RALI : FX 16
DATE OF EFFECT : 14/02/2018

Radiocommunications Assignment and Licensing Instruction

FREQUENCY ASSIGNMENT REQUIREMENTS FOR THE POINT TO MULTIPOINT SERVICE IN THE 400 MHz AND 800/900 MHz BANDS

AUSTRALIAN COMMUNICATIONS AND MEDIA AUTHORITY
SPECTRUM PLANNING AND ENGINEERING BRANCH

Amendment History

Date	Comments
November 1999	Initial release.
October 2003	Tables B1 and B2 amended to add missing channels.
September 2012	Amendments to align with 400 MHz changes.
January 2015	Updated to include additional spectrum for PMP two-frequency services, as per the update to MS22.
May 2016	Consultation draft for update to introduce a low power service model for use in the 400 MHz frequency band.
February 2018	Inclusion of the new PMP segment in the 800 MHz band

Suggestions for improvements to Radiocommunications Assignment and Licensing Instruction FX 16 may be addressed to The Manager, Spectrum Engineering, ACMA at PO Box 78, Belconnen, ACT, 2616, or by e-mail to freqplan@acma.gov.au. It would be appreciated if notification to ACMA of any inaccuracy or ambiguity found be made without delay in order that the matter may be investigated and appropriate action taken.

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FREQUENCY ASSIGNMENT REQUIREMENTS FOR THE POINT TO MULTIPOINT SERVICE IN THE 400 MHZ AND 900 MHZ BANDS

1 Purpose

The purpose of this Radiocommunications Assignment and Licensing Instruction (RALI) is to provide information on frequency coordination and licensing arrangements for two frequency Fixed Point to Multipoint (PMP) services operating in the 400 MHz and 800/900 MHz bands.

The information in this document reflects the ACMA's statement of current policy in relation to frequency assignment requirements for PMP services in the 400 MHz and 800/900 MHz bands.[1] In making decisions, Accredited Persons (APs) and the ACMA's officers 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 Engineering Section, PO Box 78, Belconnen, ACT, 2616, or by e-mail to facpolicyexemptions@acma.gov.au

2 Service Description

A two frequency PMP system consists of a single central master station communicating with a number of outlying remote fixed stations. The use of PMP services is usually for data transmission; typical applications include telemetry, supervisory control and data acquisition (SCADA) systems, computer networking and alarm systems.

The master station (Base station) may also be wired as a repeater, with outlying remote control stations (RCSs) operating in the remote frequency configuration and communicating with remote stations via the master station.

If necessary, supplementary stations may be used to improve coverage within the service area. The master station may be linked to a supplementary station via a remote station configured as a repeater or by a separate fixed link.

From an interference management perspective, a PMP system is characterised by:

- a central master station usually at a high site;
- a number of remote stations - distributed randomly throughout the service area;
- one or more RCSs that control the master station;
- no direct communication between remote stations;
- full duplex (2 frequency working) or half duplex (single frequency working) operation; and
- data throughput in the range 1.2 to 9.6 kbps or greater.

[1] Noting that services in the 853.5-854.0/929.5-930 MHz segment are required to cease operation by 30 June 2021, in accordance with the ACMA's review of the 803-960 MHz band (see The ACMA's long-term strategy for the 803-960 MHz band).

3 Service Models

The purpose of the service model is to define a set of characteristics for PMP services which will result in a specified ("target") grade of service. There are two service models defined; one for large area coverage applications (High Power Service Model) and the other for small area coverage applications in the 400 MHz band (Low Power Service Model). The 900 MHz frequency band Low Power Service Model can be found in RALI FX10.

The target grade of service (TGS) is defined as a 10 dB signal to noise ratio (SNR) at the receiver input for an output bit error rate (BER) of 10^{-3}. The service model is designed to achieve the TGS for receivers at 90% of locations within the service area.

