RALI-AA3

Radiocommunications Assignment and Licensing Instruction - Amateur Assigned 3

Amateur (Assigned) Station (146 MHz Band) Frequency Assignment Requirements

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Contents

1 Introduction

This document contains technical instructions to facilitate the selection of frequencies for the operation of amateur assigned repeater stations within the amateur service spectrum in Australia, once the need to obtain an amateur assigned licence has been determined. For any questions on whether a particular licence is required, applicants should first contact the Australian Communications and Media Authority .

Specifically, this document details frequency selection criteria for the following types of assigned frequency amateur repeater stations.

- All stations operating on the 146 MHz amateur band.

Assignment requirements for repeater stations on the following frequency bands are found in the associated corresponding RALI.

- Beacon Stations – RALI-AA1
- Repeater Stations (including Television Repeater stations) – RALI-AA2
- Repeater & Link Stations operating between 430 – 450 MHz – RALI-AA4 (excluding TV)

Where interactions are required to be assessed between amateur repeater stations and amateur beacon stations, information about those beacon stations can be obtained from document RALI-AA1.

1.1 Basis for amateur service spectrum planning

The Amateur Radio Service band-plans plans are derived from international plans set down by the International Amateur Radio Union (IARU). Broad segment allocations, particularly for international activity relating to satellites and inter-continental communications, have been defined across all amateur service radio spectrum. The WIA, as the representative body of the IARU in Australia, is responsible for maintaining the amateur service band plans in Australia while ensuring they are always consistent with the Radiocommunications Licence Conditions (Amateur Licence) Determination 2015[1](the LCD).

Australian Amateur Service Band plan information is available here:

- https://www.wia.org.au/members/bandplans/data/

For amateur assigned repeater stations, it is a requirement that an assignment first be attempted based on the instructions provided in this RALI. The channel plans in this RALI for assigned amateur repeater stations are derived from the Australian amateur radio band plans. They have been designed to minimise interference to both assigned and class licenced amateur radio stations. Where no assignment solution can be found or the proposed amateur assigned repeater station does not fit the service models described in this instruction, then non-standard assignment process should be followed as

1 https://www.legislation.gov.au/Series/F2015L01113

described in Frequency assignment practice '**Guideline No. 10 — Application process for assigned amateur beacons and repeaters**[2]'(FAP 10)

Operators of amateur assigned stations should also recognise that class licenced amateur stations are not prevented from operating anywhere in the radio spectrum assigned to the amateur service (in accordance with their own licence conditions). However, non-assigned amateur stations have been requested to voluntarily follow the defined amateur radio band plan to manage interference between different activities and in particular amateur assigned stations.

1.2 Grand-fathered frequency allocations

The Amateur band plans have evolved multiple times particularly over the past 30 years. This evolution has occurred in response to changing environmental conditions, particularly on spectrum bands where the amateur service has only secondary status in the Australian Radiofrequency Spectrum Plan (ARSP).

Due to the costs and disruption involved in making changes to established systems, the current practice is that those established legacy stations are not expected to change frequencies when the band plans are revised, unless they are either:

a) Required to make changes to their station in response to changes within the amateur radio service LCD.

b) Wish to take advantage of the improved arrangements offered by the new band plan.

c) Are planning other changes to services co-located with the legacy service, in which case they are encouraged to migrate their existing systems to the new channel plan at the same time.

It should be noted that that legacy band plans are not relevant when selecting frequencies for new or upgraded services. Should an assigned amateur service station operator seek to amend or change the nature of their service, they should align their service frequencies with the band plan in force on the day.

[2] https://www.acma.gov.au/frequency-assignment-practices

2 Assigned Amateur Station Classifications

2.1 Amateur Analogue Voice Repeater Station

An analogue voice repeater station in the amateur service is typically a duplex station using 16K0F3E modulation (narrowband FM) where the station is transmitting and receiving simultaneously using two frequencies, one for transmit and one for receive. These stations are usually sited at elevated locations to provide a wide area service to multiple amateur radio operators.

2.2 Amateur Digital Voice Repeater Station

A digital voice repeater station in the amateur service is typically a duplex station using 6K25F9W modulation (D-STAR[3] protocol-based systems) or 11K3F9W (C4FM[4] or DMR[5] (P25 derivative) based systems where the station is transmitting and receiving simultaneously using two frequencies, one for transmit and one for receive. These stations are usually sited at elevated locations to provide a wide area service to multiple amateur radio operators.

2.3 Amateur Mixed Analogue/Digital Voice Repeater Station

A mixed analogue/digital voice repeater system station in the amateur service is a station that can operate in both analogue and digital modes on a time-shared basis. Currently the C4FM repeater systems can also operate in analogue mode. These systems should only be assigned to operate on certain repeater sub-bands (see information below for details).

2.4 Amateur Analogue/Digital Gateway Station

An analogue gateway station in the amateur service provides a connection from a tunnelled audio link (often carried via VOIP technologies on the Internet) onto the amateur radio spectrum, typically using 16K0F3E narrowband FM modulation or 11K3F9W GMSK Digital modulation. These stations use single frequency Tx/Rx operations to relay amateur station audio from licenced radio amateurs received via commercial carriage services out onto local amateur frequencies, most typically on the 144 MHz and 432 MHz amateur bands.

[3] DSTAR system specification (Japan Amateur Radio League) https://www.jarl.com/d-star/shogen.pdf
[4] C4FM System Specification document (Yaesu)
https://www.yaesu.com/downloadFile.cfm?FileID=9039&FileCatID=263&FileName=Yaesu%5FAmateur%20Radio%20Digital%20Specs%5F1V02%5FEN%2DGB.pdf&FileContentType=application%2Fpdf
[5] Amateur Radio adaptation of the commercial DMR standards https://www.dmrassociation.org/dmr-standards.html

2.5 Amateur Store and Forward Single Frequency Data Repeater Station

A store and forward single frequency repeater station is using typically AFSK, GMSK or QPSK (or similar) signals formatted to send packets of data that are stored and then on-forwarded once they are received within a single frequency network. The amateur service typically uses the Amateur (AX.25)[6] transmission protocol for this purpose. The channels are typically low-rate data (1200 bps) although some systems run much higher data rates (and hence higher bandwidths).

A particular use of this technology has been in the APRS[7] (Amateur Position Reporting System) network which is used for various information broadcast and location tracking applications within the amateur service. This, however, is not the only use of these AX.25 protocol-based store and forward repeater stations.

2.6 Amateur Repeater Link Two Frequency Station

An amateur repeater link station is used to provide a channel to carry the voice information from one repeater site to another, such that it may be transmitted on an additional amateur repeater station in addition to the one where the voice signal was originated from.

Two frequency link stations are not relevant on the 146 MHz amateur band in the context of this RALI as no frequency allocation has been made for these systems in the current Australian amateur radio band plan.

[6] AX.25 standard https://www.tapr.org/pdf/AX25.2.2.pdf
[7] Refer to http://www.aprs.org/ for more information about APRS

3 Amateur Repeater Station Service Model

The purpose of the service model for assigned Amateur Repeater stations is to define a set of characteristics that will achieve an agreed service level and acceptable levels of short-term interference that can be tolerated by class licenced amateur radio stations using these assigned repeater services.

Class licenced amateur stations typically have several different configurations.

- Vehicle mounted mobile.
- Handheld.
- Base station – elevated omni-directional antenna.
- Base station – elevated directional antenna (up to 10-18dBi depending on the operating band).

Frequency reuse distances described in this document are defined based on notional vehicle based mobile station characteristics which have been built into the frequency reuse rules defined throughout this document. Home based fixed location and itinerant stations temporarily located on elevated terrain are not considered as their typical configurations would drive excessive frequency reuse requirements (noting home stations can operate using very high gain (10dBi+) directional antennas).

The service model also needs to consider the nature of the spectrum being used and what propagation mechanisms will affect that spectrum. The Amateur Service operates voice repeater stations in all amateur bands between 29 MHz and 1300 MHz. On the 146 MHz band, tropospheric propagation is the dominant mode affecting mode frequency selection decisions.

The target grade of service is defined as a signal quality of 12 dB SINAD 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 that, when satisfied, will on average achieve the expected service level while aiming to provide sufficient adjacent site interference protection for 90% of the time for vehicle mobile based stations.

