RADIO SPECTRUM MANAGEMENT

Radio Licence Certification Rules (PIB 38)

Engineering Rules and Information for Approved Radio Certifiers and Approved Radio Engineers

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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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New Zealand Government

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RADIO SPECTRUM MANAGEMENT

1. Introduction

1.1 Contents

This Public Information Brochure, Radio Licence Certification Rules (PIB 38), specifies the requirements for certification of Radio Licences in the Radio Licensing bands. These rules enable Approved Persons[1] to complete a certificate as provided by Regulation 12 of the Radiocommunications Regulations 2001 (the Regulations). The certification and content of licences must also meet the requirements of the Radiocommunications Act 1989 and its amendments ("The Act").

Approved Persons, being Approved Radio Engineers and Approved Radio Certifiers, are required to comply with these rules when certifying radio licences.

1.2 Disclaimer

The Ministry of Business, Innovation and Employment (the Ministry), makes no warranty, express or implied, nor assumes any liability for any loss suffered, whether arising directly, or indirectly, due to the sole reliance on the accuracy or contents of this Public Information Brochure (PIB 38).

1.3 Changes

Radio Spectrum Management (RSM) may change, delete or add to or otherwise amend information contained in this PIB from time to time to reflect evolving policies, technologies and services. It is the responsibility of the Approved Persons to ensure that they are familiar with the latest version of these Rules.

Changes to this document will be notified through the 'Radio Spectrum Management Business Update' e-newsletter that is emailed to those who subscribe. The changes are also notified in the news section on the RSM website.

1.4 Clarification and Corrections

RSM will provide clarification of the information contained in this document when requested and would appreciate receiving suggestions for its improvement or advice relating to inaccuracies or ambiguities. Such matters may be emailed to radio.spectrum@mbie.govt.nz. Correspondence received will be acknowledged, investigated and appropriate action taken.

[1] In the context of this document Approved Persons are Authorised Persons

1.5 Abbreviations and definitions

Abbreviation	Definition
ACLR	Adjacent Channel Leakage Ratio (of a transmitter)
The Act	The Radiocommunications Act (1989)
ACS	Adjacent Channel Selectivity (of a receiver)
AGL	Above Ground Level
AM	Amplitude Modulation
ATPC	Adaptive Transmitter Power Control
APCO	Association of Public- Safety Communication Officials
AS/NZS	Joint Australia and New Zealand Standard
ARC	Approved Radio Certifier
ARE	Approved Radio Engineer
BSS	Broadcasting Satellite Service
CAA	Civil Aviation Authority
CCI	Co-channel Interference
C/I	Carrier to Interference
CTCSS	Continuous Tone Coded Squelch System
DSC	Digital Selective Calling
DMA	Defined Metropolitan Area
EES	Earth Exploration Service
EIRP	Equivalent Isotropically Radiated Power
F/B	Front to Back Ratio
FDR	Frequency Dependent Rejection
FM	Frequency Modulation
FSS	Fixed Satellite Service
GURL	General User Radio Licence
HRP	Horizontal Radiation Pattern
IRR	The International Radio Regulations (of the ITU-R)
ITU-R	International Telecommunication Union - Radiocommunication Sector
The Ministry	The Ministry of Business, Innovation and Employment
MMSI	Maritime Mobile Service Identity
MNZ	Maritime New Zealand
NZART	NZ Association of Radio Transmitters
NZDF	NZ Defence Force
PIB	Public Information Brochure
PRS	Personal Radio Service

Abbreviation	Definition
PSRFMG	Public Safety Radio Frequency Management Group
Register	Register of Radio Frequencies
The Regulations	The Radio Regulations (2001)
RPE	Radiation Pattern Envelope
RSM	Radio Spectrum Management
SCADA	Supervisory Control And Data Acquisition
SES	Satellite Earth Station
SINAD	Signal to Noise And Distortion
SO	Space Operations
SR	Space Reserch
STL	Studio-To-Transmitter link
TETRA	Terrestrial Trunked Radio
TT	Telemetry and Telecommand
TVOB	Television Outside Broadcast
VHF	Very High Frequency (30 - 300 MHz)
UHF	Ultra High Frequency (300 - 3 000 MHz)
SHF	Super High Frequency (3 - 30 GHz)
XPD	Cross Polar Discrimination
XPIC	Cross Polar Interference Cancelling

1.6 Amendment History

Issue	Date of effect	Description of Amendment	Authorised by
01	23 September, 2004	First Public Release	
02	May 2005	First amendment	
03	August 2005	Simplex clarification	
04	December 2005	UHF parameter clarification. New antenna criteria. Minor editorial changes.	
05	December 2008	Update to Land mobile Trunk Dispatch 800 MHz	
06	June 2009	Updated for the addition of the 80GHz band. Correction to Fixed service band table. Corrections to Appendix D. Editorial amendments.	
07	December 2010	Substantial revision	
08	August 2011	Update STL rules, include KL band rules. Editorial amendments.	
09	November 2011	Update to include new spectral efficiency rules for 56 MHz channels in V, U, X and 38 GHz bands	
10	June 2014	Update to Section 4 “Land Mobile” to include DMR colour codes. Update to Section 5.18 “Studio to Transmitter Links”. Other minor editorial amendments and format update	Len Starling
11	November 2015	Update to include changes resulting from the 2015 Fixed Service review. Moratorium on new Maritime Repeater services.	Jeff Hicks
11.1	February 2016	Update to spectral efficiency rules in the wide band channels of 8GU and 11G channels Editorial amendments	Jeff Hicks
11.2	February 2018	Update to Studio to Transmitter Links rules Editorial amendments including: adding abbreviation and definition in Section 1, updating appendix numbering, splitting maritime and aeronautical services in section 7 and general formatting.	Siegmund Wieser
11.3	April 2019	Update to 25 kHz land mobile channels above 470 MHz	Siegmund Wieser
12	March 2021	Update to include new 2 GHz fixed service band and new S Band space service. Several other corrections implemented	Len Starling

2. General

2.1 Purpose of this Public Information Brochure

These Radio Licence Certification Rules (Rules) outline the requirements for certifying radio licences. These Rules apply to radiocommunication services in specific bands that are not within management rights.

These Rules include regulatory and engineering aspects that an Approved Radio Certifier (ARC) or Approved Radio Engineer (ARE) (Approved Person) must consider when undertaking engineering activities associated with the preparation and certification of radio licences.

These Rules:

1. Include discussion of regulatory licensing matters, but do not purport to provide legal advice on the Radiocommunications Act 1989 (the Act) or Radiocommunications Regulations 2001 (the Regulations). Readers should take independent legal advice on such matters.
2. Must be read in conjunction with the Radio Licence Policy Rules (PIB 58) and other Public Information Brochures (PIBs)[2] and information published on the RSM website.
3. Don't include all the engineering knowledge and expertise that an Approved Person needs for the preparation and certification of radio licences.

Radio Licence Policy Rules' (PIB 58)

Approved Persons must have regard to relevant information contained in sources such as:

- The International Radio Regulations (IRR); and
- International Telecommunications Union Radio Sector (ITU-R) Reports and Recommendations; and
- Annex 10 to the convention on International Civil Aviation; and
- The International Convention for the Safety of Life at Sea; and
- The nature of the service proposed to be operated under the radio licence.

Approved persons must certify that the proposed licence:

- will not endanger the functioning of any radionavigation service; and
- will not endanger the functioning of any radio service essential to the protection of life or property; and
- will not cause harmful interference to rights conferred by registered spectrum or radio licences; and
- is technically compatible with services authorised to be operated under existing spectrum licences and radio licences; and

[2] Should there appear to be a conflict between these rules and another PIB, or for other matters requiring clarification, please email rsmlicensing@mbie.govt.nz.

- will sufficiently define the nature and characteristics of the proposed transmissions to enable subsequent spectrum licences and radio licences to be co-ordinated for the purpose of avoiding harmful interference.

An example of the certificate is attached as Appendix D: Certificate. This document is automatically generated by the Register of Radio Frequencies (the Register) when certifying a radio licence.

These Rules may change from time to time. Any new or modified licence granted shall be certified in accordance with the Rules current at the time of granting.

Changes to the Rules will not apply to radio licences certified and granted prior to those changes. It is the responsibility of Approved Persons to ensure they are familiar with the current version of this document published on the RSM website.