3.1 High Power Service Model Description

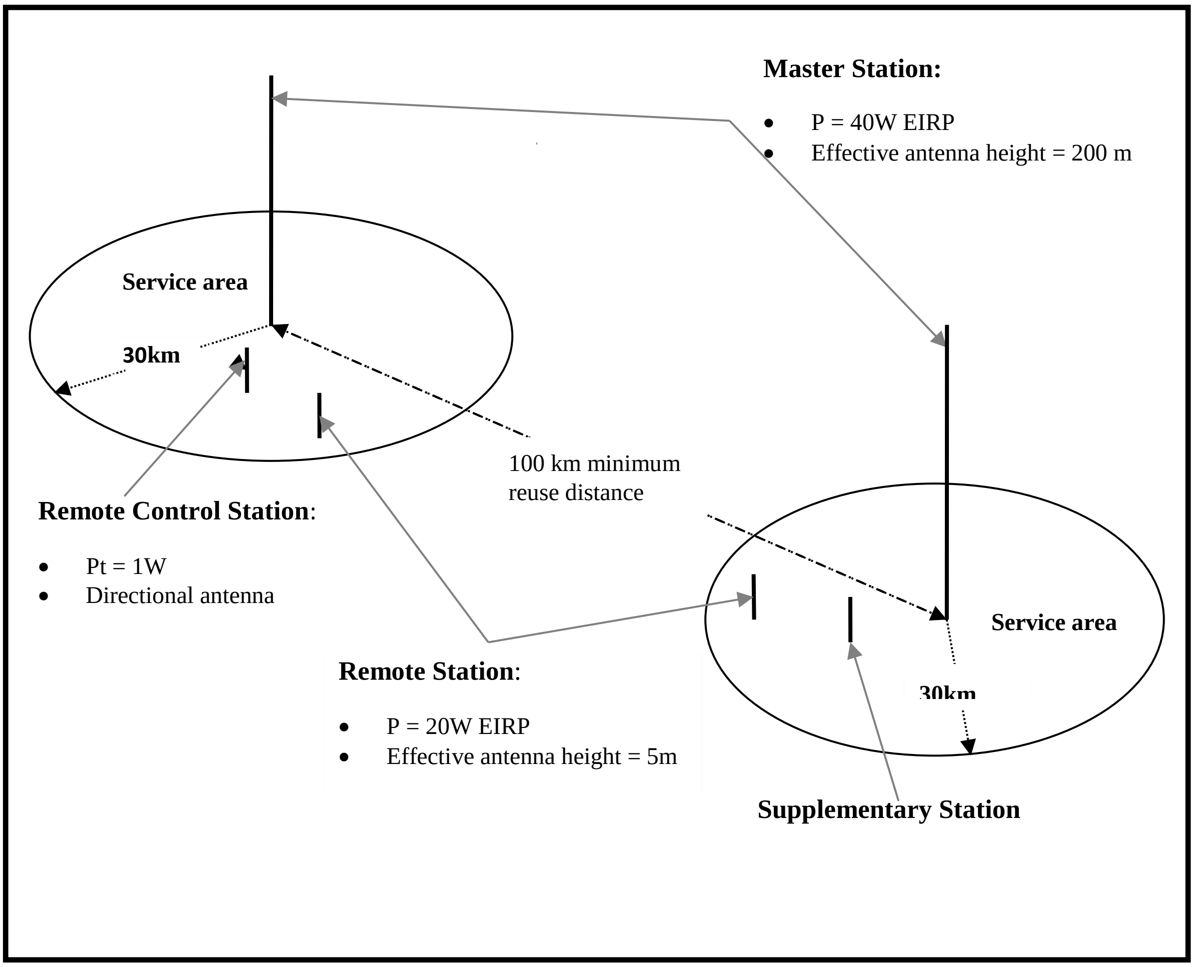

Figure 1: High Power PMP Service Model

Key features of the service model are -

- Transmitter power requirements:
  - the maximum station EIRP (considering transmitter power, cable loss, antenna gain) for master stations shall be 40 W;
  - the maximum station EIRP (considering transmitter power, cable loss, antenna gain) for remote and supplementary stations shall be 20 W.

- Minimum antenna performance characteristics for an RCS:
    - in the 400 MHz band: directional antenna with a mid-band gain of 13 dBi, minimum front-to-back ratio of 16 dB and a maximum beam width (in E-plane) of 36° (e.g. a 9 element Yagi);
    - in the 800/900 MHz bands: directional antenna with a mid-band gain of 16 dBi, minimum front-to-back ratio of 17 dB and a maximum beam width (in E-plane) of 30° (e.g. a 15 element Yagi).
- For a master station the antenna shall be a vertically polarised antenna with a maximum gain of 8.2 dBi. Use of a directional antenna is permitted (maximum gain 8.2 dBi).
- For a remote station use of directional antennas is encouraged but not mandatory, e.g. typical antennas used :
    - in the 400 MHz band directional antenna with a mid-band gain of 13 dBi, minimum front-to-back ratio of 16 dB and a maximum beam width (in E-plane) of 36° (e.g. a 9 element Yagi);
    - in the 800/900 MHz bands: directional antenna with a mid-band gain of 16 dBi, minimum front-to-back ratio of 17 dB and a maximum beam width (in E-plane) of 30° (e.g. a 15 element Yagi).
- In both bands radiated power 180 degrees from the direction of the remote station to the base shall not exceed 5 Watts, i.e. if an omnidirectional antenna is used on a remote, the EIRP shall not exceed 5 Watts.
- Remote stations transmitting on frequencies in the bands 451.5 – 452.5 MHz, 805.5 – 806 MHz or 853.5 – 854 MHz are limited to a maximum transmitter output power at the input of the antenna of 5 W and in all other bands to a maximum transmitter power of 1 W, by the requirements of subsection 9(3) of the Radiocommunications Licence Conditions (Fixed Licence) Determination 2015[2].
- Typical master station antenna height of 200 m above surrounding terrain.
- Typical remote station antenna height of 5 m above surrounding terrain.
- 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:
    - a 20 dB in line attenuator[3] fitted between the transmitter output and the antenna;
    - an antenna height limited to 30 m.
- Unwanted emission limits for transmitters are mandated in Annex A.
- Frequency coordination is performed for the master station only (interference protection for remote stations, supplementary stations and RCSs is intrinsic to the service model).

[2] http://www.comlaw.gov.au/Details/F2015L01430

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

- A service area radius of 30 km. All stations must be contained within the service area.
- A co-channel minimum re-use distance of 100 km between master stations.
- Supplementary stations have no re-use distance requirements, they are included to improve the service reliability within, but not outside, the service area.
- A maximum necessary bandwidth of 12.5 kHz (or 25 kHz if two contiguous channels are assigned).