3.1 Amateur Analogue and/or Digital (Two frequency) Voice Repeater Model 146 MHz

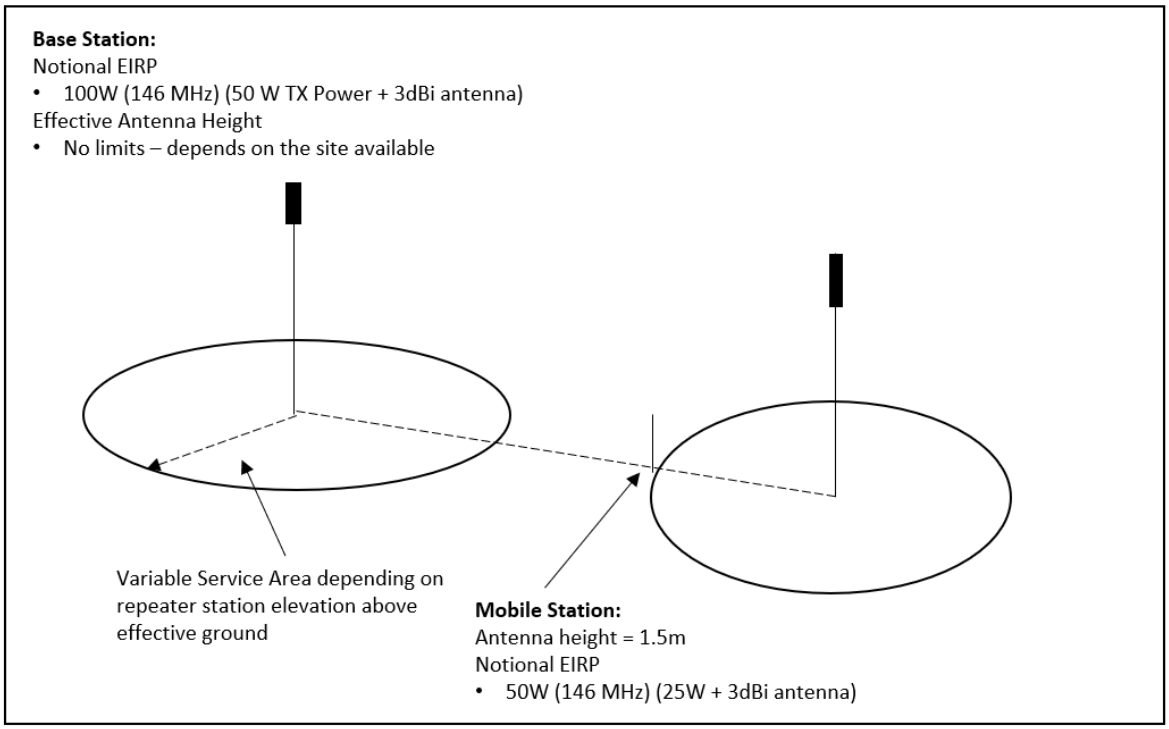


Figure – Amateur Repeater & Gateway Model

The key requirements of the service model are:

- Assumed receiver blocking performance of 90dB above the minimum receiver usable sensitivity.

Characteristic	Value
TX Power	50W Py (47dBm)
TX Antenna Gain	3.0dBi
Polarisation	Vertical
Feeder / Filter Losses	2dB
Notional Receiver Sensitivity	1.0uV @ 20dB SINAD (-107dBm)
RX Antenna Gain	3dBi
Maximum Allowable Path Loss	157dB

3.2 Amateur Analogue / Digital Voice Gateway Station Model (146 MHz)

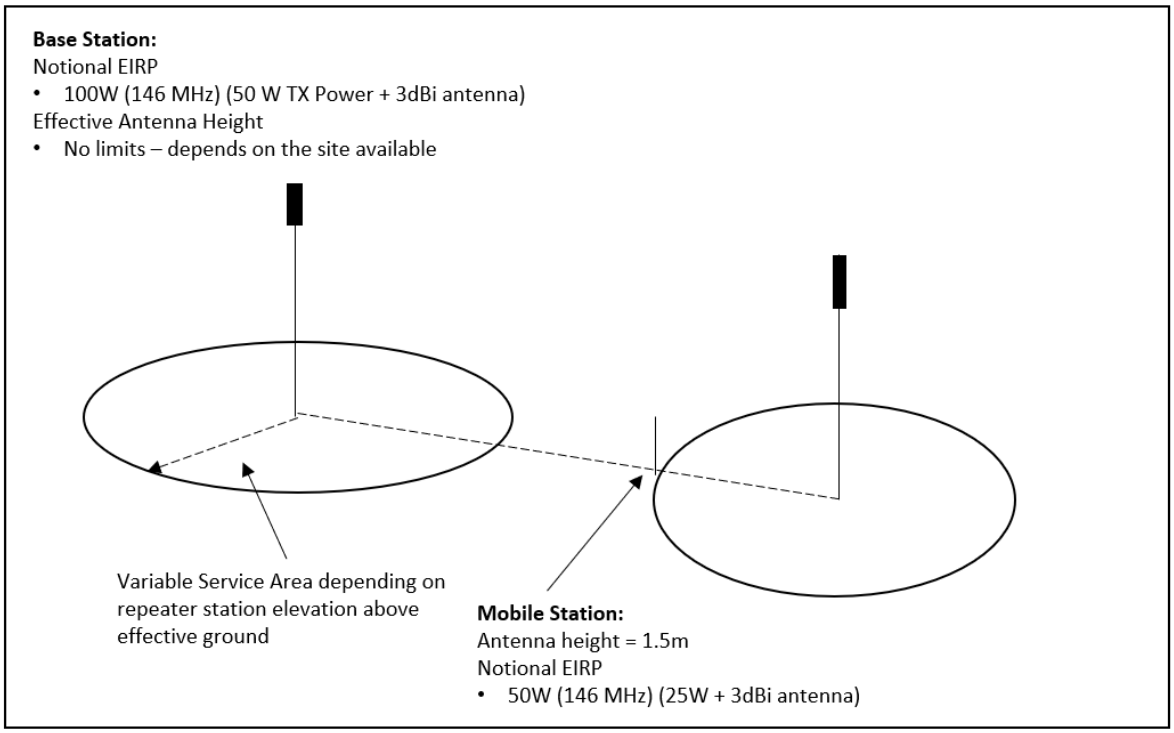


Figure – Amateur Repeater & Gateway Model

- Gateway stations do not repeat signals that they receive over the air. They only relay those signals to another gateway linked station connected by an off-band telecommunications carriage service. Transmissions from Gateway stations originate from remote amateur stations that have connected to the gateway transmitter via the same telecommunications carriage service.
- So that users of gateway stations are aware when the channel is in use, the operational footprint of the gateway station should be defined by the applicant as the expected area where 90% of the Class licenced amateur stations accessing the system are able to not only hear the gateway station but also hear each other. This will reduce the risk of collisions where multiple stations are attempting (unknowingly) to access the gateway station at the same time. The applicant should try to ensure excessive coverage is avoided.
- Gateway stations are designed mostly to be accessed by non-assigned itinerant amateur base stations. As such, they may not provide reliable mobile communications access over more than 30-50% of their footprint.
- These stations are not expected to be provided on elevated sites and should as far as possible be limited to locations where the effective height about average terrain (H_{eff}) is kept below 200m.

The notional specifications of the station are as follows:

Characteristic	Value
TX Power	50W Py (47dBm)
TX Antenna Gain	2.2dBi
Polarisation	Vertical
Feeder / Filter Losses	3dB
Notional Receiver Sensitivity	1.0uV @ 20dB SINAD (-107dBm)
RX Antenna Gain	0dBi
Maximum Allowable Path Loss	157dB