2.2 Radio Spectrum Management

The role of the Ministry in relation to the radio spectrum includes:

- Identifying social, economic, and technology impacts on the radio spectrum;
- establishing competition policies for spectrum use;
- establishing and managing the regulatory aspects governing spectrum use;
- planning spectrum allocation;
- managing radio and spectrum licensing functions;
- mandating technical planning requirements for spectrum use;
- managing the New Zealand Government's radio spectrum international treaty obligations; and
- managing the spectrum in the radio licensing regime.

In relation to these roles, the Ministry requires that a radio licence submitted for granting must be certified to the requirements set out in section 25(5) of the Act and regulation 12(b) of the Regulations. In particular, a licence submitted must be technically compatible with existing radio licences and spectrum licences recorded in the Register. The principle of *technical compatibility* is embodied in Article 3.3 of the IRRs.

The certifier of radio licences (the Approved Person) can include a Ministry employee or an engineer external to the Ministry (external engineer).

In these Rules:

- Section Two discusses regulatory, policy and administrative issues common to radio frequency bands allocated for radio licensed services;
- Section Three provides technical and related information common to the certification requirements for all services; and
- Sections Four to Seven provide technical and related information for the certification of specific services.

2.3 Scope

These rules provide the essential engineering information for Approved Persons to undertake the technical compatibility analysis necessary for the certification of a licence.

As this document describes the minimum requirements, in many cases more detailed engineering analysis may be required. This document is not intended to serve as a radiocommunications system design or planning guide.

This document covers the following radiocommunications services in the radio licensing regime:

- Fixed services;
- Land Mobile services;
- Fixed Satellite services;
- Aeronautical services;
- Maritime services;
- Other services:
  - Radio Paging;
  - Telemetry / Telecommand; and
  - Personal Radio Service Repeaters.
- Meteorological aids;
- Radiodetermination:
  - Radionavigation;
  - Radiolocation; and
- Services under 30 MHz.

This document is not applicable to services operating under General User Licences (GUL's).

2.4 International allocations, band planning and channel arrangements

In New Zealand, the national allocation plan for the radio spectrum is specified in the Table of Radio Spectrum Usage in New Zealand (PIB 21). PIB 21 conforms to the Table of Frequency Allocations for Region 3 in the IRRs.

Table of Radio Spectrum Usage in New Zealand (PIB 21)

The IRR, including the Table of Frequency Allocations (Article 5), has the status of an international treaty, to which the New Zealand Government is a signatory. The obligation of the Ministry (as the administration on behalf of the Government) to comply with these international regulations rests in clause 12 (a) of the New Zealand Radiocommunications Regulations (2001), which requires that the Chief Executive of the Ministry of Business, Innovation and Employment -

> *"…in determining whether to grant a radio licence...must take account of -*
>
> *(a) any agreement between New Zealand and any other country or countries relating to radiocommunications;..."*

In certifying a radio licence, an Approved Person must also comply with all such agreements. In conforming with the IRR, PIB 21 fulfils the majority of international obligations. Any other international agreements will be accommodated by Policy Documents and Standards referred to in the right hand column of the tables in PIB 21 (References and Policies).

The majority of the spectrum bands in the IRR are allocated to more than one service (see column 2 of PIB 21). To avoid incompatibility, countries select particular services for their national allocations in each band to meet their needs. Not all national allocations are the same for all countries, nor can it be expected that they will all be implemented in the same manner.

In New Zealand, Government policy and broad public interest criteria generally determine how particular bands will be used. Some frequency bands are reserved for exclusive use of one service, whilst others may be available on a shared basis with other ITU allocated services. The specific national allocation plan for bands in New Zealand is the result of historical circumstances, including the intra and inter-service sharing and co-ordination considerations prevailing when the original allocations were made.

2.5 Dispensations

These rules must be followed by all Approved Persons. In special circumstances, dispensation for minor variation from the rules may be considered by the Manager RSM Licensing[3]. Requests for dispensations must be justified in writing to the Manager RSM Licensing. Approved Persons must document the approval for auditing.

Some examples of items that may be considered for dispensation are:

- Antenna performance requirements; and
- Path lengths shorter than the minimum requirements.

Some examples of items that will not be considered for dispensation are:

- Interference / sharing criteria; and
- Power limitations.

2.6 Records of certification and their retention

The certification documentation associated with the planning and coordination of a proposed radio service is required to be retained for audit purposes. The actual documentation retained is at the Approved Persons discretion but should include:

- An overall summary report of the coordination calculations and any usage and policy assumptions made;
- A record of the transmitter and receiver parameters, class of emission, modulation, frequency, antenna types, site details, receiver locations with supporting calculated values of all existing and planned assignments likely to impact upon or by impacted by the proposed licence for co- and adjacent channel services;

[3] The Manager RSM Licensing has the day to day responsibility for the granting of licences through delegated authority from the Chief Executive of the Ministry of Business, Innovation and Employment. The Licensing Manager can be contacted on the email address rsmlicensing@mbie.govt.nz

- Copies of calculations, assumptions and what has been considered in the assessment of onsite compatibility;
- Copies of path profile, calculations and assumptions made in the interference analysis of wanted and unwanted (interference) paths for off-site compatibility;
- Copies of calculations and assumptions related to intermodulation and safety of life interference issues;
- Assumptions relating to inter-service and intra-service compatibility between services; and
- Anything else that is considered for the certification of the licence.

The certification documentation is to be retained by the Approved Person and made available for audit purposes for the period of 5 years from the date of certification of the licence.

Certification documentation is to be made available within 10 working days of a request by the Ministry.

2.7 Agency recommendation and Ministry certification

Some frequencies and frequency bands can only be certified by the Ministry and some are allocated to radiocommunication services for which a range of government agencies or organisations have statutory or policy responsibilities, or other bodies have a recognised spectrum management advisory role. The key agencies are detailed in Table 1. An agency recommendation is automatically requested by the Register when an application is requested in one of these bands.

Notwithstanding these agency roles, the Ministry retains ultimate responsibility for the granting of any radio licence.

Table 1 – Licensing agency approval and who can certify

Service	System		Licensing Agency approval required?	Who can certify
Aeronautical	Beacon	Marker	CAA	ALL
		VOR	CAA	ALL
	Land	<30 MHz	CAA	ALL
		≥30 MHz	CAA	ALL
	Mobile	<30 MHz	CAA	ALL
		≥30 MHz	CAA	ALL
	Radionavigation	ILS	CAA	ALL
		Radar	CAA	ALL
Amateur	Beacon		NZART	ALL
	Fixed		NZART	ALL
	Repeater		NZART	ALL
Defence	225-328.6 MHz & 335.4-399.9 MHz		NZDF	NZDF
Fixed	Point to point	<30 MHz	RSM	ALL

Service	System		Licensing Agency approval required?	Who can certify
		≥30 MHz		ALL
	Point to multipoint			ALL
	TVOB			ALL
Land mobile	Repeater	<30 MHz	RSM	ALL
		≥30 MHz		ALL
		ES bands	PSFRMG	ALL
	Simplex	<30 MHz	RSM	ALL
		≥30 MHz		ALL
		ES bands	PSFRMG	ALL
	Paging			ALL
	Citizen band / PRS repeaters			ALL
Maritime	Beacon		MNZ	ALL
	Coast	<30 MHz	MNZ	ALL
		≥30 MHz	MNZ	ALL
	Mobile		MNZ	ALL
	Radionavigation		MNZ	ALL
	Repeater		MNZ	ALL
Meteorological Aid	Radar			ALL
Radiodetermination	Radiolocation			ALL
	Radionavigation			ALL
Satellite	Fixed		RSM	ALL
	Receive Protection		RSM	ALL
	VSAT/SNG		RSM	ALL
	Mobile		RSM	ALL

CAA	Civil Aviation Authority
MNZ	Maritime New Zealand
NZART	New Zealand Association of Radio Transmitters
NZDF	New Zealand Defence Force
PSRFMG	Public Safety Radio Frequency Management Group
RSM	Radio Spectrum Management

3. Compatibility and Technical Issues

3.1 Technical compatibility

Article 3.3 of the IRR notes:

> "Transmitting and receiving equipment intended to be used in a given part of the frequency spectrum should be designed to take into account the technical characteristics of transmitting and receiving equipment likely to be employed in neighbouring and other parts of the spectrum, provided that all technically and economically justifiable measures have been taken to reduce the level of unwanted emissions from the latter transmitting equipment and to reduce the susceptibility to interference of the latter receiving equipment."