3.2 Low Power Service Model Description

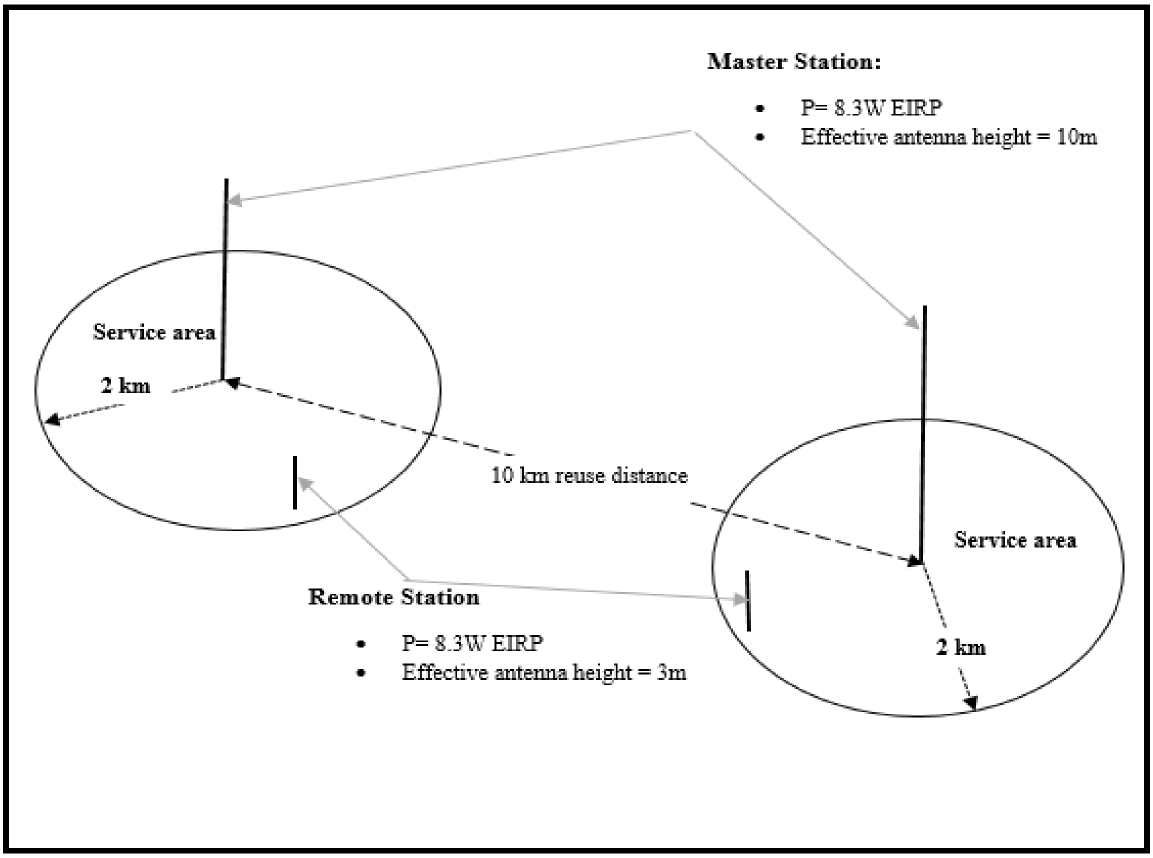

Figure 2: Low Power PMP Service Model

Key features of the service model are -

- Transmitter power requirements:
  - the maximum station EIRP (considering transmitter power, cable loss, antenna gain) for master stations shall be 8.3 W.
  - the maximum station EIRP (considering transmitter power, cable loss, antenna gain) for remote stations shall be 8.3 W;
- While a maximum antenna gain is not specified for a master station, coordination requirements have been based on an assumption of a vertically polarised antenna with a maximum gain of 8.2 dBi. Use of higher gain antenna might result in interference levels at the master station receiver greater than those assumed in the planning modelled. No

protection from interference is provided in such situations. Use of a directional antenna is permitted.

- For a remote station use of directional antennas is encouraged but not mandatory, e.g. typical antenna used:
  - a directional antenna with a mid-band gain of 13 dBi, minimum front-to-back ratio of 16 dB and a maximum beam width (in E-plane) of 36° (e.g. a 9 element Yagi);
- Typical master station antenna height of 10 m above surrounding terrain.
- Typical remote station antenna height of 3 m above surrounding terrain.
- The reuse distance specified for the low power service is based on the maximum EIRP for the remote station (equivalent to the use of an omni directional antenna), and as such there is no need to place an additional restriction on the radiated power 180 degrees from the direction of the base station.
- Low power services typically do not use remote control stations because of the small service area, however should they be required, they must comply with the parameters specified for remote stations.
- Unwanted emission limits for transmitters are mandated in Annex A.
- Frequency coordination is performed for the master station only (interference protection for remote stations, and RCSs is intrinsic to the service model).
- A service area radius of 2 km. All stations must be contained within the service area.
- A co-channel minimum re-use distance of 10 km between master stations.
- A maximum necessary bandwidth of 12.5 kHz (or 25 kHz if two contiguous channels are assigned).

4 Frequency Assignment Policy

To successfully manage interference, all PMP stations (master, remote, RCS) are required comply with the technical constraints in this RALI.

Frequency assignment must take into consideration both inter-service and intra-service requirements consistent with the assignment philosophy promulgated in RALI MS 22, RALI MS 40, and RALI MS 41 (where applicable).

Inter-service coordination of PMP services with other radiocommunications services is not addressed in this document. This may be addressed, in some cases, by ITU-R Recommendations. 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.

Intra-service requirements 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 5 of this RALI.

4.1 Spectrum and Channelling Arrangements

There are three UHF bands available for two frequency PMP data services; all based on 12.5 kHz channelling arrangements.

Use of 25 kHz channelling, by assignment of two contiguous 12.5 kHz channels, is permitted provided that a data rate of at least 4.8 kbps is used. When contiguous channels are combined the lowest channel shall be an odd numbered channel (e.g. 39-40). In locations where the service area is contained entirely within Low Density and Remote Density geographic areas[4] the data rate requirement does not need to be applied.

The bands of operation, as specified in the relevant ACMA plans[5], are:

	Master Transmit	Master Receive
1.	461.0125 - 462.0 MHz	451.5125 - 452.5 MHz
2.[6]	850.5 – 851 MHz	805.5 – 806 MHz
3.[7]	929.5 - 930.0 MHz	853.5 - 854.0 MHz

Table 1: PMP Bands of Operation

Detailed channelling arrangements are given at Annex B.

For use of Land Mobile Frequencies for PMP services refer section 5.4 of this RALI.