3.3 Amateur Store and Forward Data Repeater Station Model

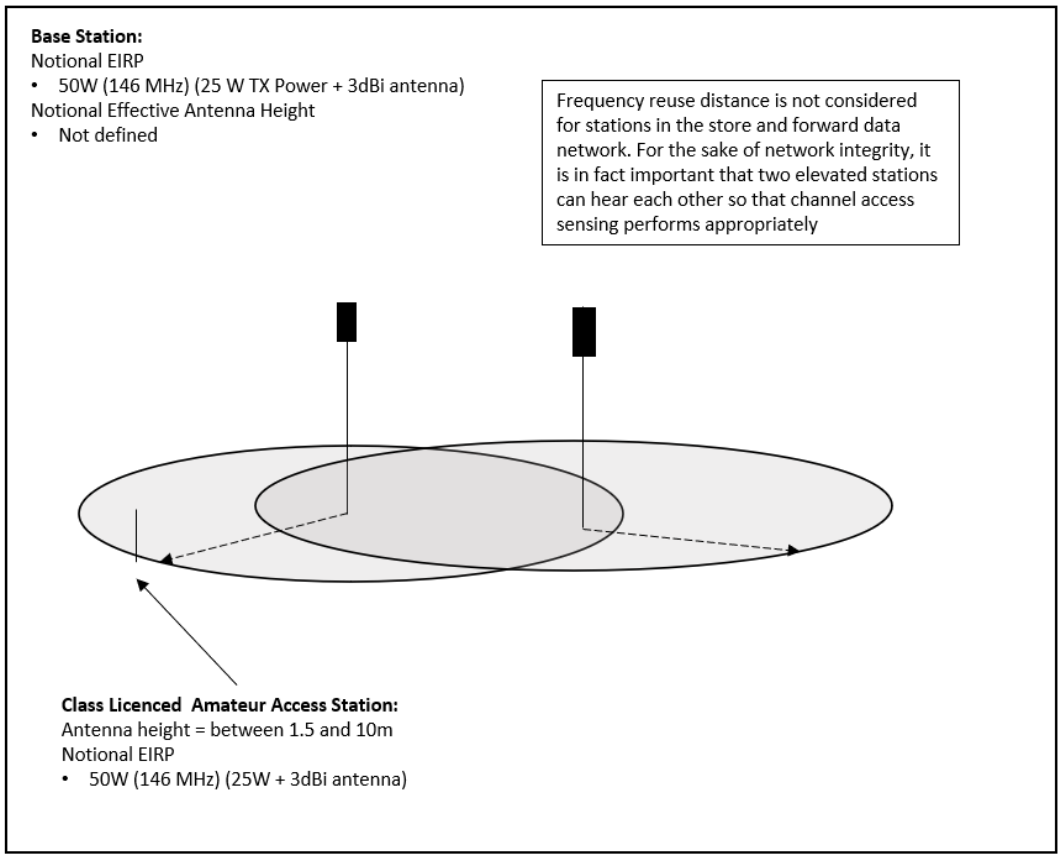


Figure – Amateur Store and Forward Single Frequency Data Model

- Store and forward data repeaters in the amateur service are required to use the same transmission protocol that is already in use on a given frequency to prevent inter-station interference. Typically store and forward data stations in the amateur service are using the AX.25 protocol with CSMA channel access technology.
- These repeaters have no frequency re-use limitations and in fact require a degree of overlapping coverage in order to correctly function.
    - Overlapping coverage facilitates effective linking of repeaters so that data can be relayed over multiple hops from Station A via Station B then via Station C to Station D.
    - One of the specific uses of store and forward data repeaters involves the provision of wide area networks designed to relay position and other tactical and telemetry data, known as the Amateur Position Reporting System (APRS). These networks operate on a single frequency nationwide and hence do not need inter-site co-channel coordination from an ACMA perspective.

Typical TX Power	Typical Antenna Gain	Emission	Polarisation
50W	3dBi	16K0F2D	Vertical

3.4 In-Band Repeater Link Transmitter Station Model (144 – 148 MHz Band)

Repeater Link Station Transmitter B End: (Used for "Off Air" linking of two VHF repeaters)

Notional B-End transmitter EIRP

- 10W (146 MHz) (1 W TX Power + 7dBi antenna
    - Note Link system using on-frequency transmitters to the adjacent repeater must use the minimum power possible in order to avoid causing interference to the next adjacent co-channel main repeater.
    - Directional yagi types MUST be used to avoid widespread co-channel uplink interference

B-End Effective Antenna Height Qualifying criteria

- B end link transmitter sites on a repeater site with a Heff greater than 200m should be carefully designed with the use of minimum power, appropriate antennas and additional filtering to minimise unwanted interference. The use of alternative linking methods should be considered

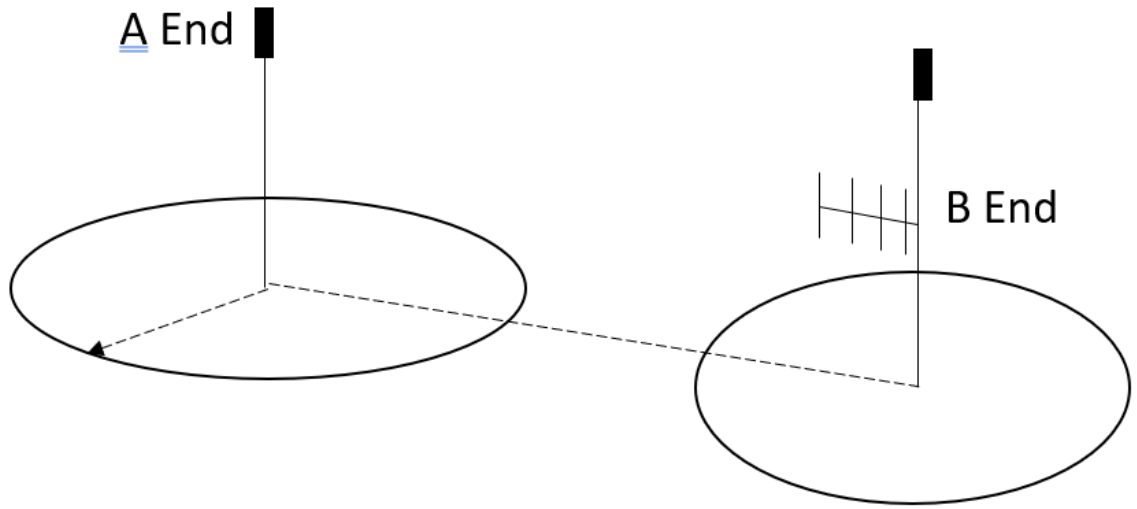


Figure – Amateur Repeater Off Air Link Model

- Linking repeaters using in-band link transmitters can typically only be achieved when the A and B end repeaters are licenced in opposite channel blocks (i.e. Repeater A operates on Block A (-600 kHz offset) and Repeater B operates in Block B (+600 kHz offset).
    - The potential for the Repeater B transmitter to cause interference to another co-channel repeater some distance away is high, given the amateur repeater frequency reuse models are based on repeater uplink transmitters normally taking the form of land mobile stations. This is why restrictions on the operating conditions have been placed on these station configurations.
    - Should an applicant not be satisfied with these conditions then the application should be referred to the ACMA for processing via the non-standard process specified in the FAP.

Typical TX Power	Typical Antenna Gain	Emission	Polarisation

1W	7dBi (directional)	16K0F2D	Vertical

4 Frequency Assignment Policy Guidelines

4.1 Overview

Assigned amateur repeater stations can take on several forms.

- Duplex (two frequency operation) repeater stations often located on elevated sites targeting mobile and / or portable amateur station activity.
- Simplex (single frequency operation) repeater stations used to either provide:
  - store and forward data relay services (such as the Amateur Position Reporting System (APRS) based on AX.25 1200 bps data transmissions) or;
  - single frequency "gateway" stations which facilitate access to global voice relay networks (often internet based).
- Inter-repeater dedicated links (using either one or two frequency configurations) used to connect multiple repeater stations together into larger regional networks.

Frequency planning for this wide variety of services, where certain combinations of these services are requested in the same locality or region, can therefore be complex.

It should be noted that amateur radio repeater station frequency assignments do not consider the full range of station types found in the amateur service that would wish to access these assigned repeater stations. Amateur VHF/UHF/SHF activity can be carried out under a wide range of circumstances including from home stations with high gain elevated antennas or portable stations located atop terrain prominences etc. Interference protection for these additional types of station uses is not required to be provided, nor is it practical given the limited channel capacity available on some frequency bands.

Assigned amateur stations are also not provided any special interference protection from class licenced amateur station activity, which is permitted to occur across any spectrum allocated to the amateur service in the Australian Radio Spectrum Plan. It should be noted, however, that class licenced (non-assigned) amateur stations are encouraged globally to voluntarily confine their operating in certain segments of the amateur spectrum to transmission modes that are broadly compatible with each other, in accordance with the published amateur radio band plans that are sanctioned by the IARU representative bodies in each country.

4.2 Use of the 146 MHz band for dedicated link transmitters

The amateur band plans do not support this type of operation on the 146 MHz band due to the relatively small amount of spectrum available to radio amateurs in this frequency range.

Should an applicant be seeking to use the 146 MHz band for a dedicated repeater to repeater station link, the application should be referred to ACMA to follow the non-standard application process.

4.3 Assignment of Nominated Special Use Channels – 146 MHz Band

Within the band channel plans, some channels are reserved for particular use cases. Typically, these are to support portable repeater stations that can be deployed anywhere in the named state for periods of less than 7 days at a time, typically to support community events or emergency services support communications.

When presented with a request to licence a new portable repeater, one of the channel plan's nominated state or territory based portable use channels (see the channel plans below) should be assigned on an area wide basis.

Permanent assigned repeater stations should not be allocated to those frequencies (which are defined in the band plans state by state). Should an applicant, however, wish to proceed with such an application, it should be referred to ACMA using the non-standard application process.

The following channels are notionally reserved for portable repeaters, although they may be used for legacy fixed repeaters installed prior to 2024:

- 147.175 (all states)
- 147.125, 147.150 (NSW, Queensland)
- 146.925, 147.300 (Victoria)
- 147.300 (South Australia)

4.4 146 MHz band intermodulation management with external non-amateur services

Problems can arise at amateur repeater station locations when they are co-located with VHF land mobile base stations operating in accordance with the band plan defined in RALI MS42. That plan allows transmitters to operate with 600 kHz frequency separation. This can become problematic for amateur radio repeaters which operate with 600 kHz TX / RX frequency separation.

Amateur repeater station operators who wish to locate stations adjacent to VHF land mobile base stations should be made aware of this risk and undertake the necessary site engineering to avoid the problem as far as possible. However, to avoid a situation where practical filtering solutions fail to resolve the interference, two -1.6 MHz offset channel blocks are defined for this purpose.

- Block D is the preferred channel block to study first.
- Block E being considered only as a last resort. (Block E can create interference to existing class licenced amateur activity which shares Block E receive channel allocations).