For Approved Persons, the order of the terms below reflects the increasing seriousness of the effect of interference issues on radio system operations:

- The term "technical compatibility", as used in the Act in section s25(5) in relation to the certification of licences, is not defined but can be taken to mean that that radio services operating normally will not significantly reduce the ability of other radio services to perform with an appropriate quality of service;
- Interference is defined in the Act as "the effect of radio waves owing to 1 or more emissions, radiations, or inductions, or any combination of one or more of those things, on the reception of radiocommunications"; and
- Harmful interference is defined under the Act as meaning "interference which endangers the functioning of a radionavigation service, or of other safety services, or seriously degrades, obstructs, or repeatedly interrupts radio communications"

The reception of radiocommunications by inappropriate receivers as declared under the Regulations should not be considered either in respect of technical compatibility or harmful interference.

Nothing in this document alters the general requirement that power is to be recorded on all licences in decibel Watts (dBW) as Equivalent Isotropically Radiated Power (EIRP). The power recorded on the licence is the total power within the channel.

3.2 Efficient use of the spectrum resource

New Zealand is a signatory to the IRR as outlined in section 2.4 International allocations, band planning and channel arrangements. As a signatory to this treaty and in a more general sense there is an important responsibility in ensuring the efficient use of the valuable radio spectrum resource. Some of the factors influencing the efficiency of spectrum use include:

- Path length versus frequency band;
- Antenna discrimination;
- Maximum power;
- Modulation mode;
- Channel bandwidth; and
- Fade margin allowance.

3.3 Assessment requirements

These assessment requirements are set out as a methodology to be followed by Approved Persons considering a certification. It is necessary to refer to this section together with the relevant section for the specific service that is proposed.

3.3.1 Determine the service

To determine the service, it is necessary to be familiar with Article 1, Section III of the IRR which defines the services and Recommendation ITU-R SM1133. Some of the common service types covered by this document are the following:

- Land Mobile;
- Fixed;
- Fixed-Satellite;
- Maritime Mobile; and
- Aeronautical Mobile.

3.3.2 Determine band and channelling

Refer to the following PIBs for an overview of the New Zealand allocations, band uses and references to important documents, channel plans, channel structures, and other details[4].

Table of Radio Spectrum Usage in New Zealand (PIB 21) in conjunction with:

Fixed Service Bands in New Zealand (PIB 22) or

Mobile Service Bands in New Zealand (PIB 23).

Some items that shall be considered when choosing a band and channelling are:

- Service type;
- Proposed equipment capability;
  - Frequency range;
  - Channelling options;
- Capacity;
- Path length or coverage area;
- Terrain;
- Spectral efficiency;
  - Application of spectrum efficiency principles in the choice of bands and frequencies; and
  - Choosing frequency bands suitable for the operational requirements and ensuring services are not given channel band widths greater than required.

[4] Can be found at www.rsm.govt.nz

3.3.3 Onsite compatibility

Onsite compatibility is related to the location of the transmit and receive equipment and its technical compatibility with co-located or nearby located equipment. The analysis will depend on the type of service; however this general methodology must be followed when assessing the technical compatibility of licences.

The location of services falls under the following two categories:

Specific location

This is a service located at one or more specific defined locations. The Register records these as point location types. Typical services that are at a specific location include Fixed Services, Land mobile repeater base stations, Fixed Satellite earth stations and Paging.

Defined area

This is a service that operates within a defined area. The Register records these as the following:

- Geographically defined: 'Multiple points', 'Defined Area' location types; and
- Non-geographically defined: *'Name'* location types.

The Ministry has made available methods to provide the data from the Register to assist in on-site analysis in a format that can be used to input it into software tools. AREA SEARCH DATA EXTRACT is the Register tool suitable for these purposes.

Assess geographic locations

The locations of all transmitters and receivers in the proposed service must be determined and the approved person must be confident that the geographic locations or areas are reasonable and rational. For example, if a transmitter is intended to be on a hilltop but the grid reference indicates otherwise, this needs to be rectified. It can be helpful to plot locations and areas on a topographical map or similar mapping systems or software.

Assess the proposed location against existing locations.

This assessment shall be used to determine information about location. This shall be used to determine the proposed location is correct and if the proposed service is going to be co-located with an existing user or at an existing site location.

Services at a specific location

The assessment shall be done for each location for the proposed service. The assessment will be used to check the proximity of the proposed services location(s) to the locations of existing licences within a small area. An example of where this type of search is important is when the proposed transmitter / receiver is located on a hilltop with multiple sites or masts belonging to different organisations. This can quickly indicate if there are any errors with the proposed location and if further information is required.

Services in a defined area

This assessment is done more broadly where a general search of the Register reference data and other licences is acceptable.

Assess the site sense

An Approved Person must ensure that a proposed licence placed at a given site must be compatible in the following aspects:

- It must not cause desensitisation to an existing service;
- It must not be subjected to desensitisation from an existing services; and
- The existing site sense must be preserved.

For services at a specific location(s), a thorough analysis is required with everything in this section carefully considered. For services in a defined area, the amount of analysis required will be less, due to assumptions that may be made about the mobile nature of the proposed service. However if the service is known to be used in certain areas or in close proximity to transmitter and receivers, such as an established radio site, a more detailed analysis is required.

The extent of desensitisation may range from a small reduction in available system fade margins, or increasing base-band noise, through to severe blocking where receivers essentially become inoperative. Some bands may be interleaved or adjacent to other bands where there is a potential for a transmitter to be close in frequency to a receiver. Typical bands where this conflict commonly occurs are EE, C, J, D, TS and KK bands. An Approved Person must be confident and demonstrate that desensitisation will not occur. Some factors in the order of importance that shall be considered when analysing desensitisation are the following:

- Frequency separation between transmitters and receivers; and
- Distance separation (different poles, masts or nearby sites).

Preservation of site sense is necessary to ensure both business continuity and expansion capability. The majority of radiocommunications channels are frequency division duplex and are defined in pair blocks of “go” and “return”. These channel pairs are usually numbered 1/1#, 2/2#, etc.

Figure 1 – Preserving the site sense by using only ‘low’ (non #) or ‘high’ (#) channels on a site. Do not mix ‘low’ and ‘high’ channels.

To preserve a suitable level of isolation between co-located transmitters and receivers operating in the same band at any given site, transmit frequencies are assigned from either the lower frequency block (site sense “low”), or the higher frequency block (site sense “high”), and the corresponding paired duplex receive frequencies in the other block.

The site sense must be preserved where there is one or more existing services on a site. For example; if a proposed service is going to be in J band and there is an existing J band service on the site that is transmit high channel (# channel), then any new J band services must be transmit high.

Where some bands have a slight frequency overlap, or are contiguous (such as the 6G through 8GU bands), the “high-low” issue becomes more complex. For example, channels in the 7GM# “high” frequency block shall be co-sited with channels in the 7GL and 7GU “low” block, or the 8GL# “high” block frequency ranges.

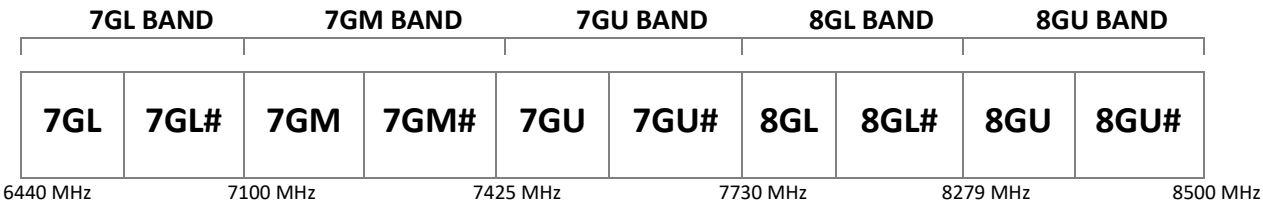


Figure 2 – An example of frequency bands that are contiguous making site sense is more complex.