4.1.1 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 Decision paper). The Decision paper outlines the implementation of new arrangements in the band which will be completed by June 2024. The implementation phase of the review will include the transition of the Fixed Service allocations to new arrangements over a number of milestones – milestone dates are available in the Decision paper.

With regards to PMP services, the current PMP allocation (853.5-854/929.5-930 MHz) will close on 30 June 2021 and is being replaced by a new PMP allocation (805.5-806/850.5-851 MHz). Arrangements for the new PMP allocation in this RALI are provided to allow existing

[4] As defined in the ACMA's Apparatus Licence Fee Schedule.

[5] The "400 MHz Plan" - RALI MS 22, the "800 MHz Band Plan" – RALI MS41, and the "900 MHz Band Plan" – RALI MS 41.

[6] Access to the 805.5-806/850.5-851 MHz segment is limited to existing PMP services in the 853.5-854/929.5-930 MHz segment which are required to change frequency as part of the implementation of the 803-960 MHz review, see Embargo 64.

[7] The 853.5-854/929.9-930 MHz segment is subject to Embargo 64.

PMP services to transition to this new segment prior to the commencement of the 'transition window' (30 June 2019).[8] Thus the concurrence of arrangements for PMP services in both the 805.5-806/850.5-851 and 853.5-854/929.5-930 MHz segments in this RALI is only a temporary arrangement until transition from old to new arrangements has been completed.

The 800 MHz Band Plan[9] will not be updated with the new arrangements until immediately prior to the opening of the transition window. Although the service allocations and channelling arrangements for the 805.5-806/850.5-851 MHz segment in this RALI are not currently consistent with the 800 MHz Band Plan, existing PMP services wishing to transition to the new PMP allocation before 30 June 2019 are permitted to do so in accordance with this RALI.

PMP services operating in the segment 850.5-851 MHz will need to coordinate with SFFLs prior to their relocation out of the 849-852 MHz segment.[10] The interference mechanism to be considered is from PMP master station transmitters to SFFL receivers.

Applicable co-channel and adjacent channel protection ratios for SFFL receivers are detailed in section 5.2.2 of RALI FX11.[11] No protection will be afforded to PMP remote stations receiving harmful interference from SFFL services operating in the segment 850.5-851 MHz.

As described in the 803-960 MHz review decision paper, arrangements may be introduced to allow PMP services to access spectrum in the adjacent TLMS segment (806-809/851-854 MHz) on a secondary basis as a means of alleviating potential congestion in the future (see section 3.2.3.1 of the Decision paper). The ACMA will consider introduction of these arrangements at a future date if congestion issues arise.

4.2 Assignment Strategy

The assignment strategy for dedicated PMP segments shall be as follows:

- Assign the highest available channel;
- This channel is assigned until it is fully loaded; and
- Once a channel is fully loaded, the next highest available channel is assigned.

This strategy optimises the protection of services in the lower adjacent spectrum.

When PMP services are assigned in 400 MHz land mobile segments, the assignment process shall be as prescribed in RALI LM8.

4.3 Supplementary Transmitters

A supplementary station is a transmitter intended to improve the service reliability within the 30 km service area of the master station. It operates on the same frequency sense as the

[8] See section 3.3 of the Decision paper for implementation timeframes.

[9] RALI MS 40, a copy is available on the ACMA website.

[10] SFFLs are required to vacate the 849-852 MHz segment by 30 June 2019.

[11] A PMP service which overlaps the emission of a SFFL service is deemed to be co-channel. A PMP service which overlaps the 1st adjacent channel of a SFFL service is deemed to be adjacent channel.

master station and does not require frequency/distance coordination, however it is recommended that checks to identify and mitigate against intermodulation issues should be carried out. A supplementary station must not cause interference to other radiocommunications services, and no additional level of protection from interference to a related receiver (above that offered intrinsically to a remote station) is provided.

Note that a transmitter that extends coverage beyond a 30 km radius of the master station is not a supplementary transmitter; it is another master station and must be separately licensed and coordinated in the same manner as any other master station.

Note that for the low power service model supplementary transmitters are not included due to the smaller service area radius.

Power and height constraints applying to supplementary stations are as follows:

Distance from Master:	Max. EIRP	Effective Antenna Height
< 10 km	20 W	100 m
< 20 km	10 W	25 m
< 30 km	5 W	5 m

Table 2: Height Constraints

5 Recommended Frequency Coordination Procedure

Frequency coordination is performed only for master stations; interference protection for remote stations, supplementary stations and RCSs is intrinsic to the service model described in section 3 of this RALI.

The following section details the coordination procedure that may be applied for frequency assignment of PMP master stations.

Alternative frequency coordination procedures may be used provided they produce equivalent results, that is, the target grade of service is achieved at 90% of locations within the service area (refer to section 3 of this RALI). APs may be required to demonstrate that an alternative methodology is suitable.

5.1 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 selection process outlined below.

5.2 Frequency Selection

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 and unwanted emissions (including transmitter broadband noise). The minimum radii and frequency ranges for this cull are:

Band of Operation	Cull Radius	Tx	Rx
400 MHz Band	120 km	±100 kHz	±100 kHz
800/900 MHz Bands	100 km	±25 kHz	±25 kHz

Table 3: Cull Parameters

The appropriate table in Annex C of RALI LM8 shall be used to establish frequency-distance relationships for PMP master stations in the 400 MHz band. For the purposes of selecting the appropriate table a high power PMP is considered to be equivalent to a LMRS and a low power PMP is considered to be equivalent to a LPMRS.

For the 800/900 MHz bands, channels are deemed not available if another master station of a PMP system has been assigned with any part of its channel within the proposed channel and is located within 100 km (the re-use distance) of the proposed site. For example, if operation of a 25 kHz system is sought on channels 1 and 2, and there is an existing 12.5 kHz assignment on channel 1 then the re-use distance is 100 km.