The policy in this case, is:

a) Where the proposed repeater is located >1000m from a VHF land mobile base station, that priority is given to allocating channels for those systems from channel block A and B that do not overlap with channel block D or E.

b) where the proposed repeater is located <1000m from a VHF land mobile base station, that it be given (where possible) a transmitter frequency from the Block D or E channel plan, but initially be given a receiver frequency from the corresponding overlapping Block B channel plan (i.e. a 600 kHz offset receive channel). Should the station operator be unable to make a 600 kHz offset receiver work at their proposed site, they can then re-coordinate the repeater operating frequencies, retaining their existing transmitter frequency, but moving their receiver to the corresponding -1.6 MHz offset Block D or E receive channel group.

To identify the sites where priority access should be given to Block D or E transmit frequencies, determine from the ACMA RRL whether there are any multi-channel VHF land mobile base stations that generate the following scenario.

For Example (from ACMA RALI LM8 – Annex B section B1 and B2):

Block 1 Group 1 TX Channel assignments are 1, 13, 25, 37 and 49

These translate into VHF land mobile transmitters being assigned to:

- *Ch 01 = 165.2000*
- *Ch 13 = 165.3500*
- *Ch 25 = 165.5000*
- *Ch 37 = 165.6500*
- *Ch 49 = 165.8000*

Consider next the generated intermodulation products:

Ch 49 – Ch 01 = 165.8000 – 165.2000 = 0.6 MHz (600 kHz)

Next consider what occurs when that 600 kHz product interacts with an amateur repeater TX (allocated within one of amateur repeater frequency Block A, B or C):

Amateur Repeater TX +/- (165.8 – 165.2) = Amateur Repeater Rx

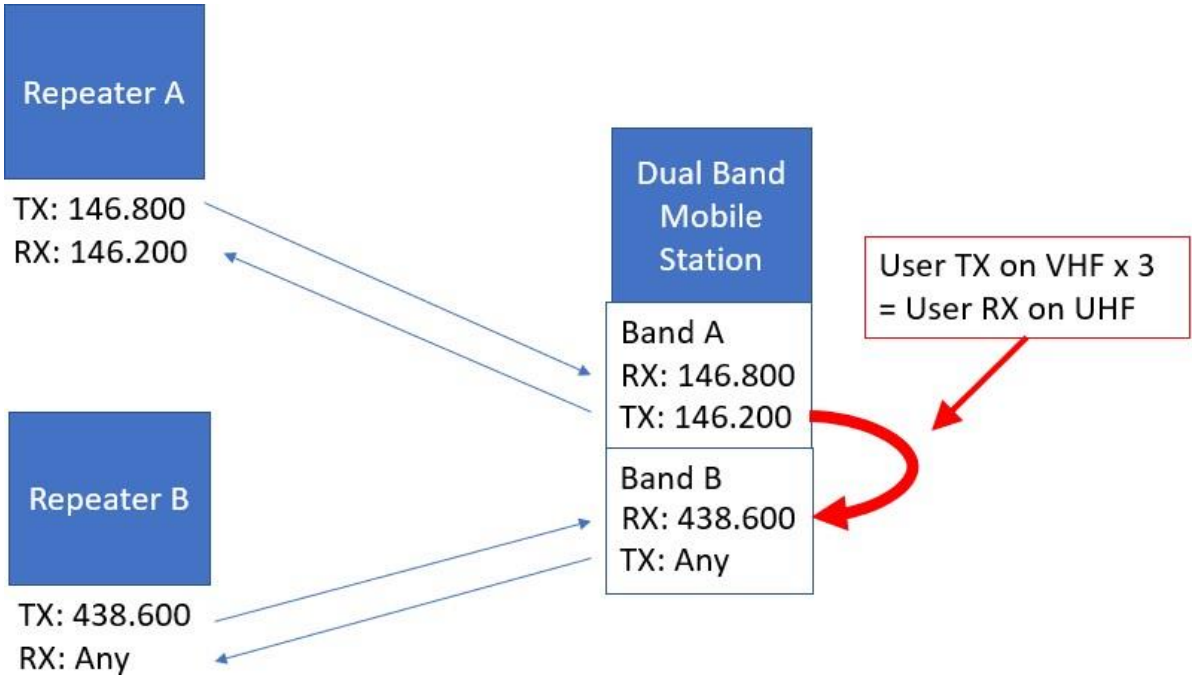
This is a direct (A – B) +/- C intermodulation product and has a greater probability of causing interference to the amateur repeater receiver.

4.5 Restrictions on harmonically related 146 / 438 MHz services within 80 km.

The amateur radio spectrum bands are historically harmonically related. This poses an additional frequency coordination constraint when selecting amateur repeater frequencies.

The mode of interference occurs in the amateur non-assigned station when transmitting to a repeater in the VHF segment and simultaneously listening to a repeater in the UHF segment. The interference that results is generated in the non-assigned mobile/portable station internally and follows the equation:

F(UHF Harmonic) = (F(VHF Repeater TX) MHz -0.6 MHz) x 3



This local 3rd harmonic interference problem is not easily solved at the affected station, and so it is preferable that the problem be avoided at the frequency assignment stage.

The following specific 146 MHz / 438 MHz band channel pairs should be avoided within the same 80km radius locality as an assigned 430-440 MHz repeater station inside that area. In addition, the 12.5 kHz channel above and below the impacted 430-440 MHz repeater transmitter should also be avoided (as the harmonic interference is up to 48 kHz wide).

144 MHz Repeater RX	144 MHz Repeater TX	Impacted 430-440 MHz Repeater TX	144 MHz Repeater RX	144 MHz Repeater TX	Impacted 430-440 MHz Repeater TX
146.0125	146.6125	438.0375	146.1625	146.7625	438.4875
146.0250	146.6250	438.0750	146.1750	146.7750	438.5250
146.0375	146.6375	438.1125	146.1875	146.7875	438.5625
146.0500	146.6500	438.1500	146.2000	146.8000	438.6000
146.0625	146.6625	438.1875	146.2125	146.8125	438.6375
146.0750	146.6750	438.2250	146.2250	146.8250	438.6750
146.0875	146.6875	438.2625	146.2375	146.8375	438.7125
146.1000	146.7000	438.3000	146.2500	146.8500	438.7500
146.1125	146.7125	438.3375	146.2625	146.8625	438.7875
146.1250	146.7250	438.3750	146.2750	146.8750	438.8250
146.1375	146.7375	438.4125	146.2875	146.8875	438.8625
146.1500	146.7500	438.4500	146.3000	146.9000	438.9000

4.6 Coordination of 146 MHz band single and two frequency assigned services.

Due to the narrow nature of the amateur service allocation in this frequency range, multiple service types are arranged near each other in the frequency domain. This leads to clashes between the two-frequency repeater stations and the single frequency gateway / data repeater stations on the band where filtering solutions are unable to solve the resulting receiver overload problems.

When selecting frequencies for new services, it is therefore a requirement to validate the frequency selected for a service against those already operating in the vicinity of the new service.

The following is the master frequency block compatibility table. This provides a summary of the most likely outcomes from conducting compatibility analysis of services within the 146 MHz band.

146 MHz Band Compatibility		Two Frequency Repeater					
		Block A	Block B	Block C	Block D	Block E1	Block E2
Single Frequency Gateway / Data	Block F1	Pass	Pass	Fail	Pass	Pass	Pass
	Block F2	Pass	Pass	Fail	Fail	Fail	Fail
	Block F3	Restricted	Fail	Pass	Caution	Caution	Fail
	Block G1	Pass	Pass	Fail	Caution	Caution	Caution
	Block G2	Pass	Fail	Pass	Pass	Pass	Pass

The following sections provide a detailed analysis and explain which combinations may pass under certain conditions. (channel block details are provided in Appendix A).

4.6.1 Single Frequency Block F1/F2 verses Two Frequency Block C systems

Case 1:- If the two frequency (duplex) repeater is required to use a receive channel in the Block C receive band segment and there is a single frequency gateway station operating within the Gateway Block F1 & F2 segment within 1km, insufficient isolation can be provided. Likewise, if there is an information beacon operating on 145.250 MHz.

Case 2:- If there is a store and forward data repeater located within 300m operating on channel Block G1, then insufficient isolation can be provided to support the assignment of a new service in repeater channel Block C

- Repeater Channel Block C would be deemed unavailable for any new assignments in each of these situations.

4.6.2 Single Frequency Block F2 verses Two Frequency Block D and E systems

If the two frequency (duplex) repeater is required to use a receive channel in the Block D or E receive band segment, insufficient isolation can be provided to enable an assignment to be made if the Block F2 services are located within 1km of the proposed site.

- Repeater Channel Block D and E would be deemed unavailable for any new assignments in this situation.

4.6.3 Single Frequency Block G1 verses Two Frequency Block C, D or E systems

If the two frequency (duplex) repeater is required to use a receive channel in either Block C, D or Block E receive band and a store and forward data repeater is operating in Block G1 then a minimum notional isolation of 110dB between the single frequency service site and the new proposed repeater site is required.

- Repeater Channel Block D and E can still be used in this circumstance provided the required isolation is met. This may require the existing service to have additional filtering fitted which would need to be negotiated prior to the application being submitted.

Repeater Channel Block C may only be useable between 144.9125-144.9500 and will be subject to a site-specific isolation requirement assessment. Additional information may be required from the applicant before a frequency in this range could be assigned at the proposed site.