Incorrectly applied site sense may lead to extensive and unreasonable spectrum denial to future services, particularly at high demand radiocommunication sites, which are often shared between a number of operators. Accordingly, appropriate consideration at the route/network planning stage is essential to ensure that potential problems of this nature are avoided.

Compromising the site sense should always be avoided, but it is recognised that in some special cases this may not be possible or practical. Approved Persons must discuss the implications with current site users or the site manager and have written agreement that they will allow the violation. This written agreement must be uploaded against the licence or application in the Register. All information must be recorded and held with the other documentation relating to the certification.

The site owner may also require a greater level of engineering analysis to confirm the compatibility of a proposed frequency with existing services at the site or location above the requirements set out in this document. The method and degree of engineering analysis applied is at the discretion of the Approved Person.

3.3.4 Identify and calculate the required power

For maximum re-use of the radio spectrum, an Approved Person must assign the minimum required power for a radio service to work reliably. The different sections of this document stipulate the requirements and must be referred to. All calculations and analysis must be kept for auditing purposes. Table 2 gives an overview of the requirements.

Table 2 – Identifying and calculating the required power

Service	Requirements
Fixed	There are strict requirements on calculating the required power – details can be found in Fixed Services.
Land Mobile	The default power shall be assigned.
Fixed & Broadcasting Satellite	The required power must be assigned however it is recognised that this is stipulated by the satellite service provider and is not necessary for the Approved Person to do the calculation.

3.3.5 Off-site compatibility

Off-site compatibility is the assessment and analysis of interference between services away from the immediate site but not necessarily excluding on-site services. This section prescribes the requirements for analysing the following:

- The proposed service causing interference to existing receivers; and
- The proposed service receiving interference from existing transmitters.

The Ministry has made available methods to extract the data from the Register in a format that can that can assist with this analysis and be used for input into software tools. LICENCE DATA EXTRACT is the tool suitable for this purpose. For a first look, the supplementary SPECTRUM SEARCH LITE tool can be used but is not suitable for complete analysis as it does not show all data records such as planned and suppressed licences.

Identify a candidate channel

The purpose of identifying a candidate channel is to select a channel for further assessment of inward and outward interference. In some cases identifying a channel may be narrowed down because of the switching range of equipment or a client's preference for a particular channel(s). The following PIBs provide you the tables of channels.

Fixed Service Bands in New Zealand (PIB 22)

Mobile Service Bands in New Zealand (PIB 23)

Identifying a candidate channel that is likely to be certifiable is not always simple, particularly in congested parts of the spectrum. In some cases several iterations of analysis may be required and in some cases for some locations there may be no channels available. Some of the methods that can be used for identifying a candidate channel are:

- Use personal experience and knowledge of geography and propagation to identify a candidate channel to conduct further analysis; and
- Use a software tool that can run a series of basic calculations to give an idea of which channels may be worth looking into further and which are not. This is sometimes referred to as a 'first cut'.

Analyse interference

The assessment of interference requires the Approved Person to determine if the proposed service will cause or receive interference. Interference is defined as a signal level threshold where if an unwanted signal is above the threshold it is interference and if it is below it is not interference. To determine if an interference threshold will be exceeded, it is often necessary to calculate the level of unwanted signal that will arrive at the victim receiver. The bands and services have defined interference thresholds that must not be exceeded. These levels are contained in the relevant sections of this document.

The interference scenario will always be from a transmitter to a receiver and there will be at least two potential interference cases that must be considered for each planned or existing licence. Care and attention is required to correctly identify the locations of all receivers and transmitters.

No universal co-ordination area model exists that can be used confidently for every possible situation. Variations in approach will be necessary to account for local factors such as band specific equipment, terrain and climate. The majority of services are bi-directional, using separate go and return channels as specified in the relevant band plan. Accordingly, the interference scenario will be different for each direction of transmission, and frequency co-ordination for each of the proposed service's terminal ends needs to be separately evaluated. It is the responsibility of the Approved Person to select a coordination area that is adequate to address all potential interference scenarios for each particular situation.

Outward interference

The outward interference assessment is from the proposed transmitter to the existing receivers. The signal level arriving at each existing receiver must be determined.

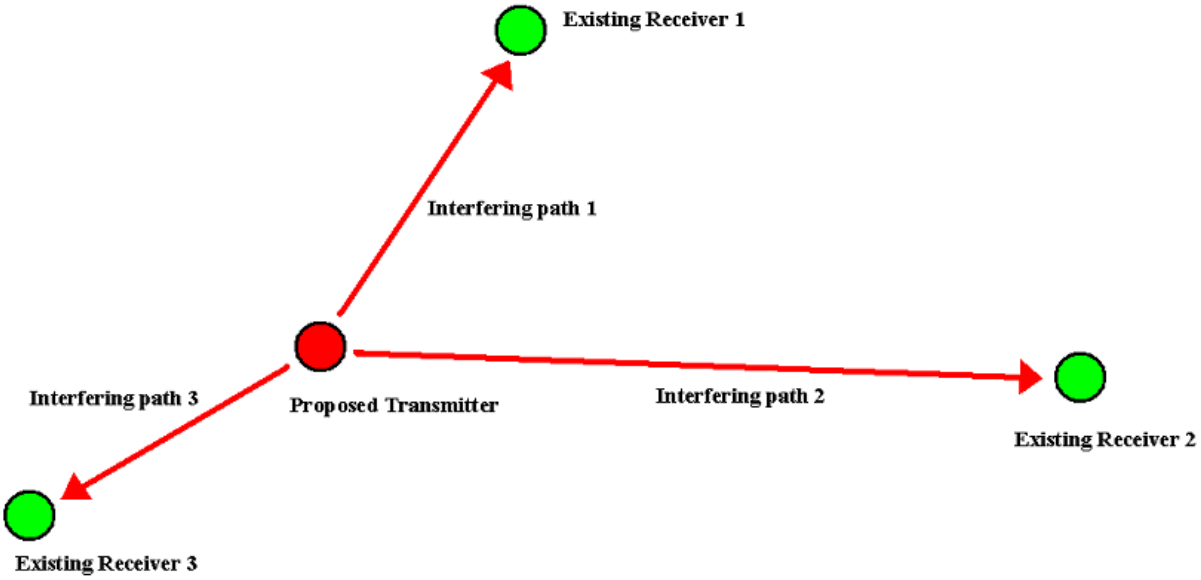


Figure 3 - This shows a simplified example of outward interfering paths that may need to be considered for a proposed transmitter.

Inward interference

The inward interference assessment is from the existing transmitters to the proposed receiver. The signal level arriving from all the existing transmitters must be determined.

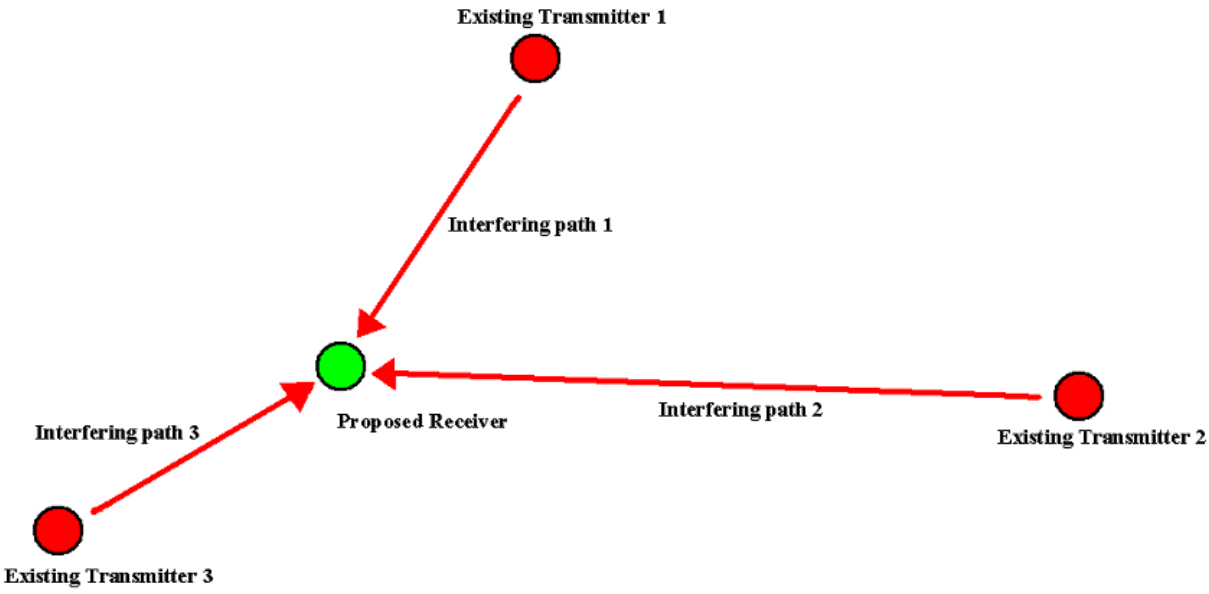


Figure 4 - This shows a simplified example of inward interfering paths that may need to be considered for a proposed receiver.