Of the remaining channels available, the channel with the highest centre frequency should then be selected, in accordance with the vertical loading principle outlined in section 4.2 of this RALI. Note that this will involve selection of a pair of frequencies (master transmit and master receive).

5.3 Intermodulation Checks

5.3.1 Introduction

Intermodulation checks are performed for two-signal 3rd order and two-signal 5th order intermodulation, for high power PMP systems only. Typically, only existing LMS and PMP services need to be considered – although sound engineering judgement should be used to determine if other existing service types should also be considered in specific circumstances.

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 (e.g. 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.

5.3.2 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 C, Table C1, of this RALI.

5.3.3 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 C Table C1), 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 C, Table C2, 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.

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

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

Receiver Intermodulation

All systems falling within the cull limits specified in Annex C, Table C1, 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 C, Table C2, of this RALI.

Once the existence of a 'hit' has been confirmed, mathematical expressions (1) and (2) shown at Annex C3 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 C3 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 other evidence can be cited to demonstrate that the level of intermodulation interference is acceptable.

If either receiver or transmitter intermodulation checks fail against the selected frequency, select the frequency that passed the frequency-distance constraints by the next greatest margin 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.

5.4 Use of Land Mobile Frequencies for PMP Services

Under section 2.1 of RALI MS 22, a PMP service is limited to segments allocated to the fixed service (point-to-multipoint) and the upper 1.5 MHz of segments NN/SS. Segments allocated for the land mobile service may only be used for PMP services if assignments cannot be accommodated in the above mentioned segments. Segments allocated exclusively for the land mobile service (trunked) are not to be used for the point-to-multipoint service.

Exceptions to this policy may be sought for existing two-frequency systems wishing to expand in segments other than those allocated to for PMP services, or the 1.5 MHz of segments NN/SS specified above.

For the purpose of frequency assigning of such PMP services, the principles and coordination procedure provided in RALI LM8 shall be used, except that the EIRP (Master Station and Supplementary) and antenna requirements of this RALI must be adhered to. The service area radius of a PMP system assigned in frequencies allocated for the land mobile service is 30 km for a high power system and 2 km for low power system.

The practical implementation of these out-of-band PMP services will be the same as in-band services. They will be issued with PMP licences, and still have a service model identical to the PMP service models outlined in section 3.0 of this RALI (i.e. the antenna and power requirements of this RALI still apply).

The procedure detailed in RALI LM8 shall be applied for avoidance of intra-service intermodulation issues. Also perform inter-service checks (including intermodulation) in accordance with the approach outlined in section 4.0 for harmful interference between the selected frequency (both transmit and receive) and existing radiocommunications systems. If the checks fail, select another frequency as outlined above until a suitable frequency is found.

5.5 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 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[12] (e.g. 60 km separation is maintained). Remote stations in at least 90% of the area of any adjacent cells using the same frequency shall be protected to a level of -120.5 dBm on channel.

Propagation path loss may be determined by the use of any appropriate method described in section 4 of ITU-R P.526 (versions 4 through 9). All methods must use computer modelling software utilising a 9 second digital elevation model (such as RadDEM) or better. Other methods for determining the propagation path loss may also be used pending ACMA agreement.

RALI Authorisation

Approved 14/February/2018

Mark Arkell
Manager
Spectrum Engineering Section
Spectrum Planning and Engineering Branch
Spectrum Infrastructure Division
Australian Communications and Media Authority

[12] The distance will depend on the power of the systems and whether both are PMP systems or one is a land mobile service (LMS). The coverage area of a high power LMS is 40 km.

Bibliography

[1] SP 4/89: '*A Rationale for the Guidelines for the Assignment of Frequencies in the Two-Frequency Point-to-Multipoint Fixed Service using a minimum of 12.5 kHz Channelling in the 400 MHz and 900 MHz Bands* - Spectrum Planning Report No. SP 4/89, March 1990.

[2] SP 2/90: '*Assignment Guidelines for the Two Frequency Point-to-Multipoint Service in the 400 MHz and 900 MHz Bands',* Spectrum Planning Report No. SP 2/90, March 1990.

Annex A: Unwanted Emission Limits

A1. 12.5 KHz PMP Systems

Unwanted emission limits for 12.5 kHz point to multipoint transmitters in the 400 MHz and 800/900 MHz bands are as follows[1]:

Over the temperature range 0°C to 60 °C, taking into consideration the transmitters frequency stability, the level of any unwanted emissions shall be attenuated below the unmodulated carrier power as follows:

* On any frequency removed from the assigned frequency by more than 6.25 kHz and up to 7.5 kHz - <u>at least 23 dB linear to 50 dB</u>.
* On any frequency removed from the assigned frequency by more than 7.5 kHz and up to 20 kHz - <u>at least 50 dB</u>.
* On any frequency removed from the assigned frequency by more than 20 kHz - <u>at least 60 dB</u>.

These unwanted emission limits are shown graphically in Figure A1 below.

NOTE: For non-continuous envelope emissions, where there is no provision for unmodulated carrier power transmission and for TDMA services, the reference level shall be established from the RMS power level during the period of transmission.