- Repeater Block C can only be partially considered and would be subject to a site-specific isolation assessment to determine viability. This may require the existing service to have additional filtering fitted which would need to be negotiated prior to the application being submitted.

This condition can be waived if the distance to any other fixed amateur service is >1 km from the proposed new repeater allocation site.

4.6.4 Single Frequency Block F3 or G2 verses Block B two frequency systems

If the two frequency (duplex) repeater is required to use a channel in repeater Block B band segment and there is a single frequency store and forward data repeater operating in Block G2 or a single frequency gateway station operating in the Block F3 segment, located within 1 km of the new proposed site, then:

- Block B is not available for assignments at this location due to lack of isolation to/from the single frequency services.

4.6.5 Single Frequency Block F3 or G2 verses Block D and E two frequency systems

If the new two frequency (duplex) repeater is required to use a channel Block D or Block E in the 147.0375 – 147.1125 MHz band segment and there is a single frequency store and forward data

repeater in Block G2 or a single frequency gateway station operating in Block F3, then the Block D or E repeater needs to establish at least 110 dB isolation to the Block F3 and G2 services. Block E services above 147.2500 MHz will likely fail isolation.

- Repeater Block D and part of Block E would be subject to a site-specific isolation assessment to determine viability. This may require the existing service to have additional filtering fitted which would need to be negotiated prior to the application being submitted.

4.7 In band intermodulation management

Single frequency assigned stations in the 147.525 – 147.600 MHz frequency segment should not be located within 1km of a two-frequency duplex station transmitting in the 146.925 – 147.000 MHz segment. Such allocations are susceptible to creating (2A – B) intermodulation products that will affect the 146.925 – 147.000 MHz repeater station receiver on the 146.325 – 146.400 MHz segment.

For example:

- Single Frequency store and forward repeater – 147.600 MHz
- Two frequency duplex repeater – 147.000 MHz (TX) / 146.400 MHz (RX)
- 2x 147.000 – 147.600 = 146.400 MHz – intermodulation fails

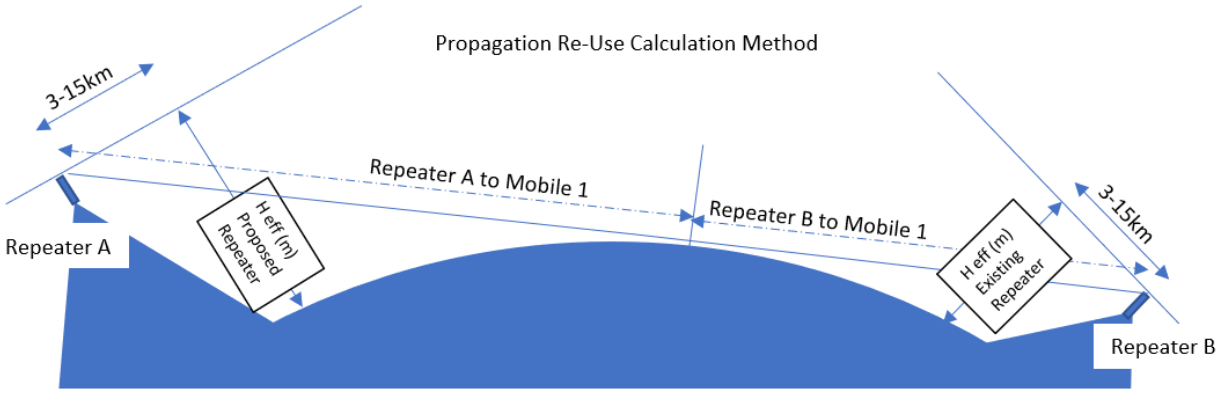
4.8 Frequency re-use for Co-Channel 146 MHz services

In assessing frequency re-use for tropospheric based propagation effects within the amateur repeater station network, a simplified approach has been developed based on ITU-R P.1546-6.

The design of inter-site distance has also discounted any assessment of home based non-assigned amateur stations where the station antenna height is usually much more than 1.5m above ground and the station antenna gain is typically > 10dBi (using directional antennas). In this sense, inter-site interference is not precluded but is managed within the very diverse portfolio of usage within the amateur radio service.

To simplify frequency reuse assessment, tables have been developed that define the minimum acceptable reuse distance for a co-channel repeater given the calculated effective height of the proposed new station and a potential co-channel frequency candidate.

The value for the effective height h_{eff} is defined (in ITU-R.1546-6 Annex 5 Section 3) as its height in metres over the average level of the ground between distances of 3 and 15 km from the transmitting/base antenna in the direction of the receiving/mobile antenna. Where the value of effective transmitting/base antenna height, h_{eff}, is not known it should be estimated from available topographic information.



To use the tables, take the value determined for H_{eff} for each site, add the tower height to the H_{eff} value and then round up to the next highest pre-determined height bracket in the re-use table. Do this for each of the two sites in each reuse distance check. Then, using the matrix, new site on the horizontal axis, existing site on the vertical axis, determine the minimum acceptable reuse distance for that pair.

4.8.1 146 MHz Repeater Reuse Distances for Co-Channel repeaters - inland

The following table provides the specific tropospheric based minimum Co-Channel Reuse Distance between co-channel amateur repeater stations on the 146 MHz band.

Should a reuse distance combination not be able to be found, then follow the non-standard process outlined in FAP 10.

Distance Between Sites (km)		New site effective height				
	Effective Height (m)	37.5	150	300	600	1200
Existing Site effective height	37.5	260 km	290 km	320 km	350 km	380 km
	150	290 km	320 km	350 km	380 km	410 km
	300	320 km	350 km	380 km	410 km	440 km
	600	350 km	380 km	410 km	440 km	470 km
	1200	380 km	410 km	440 km	470 km	500 km

4.8.2 146 MHz Repeater Reuse Distances for Co-Channel repeaters – coastal

Where the line between two repeaters crosses coastal waters, the enhanced tropospheric ducting found in these regions greatly increases the probability of interference. When evaluating frequency reuse over coastal regions, particularly where the paths between two stations cross coastal water bodies, the reuse distances quoted should have an additional 80 km added.

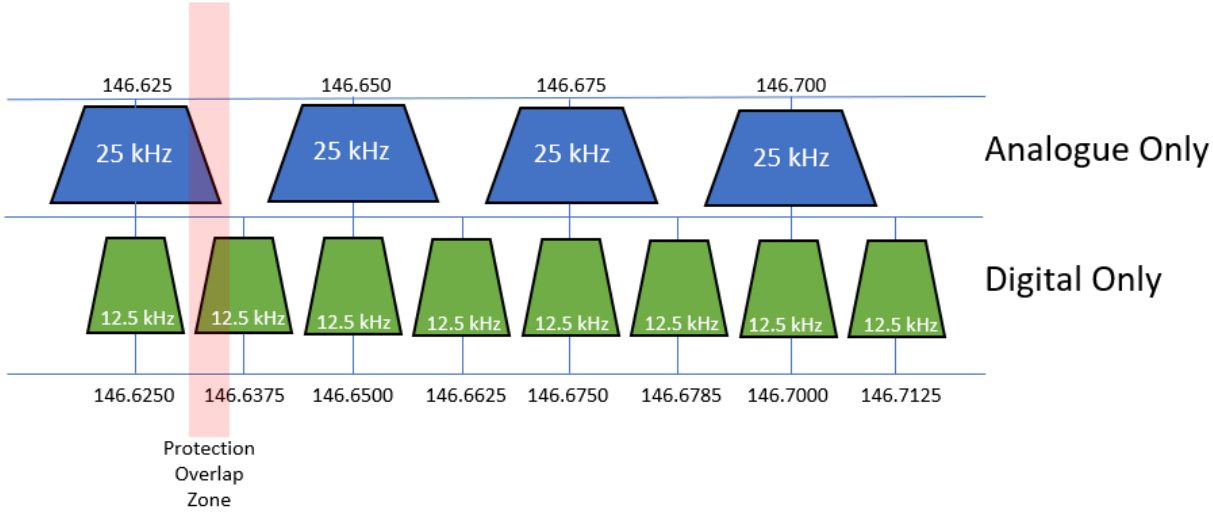
Should a reuse distance combination not be able to be found, then follow the non-standard process outlined in FAP 10.

4.9 Frequency re-use for 12.5/25 kHz overlapping adjacent channel 146 MHz services.

On the 146 MHz amateur band, the amateur repeater channel plan operates using two different channel rasters.

1. There is a primary 25 kHz channel raster that is applied to all analogue capable (including mixed analogue/digital) repeater stations.
2. For digital only repeater stations there is an additional overlapping 12.5 kHz channel plan designed to provide some increase in channel capacity.

Due to the differences in modulation bandwidth on the 25 kHz channels (using 16K0F3E or 16K0F9W modulation) versus the 12.5 kHz channels which only use 9K00F9W modulation), the amount of frequency reuse protection required in the 25 kHz channel is governed by the amount of energy from the adjacent digital channel transmission that will still be present in an adjacent 16kHz wide analogue receiver operating on the 25 kHz channel raster.



When considering adjacent channel reuse in this case, a reduction of 26dB in the required protection can be applied when comparing the co-channel case to the adjacent channel case. This translates into a corresponding reduction of required the inter-site frequency reuse distance.