Determining a signal level from a transmitter to receiver

The signal level arriving at a receiver must be calculated to determine if the interference threshold of the service will be exceeded. When completing interference calculations, they must be 'worst case' meaning that where a loss may vary over time, a conservative loss must be used in any calculation. Some considerations in determining the signal level are the following:

- Free space attenuation;
- Obstruction loss;
- Antenna discrimination (polarisation, azimuth discrimination or combination);
- Total aggregate power (where there is more than one interferer);
- Cable losses; and
- Channel offset losses.

For more detail on signal strength calculations, refer to section 3.4 Signal strength calculations.

3.3.6 Intermodulation

Intermodulation is where the energy from two or more frequency sources combining or mixing to produce another frequency.

There are three basic types of intermodulation:

- **Transmitter generated:**
  Two or more signals mix in non-linear front end output stage of a transmitter.

- **Receiver generated**
  Two or more signals mix in a receiver (often because it is driven to non-linearity).

- **Passive generated**
  Other sources of non-linear devices where signals can mix to cause intermodulation. Sources include rusty bolts, poor bonding between parts of a tower or junctions of dissimilar metals.

Intermodulation resolution

There are many methods available to a site manager to minimise, reduce or eliminate intermodulation. The site managers are best place to manage these issues. Some mechanisms that can be used are:

- Installation of Filtering such as cavity resonators / filters;
- Installation of isolation devices such as ferrite isolators or circulators;
- Antenna placement;
- Good site maintenance such as tightening bolts, bonding joints, removing / preventing corrosion; and
- Restrictions on what frequencies are allowed on-site.

Intermodulation calculations can be useful for site manager and installers to predict risks and install suitable equipment or to find resolutions to problems that occur on-site.

Intermodulation and certification

While intermodulation is predictable through calculations, it is also manageable through good site management practises. For all services except those listed in section 3.3.7 Distress and safety communications and section 3.3.8 Safety services, intermodulation does not need to be considered in the certification of a licence.

Site owners / managers may request that before a user implements their licence on a site, additional compatibility analysis outside the scope of certification is undertaken. This may include intermodulation checks. The methodology and degree of additional engineering analysis applied is at the discretion of the Approved Person and by agreement between the parties concerned.

3.3.7 Distress and safety communications

Frequencies for *Distress and Safety Communications for the Global Maritime Distress and Safety System* (GMDSS) are listed in Appendix 15 and in the Articles of the IRR.

Contained in **Error! Reference source not found.** are the frequencies from Annex 15 of the IRR denoted with an asterisk (*) that are applicable in New Zealand. These frequencies have the clause in Appendix 15 of the IRR.

"Except as provided in these Regulations, any emission capable of causing harmful interference to distress, alarm, urgency or safety communications on the frequencies denoted by an asterisk (*) is prohibited. Any emission causing harmful interference to distress and safety communications on any of the discrete frequencies identified in this Appendix is prohibited".

The frequencies in Table 3 must be given special consideration in regard to potential third-order transmitter intermodulation products and de-sensitisation issues by Approved Persons in the certification of a licence. The third-order intermodulation products to be considered are:

$$2f_1 - f_2$$

$$f_1 + f_2 - f_3$$

$$f_1 - f_2 + f_3$$

$$-f_1 + f_2 + f_3$$

Table 3 – GMDSS frequencies for special consideration

Frequency (MHz)	Channel designators	Service	International Reference
2.1745		Narrow band distress and safety communications	
2.182		Maritime – International distress safety and calling	IRR Article 31 & Appendix 15
2.1875		Distress and safety calls using DSC	IRR Article 31 & Appendix 15
4.125		Maritime – International distress safety and calling	IRR Articles 31, 52 & Appendix 15
4.1775		Narrow band distress and safety communications	Appendix 15

Frequency (MHz)	Channel designators	Service	International Reference
4.2075		Distress and safety calls using DSC	Appendix 15
6.215		Maritime – International distress safety and calling	IRR Articles 31 & Article 52 & Appendix 15
6.268		Narrow band distress and safety communications	Appendix 15
6.312		Distress and safety calls using DSC	Appendix 15
8.291		Maritime – International distress safety and calling	IRR Articles 31, 52 & Appendix 15
8.4145		Distress and safety calls using DSC	IRR Articles 31, 52 & Appendix 15
12.290		Maritime – International distress safety and calling	IRR Articles 31, 52 & Appendix 15
16.420		Maritime – International distress safety and calling	IRR Articles 31, 52 & Appendix 15
121.5		Distress beacons	IRR Article 5, footnote 5.200, Article 31 & Appendix 15.
156.525	MM70	Distress and safety calls using DSC	IRR Articles 31, 52, Appendix 18 & Appendix 15
156.800	MM16	Maritime – International distress safety and calling	IRR Articles 31, 52, Appendix 18 & Appendix 15
161.975	AIS 1	Automatic Identification System (AIS) and AIS search and rescue	Appendix 15
162.025	AIS 2	Automatic Identification System (AIS) and AIS search and rescue	Appendix 15
243.00		Distress beacons / Survival craft	IRR Article 5 footnote 5.256, Article 31 & Appendix 15
406.00 – 406.1		Satellite distress beacons	IRR Article 5 footnotes 5.266 & 5.267 Article 31 & Appendix 15

3.3.8 Safety services

Safety Services are defined in the IRR and the internationally recognised bands are listed in Annex 4 of Recommendation ITU-R SM.1535.

The frequencies in Table 4**Error! Reference source not found.** must be given consideration in regard to potential third order transmitter intermodulation products for licences in the bands listed in the table below. These licences only need to be considered where there is a receiver on-site to the proposed service (on-site for the purpose of Safety Services means within 100m). Only the following third-order intermodulation products need to be considered:

$$2f_1 - f_2$$

$$2f_2 - f_1$$

$$f_1 + f_2 - f_3$$

$$f_1 - f_2 + f_3$$

$$-f_1 + f_2 + f_3$$

Table 4 – Safety services for consideration

Frequency	Band	Description	Intermodulation frequency checks
117 – 136 MHz	Aeronautical communications (Route)	Aeronautical Voice communications	Licensed receivers that are Aeronautical (route) and associated with safe regularity of flights along civil air routes for voice communications only
960 – 1 215 MHz	Radionavigation	Distance Measuring Equipment (DME), Secondary Surveillance Radar (SSR), Automatic Dependent Surveillance-Broadcast (ADS-B), Multilateration Interrogation (MLAT)	Licensed ground based receivers. (currently only 1090 MHz ±4 MHz)

3.4 Signal strength calculations

Calculation of both wanted and unwanted signal strengths requires use of propagation models and path profiles. Generally, signal strength calculations are in decibel milliwatts (dBm) at the RF input to the receiver, while licensed power (EIRP) is expressed in decibel watts (dBW). The Ministry does not stipulate, endorse or recommend any commercial software product for this purpose. The selection of an appropriate method for conducting path profile analysis is the responsibility of the Approved Person.

Field measurements can be used to assist in validating signal strength calculation algorithms provided measurement accuracy can be determined. Measurements are not necessarily determinative; however, the Ministry uses processes based on ITU-R Recommendations and a conservative approach for the determination of field strengths. The ITU-R Recommendations commonly referenced include:

- P.341 The concept of transmission loss for radio links;
- P.525 Calculation of free-space attenuation;
- P.526 Propagation by diffraction; and
- P.1812 A path –specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands.