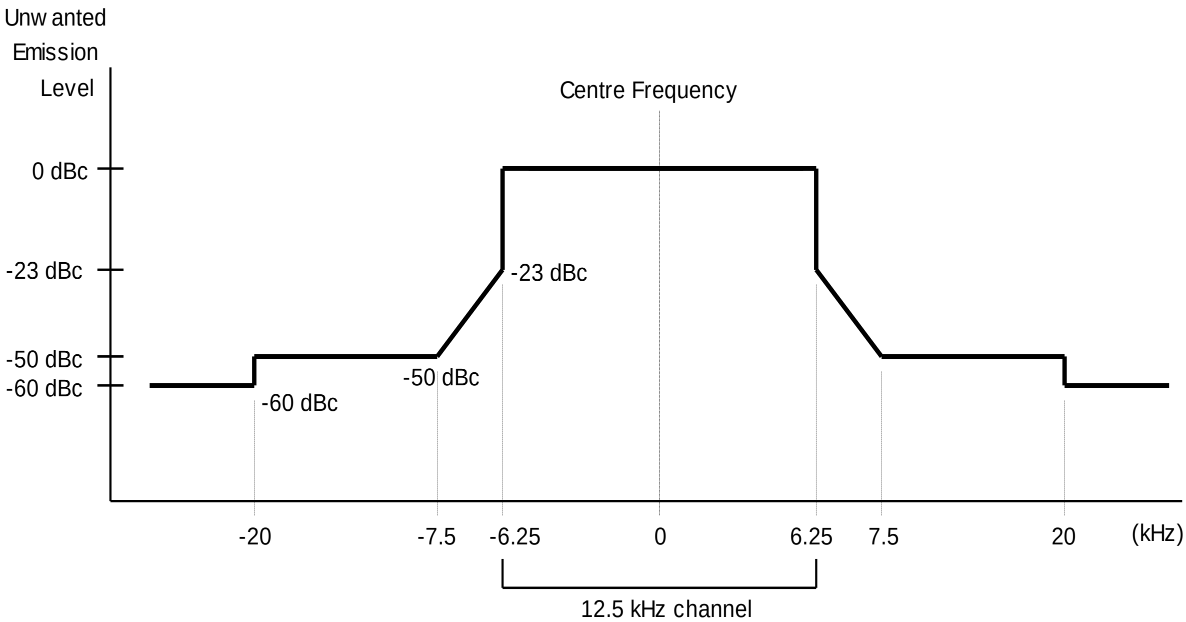

Figure A1: Emission Mask for 12.5 kHz PMP Systems

[1] The limits beyond the +/-7.5 kHz frequency offsets apply to noise and modulation components summed in any 4 kHz bandwidth

A2. 25 kHz PMP Systems

Unwanted emission limits for 25 kHz point to multipoint transmitters in the 400 MHz and 800/900 MHz bands are as follows[2]:

Over the temperature range 0°C to 60°C, taking into consideration the transmitters frequency stability, the power of any unwanted emissions shall be attenuated below the unmodulated carrier power as follows:

* On any frequency removed from the assigned frequency by more than 12.5 kHz and up to 13.75 kHz - <u>at least 23 dB linear to 50 dB</u>.
* On any frequency removed from the assigned frequency by more than 13.75 kHz and up to 26.25 kHz - <u>at least 50 dB.</u>
* On any frequency removed from the assigned frequency by more than 26.25 kHz - <u>at least 60 dB</u>.

These unwanted emission limits are shown graphically in Figure A2 below.

NOTE: For non-continuous envelope emissions, where there is no provision for unmodulated carrier power transmission and for TDMA services, the reference level shall be established from the RMS power level during the period of transmission.

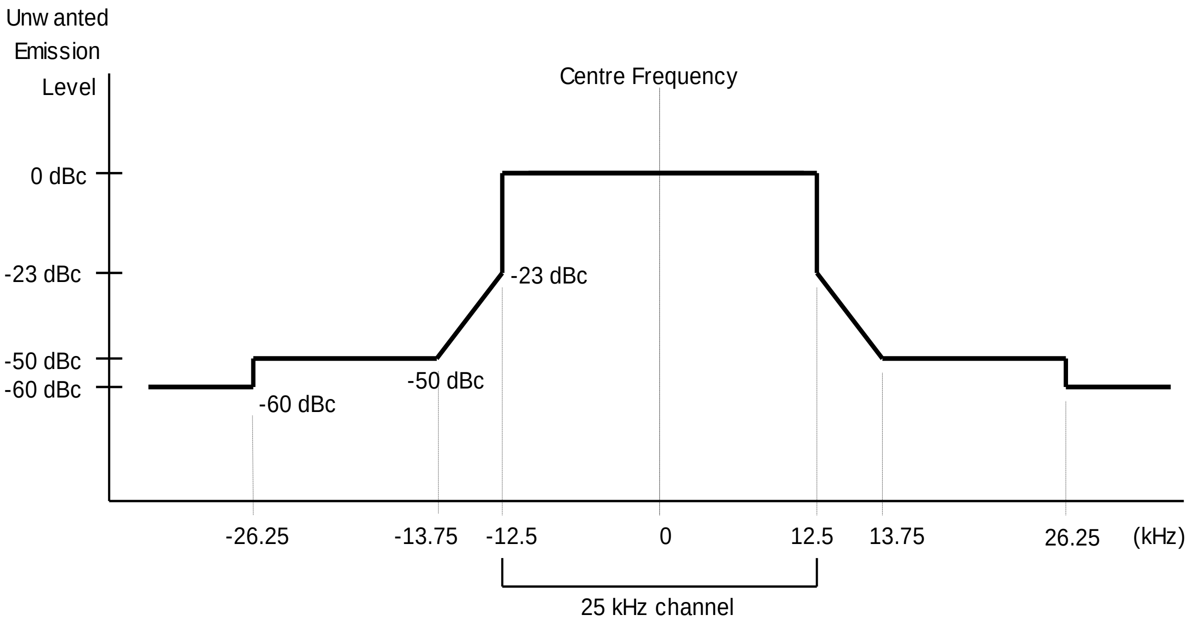

Figure A2: Emission Mask for 25 kHz PMP Systems

[2] The limits beyond the +/-7.5 kHz frequency offsets apply to noise and modulation components summed in any 4 kHz bandwidth

Appendix B: Channelling Arrangements for the Point to Multipoint Service in the 400 MHz and 800/900 MHz Bands

B1. 400 MHz Band

There are 79 channels with 12.5 kHz spacing provided at 400 MHz. The channel centres are given by the formulae:

- Master transmit = 461.00625 + N (0.0125)
- Master receive = 451.50625 + N (0.0125)

where N is any integer between 1 and 79 inclusive.