For example, on the 144 – 148 MHz band:

- A proposed 12.5 kHz channel digital repeater on 146.625 MHz co-channel with a 25 kHz analogue repeater also on 146.625 MHz will follow the inter-repeater spacing calculated values according to section 4.8.1 & 4.8.2

Whereas:

- A proposed 9 kHz transmitter occupied bandwidth digital repeater using a 12.5 kHz raster channel on 146.6375 MHz adjacent to a 16 kHz bandwidth analogue repeater on a 25 kHz raster channel on 146.625 MHz can use a minimum inter-site spacing value that is derived from section 4.9.1 and 4.9.2.

To simplify this assessment, when considering channels which have overlapped 12.5 / 25 kHz channels, the following inter-site reuse distance tables can be used in place of the co-channel ones for the relevant bands.

4.9.1 146 MHz Repeater Reuse Distances for 12.5/25 kHz Adjacent-Channel repeaters - inland

Distance Between Sites (km)		New site effective height				
	Effective Height (m)	37.5m	150m	300m	600m	1200m
Existing Site effective height	37.5m	180 km	210 km	240 km	270 km	300 km
	150m	210 km	240 km	270 km	300 km	330 km
	300m	240 km	270 km	300 km	330 km	360 km
	600m	270 km	300 km	330 km	360 km	390 km
	1200m	300 km	330 km	360 km	390 km	420 km

Should a reuse distance combination not be able to be found, then follow the non-standard process outlined in FAP 10.

4.9.2 146 MHz Repeater Reuse Distances for 12.5/25 kHz Adjacent-Channel repeaters – coastal

Where the line between two repeaters crosses coastal waters, the enhanced tropospheric ducting found in these regions greatly increases the probability of interference. When evaluating frequency reuse over coastal regions, particularly where the paths between two stations cross coastal water bodies, the reuse distances quoted should have an additional 80 km added.

Should a reuse distance combination not be able to be found, then follow the non-standard process outlined in FAP 10.

5 Amateur Repeater & Gateway Station Frequency Coordination Procedure

5.1 Amateur Two Frequency Repeater Station Assignment Process

Step 1 – is this an application for a portable system operating on an area wide basis?

a) determine if the applicant qualifies for access to one of the special use channels (i.e., is it a portable repeater that will be used for emergency service communications by the nominated organisation).

b) If it is, then it should be licenced such that "Area Wide" usage is provided within the state or territory the licence applies to.

c) Proceed to registration. (As these are itinerant and self-managed regarding interference no further assessment is required).

Step 2 – select which channel blocks are valid for use by the proposed service based on co-located and nearby services.

a) obtain a list of all VHF services within 1km of the proposed new amateur assigned service within the 148 – 174 MHz band and determine if the site should preference channel blocks A/B/C or channel blocks D/E (refer to section 4.4).

b) obtain a list of all existing assigned single and two frequency amateur stations within the same frequency band within 1km of the proposed site from the ACMA RRL and identify if any of the channel blocks / sub-bands should be excluded from consideration due to receiver blocking limitations. (refer section 4.5). Add these to a cull list of unavailable frequencies at the new site.

Step 3 – if Channel Block A is being considered, conduct a cross-band 146 / 438 MHz harmonic relationship test in accordance with Section 4.6.

a) add any frequency identified to a cull list for channel block A, so that those frequencies are no longer considered in further assessment of that channel block.

Step 4 – undertake an in-band intermodulation assessment of single frequency vs two frequency repeater systems located within 300m of each other in accordance with section 4.7.

a) add any frequency identified to a cull list for channel block A, so that those frequencies are no longer considered in further assessment of that channel block.

Step 5 – determine whether the proposed repeater requires a 25 kHz bandwidth channel or a 12.5 kHz channel.

a) If it is operating either part time or full time using analogue modulation, then a 25 kHz channel will be required. This will exclude channel block C from being available for this service.

b) Otherwise, if it is a digital only service, then it can consider using a 12.5 kHz bandwidth channel from any channel block not already blocked in the proceeding steps (including channel block C).

Step 6 – co-channel frequency reuse assessment

a) conduct a search of the ACMA RRL[8] and create a list of all services in the remaining assignable frequency blocks that are currently active within 600 km.

b) inspect the list of services gathered and compare against the available channels in the channel blocks available for consideration at this site. If there is a clear frequency, then select the lowest available channel pair and proceed to step 7.

c) if there are no clear frequencies identified, follow the frequency reuse calculation method outlined in section 4.8 to determine, based on the effective height of each system, whether a channel is available that has a reuse distance greater than the minimum specified in the section 4.8 processes. Note the different requirements for coastal vs inland systems.

d) Add to the frequency cull list any frequency where the reuse distance is less than the minimum.

e) Allocate the lowest available frequency in the block.

f) If no frequencies are available, proceed to refer the application to the ACMA for a non-standard allocation process where more detailed scrutiny of the re-use distance requirements can be conducted using more detailed terrain modelling.

Step 7 – adjacent-channel frequency reuse assessment

a) For the identified frequency candidate in step 6, inspect the ACMA RRL on the corresponding frequency 12.5 kHz above and below the proposed channel and conduct a frequency reuse assessment in accordance with section 4.9.
b) If the adjacent channel reuse fails, repeat step 6 for the next available frequency and continue until all frequency options have been exhausted.

[8] ACMA RRL https://web.acma.gov.au/rrl/register_search.main_page

Step 8 – if you have exhausted all available frequencies and not been able to identify a suitable option, APs are then requested to refer the application to the ACMA for assessment using the non-standard process outlined in FAP 10.

5.2 Amateur Single Frequency Gateway Station Process

Step 1 –Determine if there are any duplex assigned amateur repeater stations within 1km of the proposed site licenced in one of channel Block A – E based on the contents of the ACMA RRL.

Step 2 – if there are duplex repeaters within 1km of the proposed site then assess which frequency blocks are available at the proposed location as per:

(a) If repeater Block C is in use, then gateway channel block F1 and F2 are not available for use.
(b) If repeater Block D or E are in use, then gateway channel block F2 is not available.
(c) If repeater Block B or E are in use, then gateway channel block F3 is not available for use.
(d) If repeater Block D or lower E is in use, then site specific isolation design will be required in Block F3 to develop a compatible solution with the existing service.
(e) If a repeater TX on 146.925 is present, then gateway frequency 147.525 is not available.
(f) If a repeater TX on 146.950 is present, then gateway frequency 147.550 is not available.

Step 3 – if there are any single frequency repeaters within 1km of the proposed site then examine frequency allocations in block G1 and G2 to determine which gateway channel block is available as follows:

(a) If data repeater Block G1 is in use, then gateway channel block F1 and F2 are not available.
(b) If data repeater Block G2 is in use, then gateway channel Block F3 is not available.

Select a valid frequency block from F1, F2 and F3 based on the outcome of the above studies and then proceed to the next step.

Step 4 – within the valid gateway frequency block, obtain a list from the ACMA RRL of all existing licenced amateur single frequency assigned stations within 600 km.

Step 5 – if there is a frequency available that has no services licenced on it within 600 km then select the first frequency available and proceed to Step 7.

Step 6 – for each frequency, determine the distance between the two sites and the effective height H_{eff} above average terrain (as per section 4.1). Select the minimum allowed co-channel reuse distance from the table in section 0 for co-channel stations and determine if the proposed frequency meets or exceeds that requirement. If it does, then proceed to Step 6 else select the next channel option and repeat Step 5.

Step 7 – for the selected frequency, check the adjacent frequency 12.5 kHz above and below for an existing assigned amateur station and after determining its effective height H_{eff} use the adjacent frequency re-use table to determine if the distance is greater than the allowed minimum. If it is, then proceed to Step 7.

Step 8 – assess the selected frequency against the intermodulation requirements of ACMA RALI LM8. If it passes, then proceed to Step 8 else return to Step 5.

Step 9 – proceed to submit the application.

Step 10 – if you have exhausted all available frequencies and not been able to identify a suitable option, APs are then requested to refer the application to the ACMA for assessment using the non-standard process outlined in FAP 10.

5.3 Amateur Single Frequency Store & Forward Data Repeater Station Process

Step 1 –Determine if there are any duplex assigned amateur repeater stations within 1km of the proposed site licenced in one of channel Block A – E based on the contents of the ACMA RRL.

Step 2 – if there are duplex repeaters within 1km of the proposed site then assess which frequency blocks are available at the proposed location as per:

(a) If repeater Block C is in use (see section 6.2.1.2), then data repeater block G1 is not available for use.
(b) If repeater Block D E1 or E2 (6.2.1.3) are in use, then data repeater block G1 requires 110dB of isolation (made up of filtering and free space path loss to address RX blocking) to the affected existing service. If that can be achieved, then proceed to step 3.
(c) If repeater Block B or E are in use, then data repeater block G2 is not available for use.
(d) If repeater Block D or lower E is in use, then site specific isolation design will be required in Block G2 to develop a compatible solution with the existing service.
(e) If duplex repeater TX on 146.975 is present, then data repeater frequency 147.575 is not available.
(f) If duplex repeater TX on 147.000 is present, then gateway frequency 147.600 is not available.

