Services

The frequency coordination requirements detailed in RALI FX01 [5] should be observed for 403 – 500 MHz assignments within 160 km of wideband fixed services.

For assignments within 400 km of wideband fixed services licensed to Telstra on 501.9, 504.3, 506.7, 509.1, 513.1, 515.5 and 517.9 MHz, additional coordination requirements may apply. Contact the Manager, Spectrum Engineering Section in these instances.

There are restrictions on the assignment of certain trunked channels in low demand areas to provide protection to wideband fixed services. These restrictions are detailed in Embargo 19 of RALI MS 3 [3].

E3. Coordination with spectrum licensed services

The 800 MHz TLMS band is in close frequency proximity to spectrum-licensed services.

The 'Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters – 700 MHz Band) 2023', and 'Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters – 850/900 MHz Bands) 2021' set out protection requirements for services operating frequency adjacent to spectrum licensed transmitters. In summary, these protection requirements are:

> Protection of TLMS radiocommunications receivers from spectrum licensed radiocommunications transmitters is on a first-in-time basis.

> Any existing TLMS base-station receiver licensed prior to the registration of a spectrum licensed transmitter in the Register[25] is to be provided protection to protection ratio specified in this RALI. Initial assessment can be made using the applicable protection ratio and sensitivity level with the unwanted emissions from the spectrum licensed transmitter that fall within the passband of the receiver. Receiver blocking of TLMS should also be checked, using the blocking criteria of 90 dB above the receiver sensitivity level and additional RF selectivity (Table D3) with the in-band power of the spectrum licensed transmitter. Applicable protection ratios and sensitivity levels are:

  > For coordination between 700 MHz spectrum licensed transmitters and PMP receivers licensed after 1 July 2024: a receiver sensitivity of -110 dBm with an 8 dB protection ratio[26]

  > In all other cases: a receiver sensitivity of -119 dBm with a 5 dB protection ratio (also see Table D4).

Where the device registration for an existing spectrum licensed transmitter has been modified, the transmitter does not need to be re-coordinated with an existing receiver, if the interference potential for that receiver has not been increased. For example, if a transmitting antenna has been modified but the EIRP in the direction of the receiver is the same or less than radiated by the old antenna, then coordination would not be required.

In some scenarios, an apparatus licensee may choose to accept a higher level of interference. In these scenarios, the below special condition is to be included on their licence to ensure that existing licensees are not negatively impacted. For example, if future modifications are made to an existing spectrum licensed transmitter, from which the apparatus licensee has accepted a higher level of interference, the spectrum licensee will only need to re-coordinate to the level accepted by the apparatus licensee (not to the level in RALI LM8).

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[25] Register has the same meaning as in the *Radiocommunications Act 1992*.

[26] This relaxed criterion is based on receiver performance requirements in ETSI EN 300 113 V2.2.1 (2016-12) and is intended to enhance coexistence between TLMS and 700 MHz spectrum licensed services.

Special Condition:
'The licensee agrees to accept a level of interference which is [xx] dB higher the provided by [the applicable RALI], with respect to a transmitter operated under device registration number(s) [yyyyyy].' [where 'xx' is the amount in which the receiver fails the coordination criteria in the RALI LM8]

Unless otherwise stated, spectrum licensed transmitters that are exempt from registration are not required to be coordinated with PMP services. Although these transmitters have a low risk of causing interference, spectrum licensees should use judgement to identify cases where this risk might be higher than normal, e.g., for operation of high-sited stations. In the event that interference from unregistered spectrum licensed transmitters occurs, the 850/900 MHz spectrum licence contains a condition that registration exempt transmitters must not cause harmful interference to other radiocommunications devices operated under a different spectrum licence or an apparatus licence.[27]

Out-of-band protection requirements for interference from PMP services operating in bands adjacent to spectrum-licensed services are outlined in the '*Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 700 MHz band) 2023*', and '*Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 850/900 MHz Bands) 2021'*.

Coordination of proposed TLMS transmitters with spectrum licensed receivers operating in the 703-748 MHz range or above 890 MHz is not required as the frequency separation is considered sufficient to enable coexistence.

Additional guidance for coordination with 700 MHz spectrum licensed base transmitters

The 806-809 MHz TLMS base-receive segment is 3 MHz separated from the upper frequency limit of the 700 MHz spectrum licensed segment which is optimised for the deployment of base station transmitters. For cases where an initial coordination assessment fails, the accredited person and/or licensee may wish to consider more detailed assessment and/or negotiation to achieve a satisfactory outcome. This may include:

> Coordination using actual unwanted emission levels from the spectrum licensed transmitter, which are likely to be less than the maximum limits specified on the licence.

> Consideration of additional filtering on the spectrum licensed transmitter to further reduce unwanted emission levels. This may be particularly relevant when a proposed spectrum licensed transmitter is attempting to coordinate with an existing apparatus licensed receiver.

> Use of actual antenna patterns, accounting the for effects of orientation and tilt.

> Undertaking on-site measurements to assess the actual level of interference coming from an existing spectrum licensed transmitter which

[27] Radiocommunications Spectrum Marketing Plan (850/900 MHz Band) 2021.

may be impacted by higher path losses than anticipated (e.g. resulting from terrain and/or local clutter).

- Engagement with the affected apparatus licensee to ascertain whether they might accept a higher level of interference than the minimum level prescribed in this RALI. For example, where TLMS mobile stations will always be in close proximity to the base station. This may be particularly relevant when attempting to coordinate a proposed apparatus licensed TLMS receiver with an existing spectrum licensed transmitter.
- Discussion and negotiation between licensees is encouraged where appropriate and may be necessary to implement some of the above suggestions.