The 12.5 kHz channel centres are listed in Table B1.

B2. 800/900 MHz Bands

There are two PMP segments in the 800/900 MHz bands: 805.5-806/850.5-851 MHz and 853.5-854/929.5-930 MHz[3].

B2.1. 805.5-806/850.5-851 MHz segment

There are 40 channels with 12.5 kHz spacing provided in the 805.5-806/850.5-851 MHz segment. The channel centres are given by the formulae:

- Master transmit = 850.49375 + N (0.0125) MHz
- Master receive = 805.49375 + N (0.0125) MHz

where N is any integer between 1 and 40 inclusive.

The 12.5 kHz channel centres are listed in Table B2.

B2.2. 853.5-854/929.5-930 MHz segment

There are 40 channels with 12.5 kHz spacing provided in the 853.5-854/929.5-930 MHz segment. The channel centres are given by the formulae:

- Master transmit = 929.49375 + N (0.0125) MHz
- Master receive = 853.49375 + N (0.0125) MHz

where N is any integer between 1 and 40 inclusive.

The 12.5 kHz channel centres are listed in Table B3.

B3. 25 kHz Channels

Two contiguous 12.5 kHz channels should be used with the channel centre offset from those in Tables B1 and B2 by 6.25 kHz, i.e. in the centre of the two 12.5 kHz channels.

[3] Noting that PMP services in the 853.5-854/929.5-930 MHz segment are required to cease operation by 30 June 2021 – see section 4.1.1.

For example, a 25 kHz assignment over channels 1 & 2 in the 400 MHz band (Tx channel centres of 461.01875 and 461.03125 MHz respectively) would have a channel centre of 461.025 MHz (i.e. between the two 12.5 kHz channels).

When contiguous channels are combined the lowest channel shall be an odd numbered channel (e.g. 39-40).

Table B1

Centre Frequency (MHz)					Centre Frequency (MHz)				
Channel Number	Master Transmit		Master Receive		Channel Number	Master Transmit		Master Receive	
1	461.01875	461.025	451.51875	451.525	41	461.51875	461.525	452.01875	452.025
2	461.03125		451.53125		42	461.53125		452.03125	
3	461.04375	461.050	451.54375	451.550	43	461.54375	461.550	452.04375	452.050
4	461.05625		451.55625		44	461.55625		452.05625	
5	461.06875	461.075	451.56875	451.575	45	461.56875	461.575	452.06875	452.075
6	461.08125		451.58125		46	461.58125		452.08125	
7	461.09375	461.100	451.59375	451.600	47	461.59375	461.600	452.09375	452.100
8	461.10625		451.60625		48	461.60625		452.10625	
9	461.11875	461.125	451.61875	451.625	49	461.61875	461.625	452.11875	452.125
10	461.13125		451.63125		50	461.63125		452.13125	
11	461.14375	461.150	451.64375	451.650	51	461.64375	461.650	452.14375	452.150
12	461.15625		451.65625		52	461.65625		452.15625	
13	461.16875	461.175	451.66875	451.675	53	461.66875	461.675	452.16875	452.175
14	461.18125		451.68125		54	461.68125		452.18125	
15	461.19375	461.200	451.69375	451.700	55	461.69375	461.700	452.19375	452.200
16	461.20625		451.70625		56	461.70625		452.20625	
17	461.21875	461.225	451.71875	451.725	57	461.71875	461.725	452.21875	452.225
18	461.23125		451.73125		58	461.73125		452.23125	
19	461.24375	461.250	451.74375	451.750	59	461.74375	461.750	452.24375	452.250
20	461.25625		451.75625		60	461.75625		452.25625	
21	461.26875	461.275	451.76875	451.775	61	461.76875	461.775	452.26875	452.275
22	461.28125		451.78125		62	461.78125		452.28125	
23	461.29375	461.300	451.79375	451.800	63	461.79375	461.800	452.29375	452.300
24	461.30625		451.80625		64	461.80625		452.30625	
25	461.31875	461.325	451.81875	451.825	65	461.81875	461.825	452.31875	452.325
26	461.33125		451.83125		66	461.83125		452.33125	
27	461.34375	461.350	451.84375	451.850	67	461.84375	461.850	452.34375	452.350
28	461.35625		451.85625		68	461.85625		452.35625	
29	461.36875	461.375	451.86875	451.875	69	461.86875	461.875	452.36875	452.375
30	461.38125		451.88125		70	461.88125		452.38125	
31	461.39375	461.400	451.89375	451.900	71	461.89375	461.900	452.39375	452.400
32	461.40625		451.90625		72	461.90625		452.40625	
33	461.41875	461.425	451.91875	451.925	73	461.91875	461.925	452.41875	452.425
34	461.43125		451.93125		74	461.93125		452.43125	
35	461.44375	461.450	451.94375	451.950	75	461.94375	461.950	452.44375	452.450
36	461.45625		451.95625		76	461.95625		452.45625	
37	461.46875	461.475	451.96875	451.975	77	461.96875	461.975	452.46875	452.475
38	461.48125		451.98125		78	461.98125		452.48125	
39	461.49375	461.500	451.99375	452.000	79	461.99375		452.49375	
40	461.50625		452.00625						