Step 3 – if there are any single frequency repeaters within 1km of the proposed site then examine frequency allocations in block F1, F2 and F3 to determine which gateway channel block is available as follows:

(a) If gateway Block F1 or F2 are in use, then data repeater block G1 is not available.
(b) If gateway Block F3 is in use, then data repeater Block G2 is not available.

Following this assessment, select a frequency based on which block (G1 or G2) is valid.

Step 4 – if the applicant is seeking to install an APRS data repeater, they will require the station to operate only on 145.175 MHz (which is the national APRS common relay channel). Therefore, where block G1 is blocked, APRS repeaters will not be compatible with the existing services at the proposed site and the application will need to be rejected.

Step 5 – either chose a frequency from which ever block is valid or if APRS has been specified then consider that the only frequency allowed to be assigned is 145.175 MHz (which is the national common APRS channel).

Step 6 – assess the selected frequency against the intermodulation requirements of ACMA RALI LM8. If it passes, then proceed to Step 5 else return to Step 3.

Step 7 – proceed to register the transmitter.

Step 8 – if you have exhausted all available frequencies and not been able to identify a suitable option, APs are then requested to refer the application to the ACMA for assessment using the non-standard process outlined in FAP 10.

5.4 Amateur Two Frequency Repeater "off air" link station Assignment Process

Step 1 – are the source and linked repeaters operating on opposing A vs B or B vs A sub-bands (see the channel plan in the appendix)?

a) If the primary and linked repeaters satisfy this criterion move to step 2.

b) If the primary and linked repeater are both operating in the same link band, then insufficient isolation can be achieved between the link transmitter and the main repeater receiver. The application should be rejected on technical grounds or be referred to ACMA for processing using the non-standard approvals process outlined in the FAP.

Step 2 – is the B end linked repeater's location such that it's effective height (H_{eff}) is less than 200m?

a) If the H_{eff} as calculated for section 4.8 is greater than 200m then the applicant should be encouraged to design alternate linking technologies for the system (using dedicated link transmitters on the 438 MHz band) and not proceed with an off-air link solution. The risk of interference to adjacent co-channel systems, particularly under tropospheric ducting conditions, and therefore the potential to enable two separate systems to mutually interfere to the extent that each one keys the other in an infinite loop, is too high in this circumstance.

b) If the applicant seeks to proceed, then the application should be referred to ACMA for processing using the non-standard approvals process outlined in the FAP.

Step 3 – if Channel Block A is being considered for the link transmitter, identify if there is a 438 MHz repeater co-sited with the Link Repeater site where the B end transmitter will be located and conduct a cross-band 146 / 438 MHz harmonic relationship test in accordance with Section 4.6

a) If the frequency combination fails the test then the proposal is technically infeasible. The applicant will need to redesign the system to use a dedicated 438 MHz link design.

Step 4 – if Channel Block B is being considered for the link transmitter, undertake an in-band intermodulation assessment of single frequency vs two frequency repeater systems located within 300m of each other in accordance with section 4.7.

a) If it fails the tests in section 4.7 then the proposal is technically infeasible. The applicant will need to redesign the system to use a dedicated 438 MHz link design.

Step 5 – if steps 1 to 4 have been passed successfully, then proceed to register the link transmitter

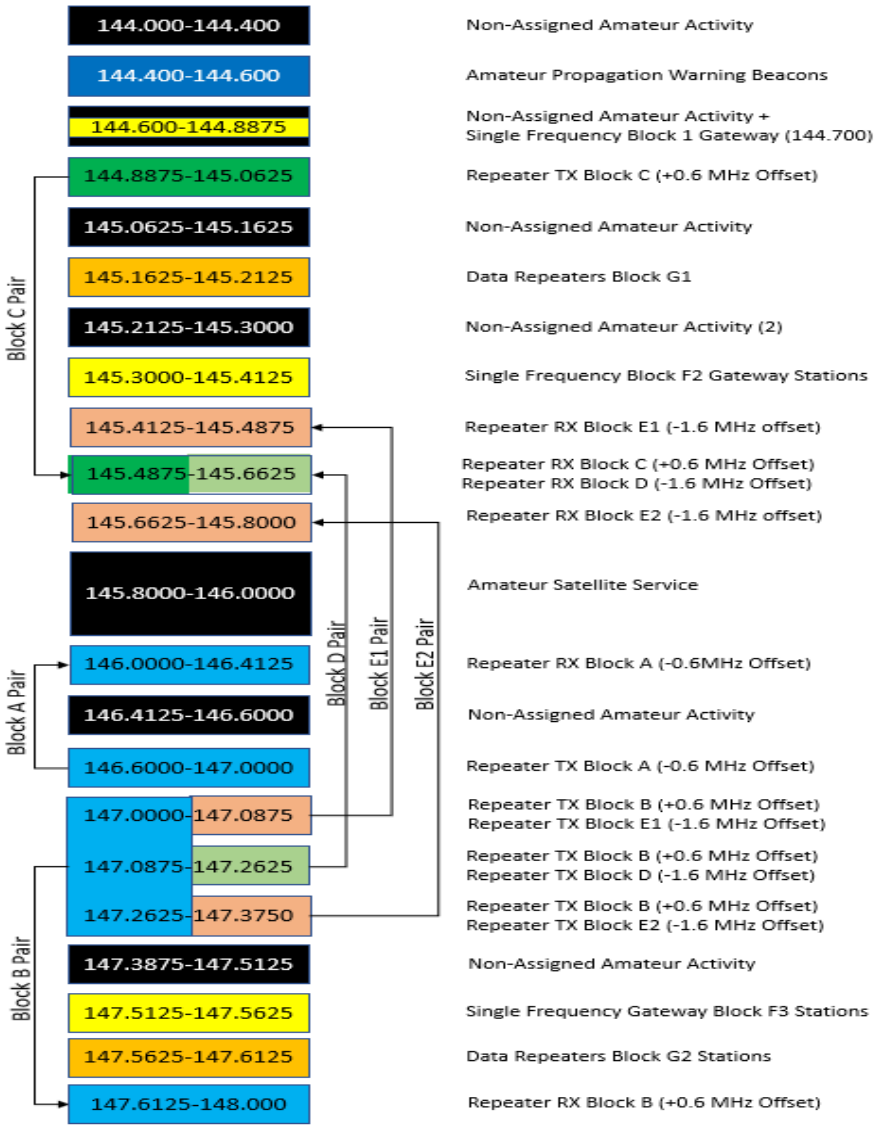
Step 6 – if you have exhausted all available frequencies and not been able to identify a suitable option, APs are then requested to refer the application to the ACMA for assessment using the non-standard process outlined in FAP 10.

6 APPENDIX A – 144 - 148 MHz band / channel plans

The amateur service has established a set of guiding band plans to manage interference between different types of activities. These plans form the foundation of the frequency assignment policies for these amateur spectrum bands.

Within each repeater sub-band specific channel arrangements have been developed. Repeater, store and forward data and gateway stations should be assigned channels only from these defined channel plans.

6.1 Amateur 144 – 148 MHz Band Plan



Notes:

(1) This segment contains some spot channels available for amateur assigned use.
(2) contains the assigned Information Beacon channel (145.250 MHz)
(3) Class Licenced Amateur activity exists across the entire band and shares assigned station frequencies.
(4) No terrestrial assignments are to be made within the Amateur Satellite Service sub-band.

6.2 Repeater & Gateway Channel Plans

Within each repeater sub-band specific channel arrangements have been developed. Repeater, store and forward data and gateway stations should be assigned channels only from these defined channel plans.

6.2.1 146 MHz Two Frequency Repeaters (Analogue or Digital or Mixed)

6.2.1.1 146MHz Sub-band A & B Channel Plan

Repeater Sub-Band A and B are the primary frequency sub-band for both analogue FM modulation based as well as mixed analogue/digital voice amateur repeater services in the 146 MHz amateur band on a 25kHz channel raster. Digital only systems are permitted to also use the 12.5 kHz channel raster.