The information provided in this section outlines the benchmark settings used by the Ministry. Approved Persons may at their discretion use more conservative settings and models than listed in the following:

For Land Mobile, Paging and Maritime services

- K Factor; 4/3 for wanted and 2.0 for unwanted signal strength analysis;
- ITU-R P.1812 Model for wanted and unwanted;
    - Wanted - 50% Locations 50% Time;
    - Unwanted - 50% Locations 10% Time;
- Ducting and troposphere not considered;
- Fresnel zone 0.6; and
- Clutter loss not included.

For other services below 3 GHz

- K Factor; 4/3 for wanted and 2.0 for unwanted signal strength analysis;
- ITU-R P.525 / ITU-R P.526 Model and Deygout 94 Diffraction geometry for wanted and unwanted interference profiles;
- Subpath attenuation loss is included. This relates to Fresnel obstruction loss and Foreground loss;
- Fresnel zone 0.6; and
- Clutter loss not included for unwanted and clutter loss may be included for wanted signal strength analysis.

For other services above 3 GHz

- Unwanted K Factor 2.0;
- Fresnel zone method Model for wanted and unwanted interference profiles;
- Fresnel zone 0.6; and
- Clutter loss not included for wanted and clutter loss may be included for unwanted signal strength analysis.

For the purposes of this document, the term clutter loss is defined as loss due to, or associated with, trees or buildings only.

Free-space loss may not necessarily be a worst case scenario. The detailed analysis of potential enhanced propagation mechanisms is not required for coordination purposes.

3.4.1 Total interfering power

Where there are multiple interfering signals arriving at a victim receiver, Approved Persons may wish to consider total aggregate power.

To find the total interfering power (I_{total}), add powers in the linear domain (i.e. Watts or milliwatts):

$$I_{total} = P1 + P2 + P3 + \ldots$$

However as most interfering powers are calculated in dBm or dBW the following equation can be used:

$$I_{total}(dBW) = 10\log_{10}\left(10^{\frac{P1(dBW)}{10}} + 10^{\frac{P2(dBW)}{10}} + 10^{\frac{P3(dBW)}{10}} + \ldots\right)$$

Table 5 shows the relationship between summing two interferers with one being weaker than or equal to the other.

Table 5 – Aggregate power relationship

Power of a weaker signal relative to the stronger one	Sum of the two signals
0 dB	**+3 dB**
-1 dB	+2.5 dB
-2 dB	+2.1 dB
-3 dB	**+1.8 dB**
-4 dB	+1.5 dB
-5 dB	+1.2 dB
-6 dB	**+1 dB**
-7 dB	+0.8 dB
-8 dB	+0.6 dB
-9 dB	+0.5 dB
-10 dB	**+0.4 dB**

3.4.2 Receiver noise floor

The receiver noise floor is the thermal noise power at the operating temperature, plus the noise figure (F) of the receiver.

$$NoiseFloor = 10Log_{10}(kTB) + F \qquad \text{(dBW)}$$

Where:

k = Boltzmann constant (1.381×10^{-23} J/K, joules per Kelvin);

T = Temperature in degrees Kelvin (293 K shall be used);

B = Bandwidth (Hertz); and

F = Receiver noise figure (dB).

Where a receiver noise figure is not available from the manufacturer's specifications, values from ETSI TR 101 854 Annex D shall be used.

3.5 Equipment, emissions and other site issues

While the Approved Person is responsible for certification requirements being met, the licensee is responsible for ensuring that the installation operates within the licence and compliance requirements.

Where known, certifying engineers should also advise the licensee of any special site and / or equipment requirements resulting from the certification of the licence that are necessary to ensure satisfactory compliance with the licence parameters and conditions.

Equipment standards

Equipment standards are specified in the compliance notices such as the Radio Standards Gazette Notice and the Electromagnetic Compatibility Standards Gazette Notice and the IRRs and ITU-R Recommendations. The Approved person can assume that the licensee is responsible for ensuring the installation and implementation of the licence meets the appropriate standards.

Site standards

There are no compulsory site standards but the voluntary site standard AS/NZS5070 is available for sites in New Zealand. Site issues and resolution are a commercial arrangement between the licensee, site manager, owner, users and other interested parties.

For the purposes of certification Approved Persons can assume that site issues are managed and that only the requirements of certification and this document need to be met.

Co-siting with safety services

Consideration is required for the safety bands and frequencies listed in section 3.3.7 Distress and safety communications and 3.3.8 Safety services. It is expected that the operators of the safety frequencies and other site users on the site apply the principles of Recommendation ITU-R SM.1535. For the purpose of certification, Approved persons can assume that this recommendation has been applied on-site.

3.6 Licensing

Notwithstanding the role of Approved Persons certifying radio licences, the Ministry remains responsible for considering the granting of licences in accordance with the provisions of Regulations 12(1)(a) and 12(1)(c).

An annual fee, as prescribed in the Regulations, is payable for each licence. Fees payable to the Ministry are specified in Schedule 6 of the Regulations.

3.7 Geographic coordinates

The coordination of radio licences is dependent on the accurate determination of the relative spatial (distance and azimuth) relationships between potential victim and interfering services. Accurate coordinates are particularly important in the higher microwave bands where small errors in endpoint coordinates can produce significant errors in calculated azimuths, particularly where path lengths are very short. To achieve an appropriate level of control and accuracy the following procedures are to be adopted when creating new site records.

Site coordinates can be obtained by any of the following methods:

- GPS measurement by a competent user;
- By use of an electronic mapping source that provides a visual image of the area or structure in question; or
- Physical survey measurement by a qualified surveyor.

The location of the actual antenna is to be recorded in full grid coordinates to a resolution of 1 metre using New Zealand Topo50 (NZTopo50) or New Zealand Transverse Mercator 2000 (NZTM2000). For example, a location should be in either of the two formats: NZTopo50 BQ31 557.66 194.63 or NZTM2000 1755766E 5419463N. The datum of the source coordinates must be ascertained. The datum must be the New Zealand Geodetic Datum 2000 (NZGD2000) for purpose of this document this is equivalent to the World Geodetic System 1984 (WGS1984).

Individual free-standing towers, poles or similar antenna support structures should be recorded as separate sites. For small roof-tops a nominal central position should be recorded. Buildings with a large roof-top area or building complexes should be identified on separate sites appropriately named and described.

Ideally each site should have one site record. If an existing site is recorded inaccurately then it should be corrected. In the event however that an incorrect site record cannot be corrected (for example if the record carries several licences) it may be necessary for the ARE or ARC to create a new site record for that same site in order to ensure that their services are correctly recorded. Location record details include:

- Site name;
- Grid reference in NZTopo50 or NZTM2000 (using the NZGD2000 datum);
- Altitude above sea level; and
- Any other site details such as, address, site access, building or tower identification. These details may be recorded in the location text field.

3.8 Site naming convention

Site naming conventions need to be simple and flexible. In general the site names in the Register should use the following conventions:

- If a current site name used in the Register is suitable then it should be used;
- If the site is named on a NZTopo50 series map, (i.e., its LINZ name), that name should be used, perhaps with the addition of a north, south, east or west designation to indicate more closely the part of the named feature used;
- If the site is on a named street, that street number and street name should be used. A number and street name should be followed by a town or area name;
- For a large named site, such as used for airports and oil refineries, etc., the site name may be followed by a building name or reference number. Generic names for large sites such as a Marae, park, factory, hospital name, etc. not on a map can also be used; and
- Do not use a customer's name as a site name unless it can be absolutely guaranteed to be unique for one site, e.g. Disney World Bldg DW98.

A check of site names in the Register, based on a search using the site name, will often provide a suitable site name choice.

3.9 Suppressed records

In accordance with s28 of the Act, some Government records are suppressed in the interests of national security. Approved Persons have access to these records; however this material is not to be made available to other parties. Approved Persons must take into account suppressed records in their analysis and keep a record of this.

4. Land Mobile Services

4.1 Introduction

The land mobile service is a land based radiocommunications service between mobile stations or between a base station and mobile stations. They typically use narrow bandwidth (6.25 kHz or 12.5 kHz) channels supporting voice, although other channel widths and non-voice applications are sometimes used.