Table B1: Channelling Arrangements for PMP Services in the 400 MHz Band

Table B2

Centre Frequency (MHz)					Centre Frequency (MHz)				
Channel Number	Master Transmit		Master Receive		Channel Number	Master Transmit		Master Receive	
1	850.50625	850.5125	805.50625	805.5125	21	850.75625	850.7625	805.75625	805.7625
2	850.51875		805.51875		22	850.76875		805.76875	
3	850.53125	850.5375	805.53125	805.5375	23	850.78125	850.7875	805.78125	805.7875
4	850.54375		805.54375		24	850.79375		805.79375	
5	850.55625	850.5625	805.55625	805.5625	25	850.80625	850.8125	805.80625	805.8125
6	850.56875		805.56875		26	850.81875		805.81875	
7	850.58125	850.5875	805.58125	805.5875	27	850.83125	850.8375	805.83125	805.8375
8	850.59375		805.59375		28	850.84375		805.84375	
9	850.60625	850.6125	805.60625	805.6125	29	850.85625	850.8625	805.85625	805.8625
10	850.61875		805.61875		30	850.86875		805.86875	
11	850.63125	850.6375	805.63125	805.6375	31	850.88125	850.8875	805.88125	805.8875
12	850.64375		805.64375		32	850.89375		805.89375	
13	850.65625	850.6625	805.65625	805.6625	33	850.90625	850.9125	805.90625	805.9125
14	850.66875		805.66875		34	850.91875		805.91875	
15	850.68125	850.6875	805.68125	805.6875	35	850.93125	850.9375	805.93125	805.9375
16	850.69375		805.69375		36	850.94375		805.94375	
17	850.70625	850.7125	805.70625	805.7125	37	850.95625	850.9625	805.95625	805.9625
18	850.71875		805.71875		38	850.96875		805.96875	
19	850.73125	850.7375	805.73125	805.7375	39	850.98125	850.9875	805.98125	805.9875
20	850.74375		805.74375		40	850.99375		805.99375	

Table B2: Channelling Arrangements for PMP Services in the 800 MHz Band

Table B3

Centre Frequency (MHz)					Centre Frequency (MHz)				
Channel Number	**Master Transmit**		**Master Receive**		**Channel Number**	**Master Transmit**		**Master Receive**	
1	929.50625	929.5125	853.50625	853.5125	21	929.75625	929.7625	853.75625	853.7625
2	929.51875		853.51875		22	929.76875		853.76875	
3	929.53125	929.5375	853.53125	853.5375	23	929.78125	929.7875	853.78125	853.7875
4	929.54375		853.54375		24	929.79375		853.79375	
5	929.55625	929.5625	853.55625	853.5625	25	929.80625	929.8125	853.80625	853.8125
6	929.56875		853.56875		26	929.81875		853.81875	
7	929.58125	929.5875	853.58125	853.5875	27	929.83125	929.8375	853.83125	853.8375
8	929.59375		853.59375		28	929.84375		853.84375	
9	929.60625	929.6125	853.60625	853.6125	29	929.85625	929.8625	853.85625	853.8625
10	929.61875		853.61875		30	929.86875		853.86875	
11	929.63125	929.6375	853.63125	853.6375	31	929.88125	929.8875	853.88125	853.8875
12	929.64375		853.64375		32	929.89375		853.89375	
13	929.65625	929.6625	853.65625	853.6625	33	929.90625	929.9125	853.90625	853.9125
14	929.66875		853.66875		34	929.91875		853.91875	
15	929.68125	929.6875	853.68125	853.6875	35	929.93125	929.9375	853.93125	853.9375
16	929.69375		853.69375		36	929.94375		853.94375	
17	929.70625	929.7125	853.70625	853.7125	37	929.95625	929.9625	853.95625	853.9625
18	929.71875		853.71875		38	929.96875		853.96875	
19	929.73125	929.7375	853.73125	853.7375	39	929.98125	929.9875	853.98125	853.9875
20	929.74375		853.74375		40	929.99375		853.99375	

Table B3: Channelling Arrangements for PMP Services in the 900 MHz Band

Annex C: 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:

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

(2) 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 C1.

C1. Cull Limits Applicable to Intermodulation Checks

	Frequency - Distance Cull Range	
Receiver Intermodulation		
Description	Third Order Intermodulation	Fifth Order Intermodulation
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	

Table C1 - Cull Limits Applicable to Intermodulation Checks

C2. 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**

Table C2 - Frequency Offset from Victim Receiver within which an Intermodulation ‘Hit’ is Deemed to Occur

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

C3. 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:
$PR + 2*(EIRP_{dBm} - L_{b\ inner} + L_c - RF_{inner}) + (EIRP_{dBm} - L_{b\ outer} + L_c - RF_{outer}) + ECR\ 2/3 \leq RS$...........**(1)**

The equation for two signal 5th order receiver intermodulation is:
$PR + 3*(EIRP_{dBm} - L_{b\ inner} + L_c - RF_{inner}) + 2*(EIRP_{dBm} - L_{b\ outer} + L_c - RF_{outer}) + ECR\ 2/5 \leq RS$..........**(2)**

The parameter values applicable to equations (1) and (2) above are specified in Table C3.

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

C4. Parameter Values Applicable to Intermodulation Checks

Parameter		Assumed Value
RS	(Master Station Usable Sensitivity[2])	-119 dBm (800 MHz Trunking Band) -116 dBm (400 MHz Band)
PR	(Protection Ratio)	10 dB
$EIRP_{dBm}$	(Transmitter EIRP)	30 + 10*log[$EIRP_{watts}$] (typically 46 dBm for high power PMP and 39.2 dBm for 8.3 W low power PMP)
L_b	(propagation loss: from 'inner' or 'outer' transmitter to victim receiver)	Free Space Loss + 10 dB
L_c	(antenna gain and feeder loss)	6.2 dBi (400 MHz & 800 MHz Bands)
RF	(receiver front-end response: achieved by the RF selectivity of a receiver in conjunction with a cavity filter)	**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 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

Table C3 - Parameter Values Applicable to Intermodulation Checks

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.