Sub-band	Repeater Transmit		Repeater Receive (-600 kHz offset)		PORTABLE AREA WIDE ALLOCATION
	25 kHz Raster	12.5 kHz Raster (Digital Only)	25 kHz Raster	12.5 kHz Raster (Digital Only)	
A		146.6125		146.0125	
	146.6250	146.6250	146.0250	146.0250	
		146.6375		146.0375	
	146.6500	146.6500	146.0500	146.0500	
		146.6625		146.0625	
	146.6750	146.6750	146.0750	146.0750	
		146.6875		146.0875	
	146.7000	146.7000	146.1000	146.1000	
		146.7125		146.1125	
	146.7250	146.7250	146.1250	146.1250	
		146.7375		146.1375	
	146.7500	146.7500	146.1500	146.1500	
		146.7625		146.1625	
	146.7750	146.7750	146.1750	146.1750	
		146.7875		146.1875	
	146.8000	146.8000	146.2000	146.2000	
		146.8125		146.2125	
	146.8250	146.8250	146.2250	146.2250	
		146.8375		146.2375	
	146.8500	146.8500	146.2500	146.2500	
		146.8625		146.2625	
	146.8750	146.8750	146.2750	146.2750	

Sub-band	Repeater Transmit		Repeater Receive (+/-600kHz offset)		PORTABLE AREA WIDE ALLOCATION
	25 kHz Raster	12.5 kHz Raster (Digital Only)	25 kHz Raster	12.5 kHz Raster (Digital Only)	
A		146.8875		146.2875	
	146.9000	146.9000	146.3000	146.3000	
		146.9125		146.3125	
	146.9250	146.9250	146.3250	146.3250	PORTABLE VIC
		146.9375		146.3375	
	146.9500	146.9500	146.3500	146.3500	
		146.9625		146.3625	
	146.9750	146.9750	146.3750	146.3750	
		146.9875		146.3875	
	147.0000	147.0000	146.4000	146.4000	
B		147.0125		147.6125	
	147.0250	147.0250	147.6250	147.6250	
		147.0375		147.6375	
	147.0500	147.0500	147.6500	147.6500	
		147.0625		147.6625	
	147.0750	147.0750	147.6750	147.6750	
		147.0875		147.6875	
	147.1000	147.1000	147.7000	147.7000	
		147.1125		147.7125	
	147.1250	147.1250	147.7250	147.7250	PORTABLE NSW/QLD
		147.1375		147.7375	
	147.1500	147.1500	147.7500	147.7500	PORTABLE NSW/QLD
		147.1625		147.7625	
	147.1750	147.1750	147.7750	147.7750	PORTABLE NATIONAL
		147.1875		147.7875	
	147.2000	147.2000	147.8000	147.8000	
		147.2125		147.8125	
	147.2250	147.2250	147.8250	147.8250	
		147.2375		147.8375	
	147.2500	147.2500	147.8500	147.8500	
		147.2625		147.8625	
	147.2750	147.2750	147.8750	147.8750	
		147.2875		147.8875	
	147.3000	147.3000	147.9000	147.9000	PORTABLE VIC/SA
		147.3125		147.9125	
	147.3250	147.3250	147.9250	147.9250	
		147.3375		147.9375	
	147.3500	147.3500	147.9500	147.9500	
		147.3625		147.9625	
	147.3750	147.3750	147.9750	147.9750	

6.2.1.2 146 MHz Sub-Band C Channel Plan

Repeater Sub-Band C is the secondary frequency band for digital voice and duplex data-based repeater services if a suitable frequency pair cannot be identified for these services in sub-band A or B.

It supports digital only repeater systems using 12.5 kHz channel rasters and modulation bandwidths less than 11 kHz. (e.g. P25, DMR, DSTAR, C4FM (digital only) etc).

Sub-band	Repeater Transmit	Repeater Receive (+/-600kHz offset)
	12.5 kHz Raster	12.5 kHz Raster
C	144.9250	145.5250
	144.9375	145.5375
	144.9500	145.5500
	144.9625	145.5625
	144.9750	145.5750
	144.9875	145.5875
	145.0000	145.6000
	145.0125	145.6125
	145.0250	145.6250
	145.0375	145.6375
	145.0500	145.6500

6.2.1.3 146 MHz Sub-Band D, E1 and E2 Channel Plan

Repeater Sub-Band D & E cover 147.0125-147.3750 MHz TX frequencies when specifically using RX frequencies that are -1.6 MHz Tx/Rx apart.

The preference is to first allocate channels from Sub-band D and to only use Sub-Band E as a last resort (when sub-band D TX channels cannot be identified in an area due to an existing Sub-band A, B or D repeater allocation).

Sub-band	Repeater Transmit		Repeater Receive (+/-600kHz offset)		EXCLUSIVE SPECIAL USE ALLOCATION
	25 kHz Raster	12.5 kHz Raster	25 kHz Raster	12.5 kHz Raster	
D	147.1250	147.1250	145.5250	145.5250	PORTABLE NSW/QLD
		147.1375		145.5375	
	147.1500	147.1500	145.5500	145.5500	PORTABLE NSW/QLD
		147.1625		145.5625	
	147.1750	147.1750	145.5750	145.5750	PORTABLE NATIONAL
		147.1875		145.5875	
	147.2000	147.2000	145.6000	145.6000	
		147.2125		145.6125	
	147.2250	147.2250	145.6250	145.6250	
		147.2375		145.6375	
	147.2500	147.2500	145.6500	145.6500	

Within block E2, 145.700/147.3000 MHz should be avoided unless no other options are available.
(This channel (145.700) is ordinarily used to support amateur class licenced use in ARDF competitions).

Sub-band	Repeater Transmit		Repeater Receive (+/-600kHz offset)		EXCLUSIVE SPECIAL USE ALLOCATION
	25 kHz Raster	12.5 kHz Raster (Digital Only)	25 kHz Raster	12.5 kHz Raster (Digital Only)	
E1		147.0125		145.4125	
	147.0250	147.0250	145.4250	145.4250	
		147.0375		145.4375	
	147.0500	147.0500	145.4500	145.4500	
		147.0625		145.4625	
	147.0750	147.0750	145.4750	145.4750	
		147.0875		145.4875	
	147.1000	147.1000	145.5000	145.5000	
		147.1125		145.5125	
E2		147.2625		145.6625	
	147.2750	147.2750	145.6750	145.6750	
		147.2875		145.6875	
	147.3000	147.3000	145.7000	145.7000	PORTABLE VIC/SA
		147.3125		145.7125	
	147.3250	147.3250	145.7250	145.7250	
		147.3375		145.7375	
	147.3500	147.3500	145.7500	145.7500	
		147.3625		145.7625	
	147.3750	147.3750	145.7750	145.7750	

6.2.2 146 MHz Single Frequency Voice Gateways (Analogue or Digital)

These channels are used for single frequency gateway stations. They are also the primary channels used by non-assigned amateur stations operating "Hotspot" low power (<1W) digital network access transmitters for networks such as DSTAR[9], FUSION (C4FM)[10], DMR[11] etc.

Analogue stations use systems like (but not limited to) IRLP[12] or Echolink[13] to connect a transceiver to a closed telecommunications connected amateur radio relay network.

6.2.2.1 146MHz Sub-band F1, F2 & F3 Channel Plan

	Transmit / Receive Frequency (MHz)		Type of Modulation
Channel Block	12.5 kHz Channel (BW < 9 kHz)	25 kHz Channel (BW < 16kHz)	
F1	144.7500	NA	Digital Only
F2	145.3250	145.3250	Digital/Analogue
	145.3375	NA	Digital
	145.3500	145.3500	Digital/Analogue
	145.3625	NA	Digital
	145.3750	145.3750	Digital/Analogue
	145.3875	NA	Digital
F3	147.5250	147.5250	Analogue
	147.5500	147.5500	Analogue

[9] DSTAR system specification (Japan Amateur Radio League) https://www.jarl.com/d-star/shogen.pdf

[10] FUSION (C4FM) C4FM System Specification document (Yaesu) https://www.yaesu.com/downloadFile.cfm?FileID=9039&FileCatID=263&FileName=Yaesu_Amateur%20Radio%20Digital%20Specs_1V02_EN-GB.pdf

[11] DMR Amateur Radio adaptation of the commercial DMR standards https://www.dmrassociation.org/dmr-standards.html

[12] IRLP (Internet Radio Linking Project) https://www.irlp.net/

[13] Echolink https://www.echolink.org/

6.2.3 146 MHz Single Frequency Store and Forward Data Repeaters

Single Frequency Store and Forward data repeaters operate on the following shared channels.

6.2.3.1 146MHz Sub-band G1 & G2 Channel Plan

Lower Band – Block G1

Channel Block	TX Frequency	RX Frequency	Network
G1	145.175 MHz	145.175 MHz	APRS
	145.200 MHz	145.200 MHz	WICEN Emergency

Upper Band – Block G2

Channel Block	TX Frequency	RX Frequency	Network
G2	147.575 MHz	147.575 MHz	General Use
	147.600 MHz	147.600 MHz	General Use

7 APPENDIX B - Distribution Rights

8 APPENDIX C - Document Control

Date	Version	Change Description
19-June-2022	0.1	First Draft for internal Review
19-June-2022	0.2	1. Added application process. 2. expanded 3rd harmonic considerations between 144 and 432 MHz bands. 3. Added 28 MHz Repeater frequency reuse determination section
Late 2022	0.3	Issued to ACMA for initial comment
10th March 2023	0.4	Revised following industry feedback
30th April 2023	0.5	Revised/restructured following industry feedback – Preliminary draft not for public distribution
15th December	0.6	Revised into separate documents and assigned designation RALI-AA3
11th March 2023	1.0	Exposure draft for ACMA internal review
17th March 2023	1.1	Added off air linking transmitter models and made minor corrections to the diagrams in the models section.
1st Jun 2024	2.0	Exposure Draft version 2 for public release
25th September	4.0	Final release
23rd October	5.0	PUBLIC Release – ACMA endorsed

Feedback on this document can be made by contacting the WIA National Office via email with the subject "Attention Repeater Coordinator".

Email Address: tac@wia.org.au