Several bands are available for land mobile services across the VHF and UHF bands. The details of these bands and channel plans and designated channel use or restrictions are in Mobile Service Bands in New Zealand (PIB 23). All bands permit analogue modulation and most permit digital modulation standards.

View Mobile Service Bands in New Zealand (PIB 23)

The land mobile services covered in this section include the following:

- Simplex Single frequency operation;
- Repeater Two frequency duplex operation; and
- Trunking Two frequency duplex operation that consists of a minimum of three equivalent voice channels controlled by a central computer system. TDX and TX band simplex are available for use in conjunction with trunking systems.

This section must be read in conjunction with Radio Licence Policy Rules (PIB 58).

Table 6 – Frequency bands for Land Mobile services

Band	Frequency Range	Channel spacing	Typical Use	Modulation
ESA	75.2 - 80 MHz	12.5 kHz	Emergency Services	Analogue
A	80 - 87.5 MHz	12.5 kHz	Commercial	Analogue and Digital
ESB	138 - 144 MHz	12.5 kHz	Emergency Services	Analogue and Digital[5]
E	150.05 - 156 MHz	12.5 kHz	Commercial	Analogue and Digital
EE	162.58125 - 173 MHz	12.5, 6.25 kHz	Commercial	Analogue and Digital
TD	406.1 - 420.00625 MHz	12.5, 6.25 kHz	Commercial Trunked Radio only	Analogue and Digital
C	449.75 - 458.3375 MHz	12.5, 6.25 kHz	Commercial	Analogue and Digital
D	458.3375 - 470 MHz	12.5, 6.25 kHz	Commercial	Analogue and Digital
F	471.5 - 494 MHz	12.5, 6.25 kHz	Commercial	Analogue and Digital
ESC	494 - 502 MHz	12.5, 6.25 kHz	Emergency Services	Analogue and Digital[5]
TS	813 - 869.025 MHz	25[6], 12.5, 6.25 kHz	Commercial Trunked Radio only	Analogue and Digital

[5] Only digital standards approved by the PSFRMG may be deployed for digital services.

[6] Only digital modulation permitted for 25 kHz channels.

4.2 Coded squelch systems, access codes and unique addressing

Coded squelch, access codes and unique addressing are functions that prevent unwanted or unintentional access to radio systems. In the context of this document, coded squelch is defined as a system using unique addressing to activate one receiver (or more) in response to a specific radio transmission. The use of coded squelch systems, access codes or unique addressing is compulsory on new land mobile services.

For analogue

The most commonly used coded squelch system is Continuous Tone Coded Squelch System (CTCSS). If CTCSS is used, the allocation of tone groups and tones is based on regional / local authorities throughout New Zealand and are listed in PIB 23. Other common systems are Selective Call (SelCall) and Digital Coded Squelch (DCS).

For digital

There are a number of different access code and unique addressing systems available for digital which will vary depending on the technology used. The common types are:

- Network Access Code (NAC) used with Association of Public- Safety Communication Officials (APCO) P25
- Colour Code used with DMR and dPMR
- Radio Access Number (RAN) used with NXDN
- Mobile Country Code (MCC) and Mobile Network Code (MNC) used with Terrestrial Trunked Radio (TETRA).

4.3 Emission designators

The emission designator restricts the licence and must be correctly specified on the licence, describing the bandwidth, modulation, and nature of service. Approved Persons must refer to Appendix 2 of the IRR and the manufacturer's stated emission designator. For example, a licence with an emission for analogue Frequency Modulation (FM) voice must be re-specified if the licensee wishes to change to a digital modulation. Also, it may be desirable for both analogue and digital emission designators to be specified on the licence where a licensee is migrating from digital to analogue noting that most new equipment is capable of both. The common emission designators are outlined in Table 7:

Table 7 – Common Emission Designators for Land Mobile Services

System	Type of information	Common Emission Designators	
		6.25 kHz channel width	12.5 kHz channel width
Analogue			
Frequency modulation	Voice	N/A	10K0F3EJN
	Data	N/A	10K0F1DXN
Amplitude Modulation	Voice	N/A	6K00A3EJN
APCO P25 Phase 1 C4FM	Voice	N/A	8K10F1EDN
	Data	N/A	8K10F1DDN

System	Type of information	Common Emission Designators	
		6.25 kHz channel width	12.5 kHz channel width
Digital			
APCO P25 Phase 2 CQPSK voice (TDMA)	Voice	N/A	9K80F1EDN
	Data	N/A	9K80F1DDN
DMR 4FSK voice	Voice	N/A	7K60FXEDT
	Data	N/A	7K60FXDDT
	Voice and Data	N/A	7K60FXWDT
NXDN	Voice	4K00F1EJF	8K30F1EJF
	Data	4K00F1DJF	8K30F1DXF
	Voice and Data	4K00F1WXF	8K30F1WXF
dPMR	Voice and Data	4K00F1WXF	N/A
TETRA	Voice and Data	N/A	18K0G7WDT (25 kHz channel – TS band only)

4.4 Simplex

Simplex is a system where transmission is made alternately in each direction on one radio channel (a single frequency). Only one transmission is able to be made at a time. These transmissions are discontinuous as the transmitter is only temporarily active. At least one end of a simplex service must be mobile (i.e. a vehicle installation or handheld unit) and not operated from a stationary location (such as an office). Simplex frequencies must not be used to provide “point-to-point” or “point-to-multipoint” fixed services, or be located at fixed locations (such as hill-tops) where other radio services land mobile repeaters operate.

PIB 23 details the simplex channel plans and their allocated use. A number of simplex channels in PIB 23 are restricted, meaning that these channels have been set aside for particular purposes and are not available other than for the specified purposes.

Where CTCSS tones are to be used on shared simplex, crane control, and bush winch licences, they must be assigned in accordance with PIB 23.

Mobile service bands in New Zealand (PIB 23)

4.4.1 Shared simplex

Shared simplex is the most common simplex type where channels are shared among multiple users with no interference protection from those other users sharing the channel. Interference is minimised by the loading of channels in geographic areas and the allocation of CTCSS tones for analogue licences or access codes or unique addressing for digital licences. Channels that are designated ‘General’ are the most common and available to any user. All shared simplex channels are for voice transmissions with the exception of some channels allocated solely for data.

Interference threshold

Shared simplex has no interference threshold or protection from other co-channel users. It is expected that users will experience some level of interference but is self-managing due to: its itinerant nature; the use of CTCSS tones for analogue; and access codes or unique addressing for digital. Approved Persons shall identify a suitable channel by taking into account issues such as the following:

- Individual channel loading to achieve uniform channel loading and minimise potential interference;
- Coordinate between other areas where nominated service areas overlap;
- The use of coded squelch, access codes and unique addressing such as CTCSS tones, colour codes, NAC, RAN, MMC or MNC. Where possible Approved Persons should assign CTCSS tones, access codes or unique addresses that have little or no use in the area of operation. (Details of the CTCSS tones and group areas can be found in the appendix of PIB 23); and
- Technical, equipment and licensee constraints.

Licensing

Licences may specify multiple channels (up to a maximum of 50), multiple locations and an unlimited number of stations (sets) are permitted.

Mobiles will only be permitted to operate within the area or areas described on the licence and shall be licensed using the following locations:

- Defined area location types:- Territorial Local Authorities (TLA) and or Regional Local Authorities (RLA) (single or a combination)
- Name Location types:- 'All North Island', 'All South Island' or 'All New Zealand'

Approved persons must record the CTCSS tone, access code or unique address in the "Access Code" field under spectrum details in the licence. Also, where possible, Approved Persons should record the number of sets operating under the licence.

The following conditions must go on a licence:

1. For analogue licences:

   "Where CTCSS is used, tone XX (XXX.X Hz) shall be used on all radio apparatus covered by the licence. Simplex is a shared service; interference related to sharing must be tolerated."

2. For digital licences:

   "Simplex is a shared service; interference related to sharing must be tolerated."

4.4.2 Crane control and bush winch simplex

Crane control and bush winch services have dedicated channels allocated in VHF and UHF simplex bands. Crane control channels are for tower cranes or cranes at fixed locations that typically operate at construction-sites. Bush winch is for log hauling winches operating in forests. A separate band has been established solely for bush winch services to provide additional channels (see PIB 23).

A crane control or bush winch licence can only be certified for a fixed term time period at a specific location. These obligations should be communicated to the licensee, together with instructions to re-apply if the location of the crane or winching operation is to be changed.

Interference threshold

Crane control and bush winch services are protected from harmful interference to a receive signal level of -106 dBm. Approved Persons will consider the following when assessing a channel for assignment:

- Geographic separation;
- Obstruction loss; and
- Frequency separation.

Licensing

Crane control must be licensed with an expiry date and for one specific location being a 'point' type location in the Register. Bush winch must also have an expiry date but can be licensed for a specific location being a 'point' type location in the Register or a 'multiple points' type location in the Register that describes the forest that the operations are in.

A CTCSS tone, access code or unique address that is unique from the nearest co-channel interferers must be assigned.

Approved persons must record the CTCSS tone, access code or unique address in the "Access Code" field under spectrum details in the licence.

The following conditions must go on the licence:

1. For analogue licences:

   "This licence permits use for Bush Winch/Crane Control [select one] operations only."

   "Where CTCSS is used, tone XX (XXX.X Hz) shall be used on all radio apparatus covered by the licence."

2. For digital licences:

   "This licence permits use for Bush Winch/Crane Control [select one] operations only."

4.4.3 Exclusive simplex

Exclusive simplex channels are only available for Emergency Services administered by the Public Safety Radio Frequency Management Group (PSRFMG) and other government agencies. Examples are; Police, Fire, Ambulance, Defence, Customs, and The Ministry of Civil Defence and Emergency Management. There are historic exclusive simplex assignments for organisations other than government agencies; however these types of assignments are no longer made.

Interference threshold

An exclusive simplex channel is assigned nationwide. Accordingly there is no interference between licensees and self-interference does not need to be considered.

Licensing

The 'Name' location type 'All New Zealand' is to be used.

4.5 Repeaters

Land mobile repeaters are duplex two frequency systems consisting of a base station at a fixed location and mobiles operating within its coverage. Repeaters are coordinated and have specified interference thresholds. The bands are channelled in paired frequencies labelled as 'Base transmit' and 'Mobile transmit'.

Base transmit

The repeater transmit frequency is known as the base transmit channel and is located at a fixed location such as a hilltop.

Mobile transmit

Mobile transmit is the channel to be used for the mobiles operating within the coverage of the repeater. The mobile channels are designated with a #, for example 1#. Channel 1# will be received at the base station / repeater.

Land mobile repeaters are used in applications such as analogue voice communications, digital voice communications, data communications such as Supervisory Control And Data Acquisition (SCADA) systems and other control systems.

4.5.1 Coverage

Land mobile repeater base station coverage is the area of service within which the licensee has a reasonable expectation of protection from harmful interference. This is defined by a theoretical continuous contour equivalent to a signal level of -95 dBm at the receiver. Anything below -95 dBm or outside the continuous coverage is considered fortuitous coverage. Fortuitous coverage is not protected from interference. Fortuitous coverage is disassociated from the main coverage and can occur on hilltops or can be diffracted signal over a knife edge range of hills or mountains.

The diagram in Figure 5 shows a simplified example of coverage and fortuitous coverage.

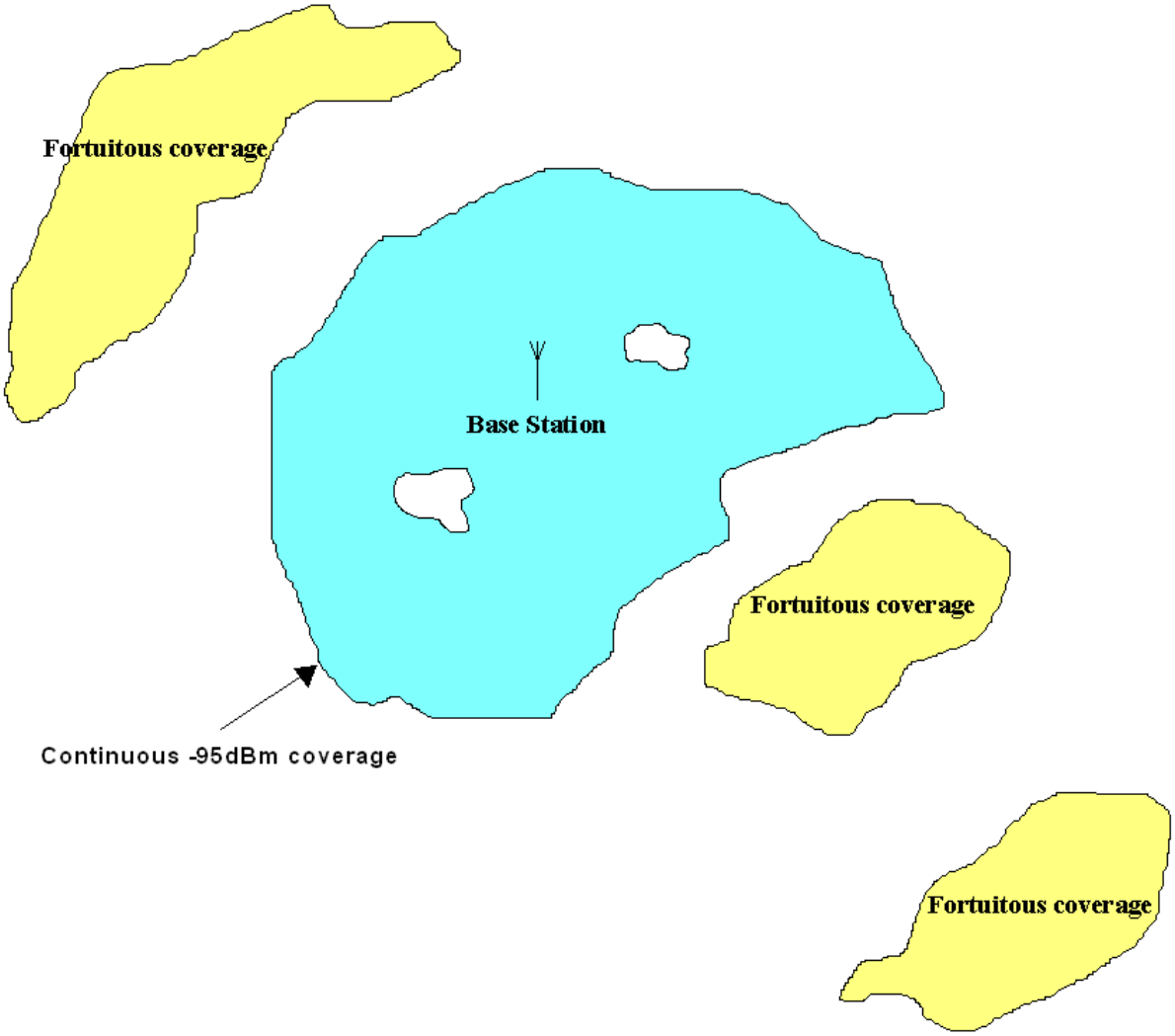


Figure 5 – This shows a simplified theoretical coverage: Blue being within coverage and signals greater than or equal to -95dBm; yellow being greater than or equal to -95dBm but outside coverage (fortuitous); the white space being signals less than -95dBm and outside the coverage.

Approved Persons are not required to predict coverage in their calculations and assessment, however is it useful and may be necessary for the interference analysis where there is a large number of nearby services. An Approved Person must have a general awareness of geography and the propagation characteristics of VHF and UHF to obtain a general idea of expected coverage.

If an approved person wishes to accurately predict coverage, there are a variety of commercially available software tools suitable for the task. When performing a coverage prediction, the antenna height for mobiles shall be 2 metres above ground level. Refer to section 3.4 for details on signal strength calculation.

4.5.2 Interference thresholds

Land mobile repeaters are protected from harmful interference within the theoretical continuous coverage. The interfering signal is not to exceed a value of -106 dBm at the wanted receiver. This applies to both analogue and digital.

Care needs to be taken when considering interference scenarios. The location of transmitters and receivers must be correctly identified. Many of the land mobile bands may have incumbent or special services in them, such as fixed links (common in EE band). These services may not align with the land mobile channel plans and it is essential that checks are carefully completed for base transmit and mobile transmit frequencies.

In conducting an interference analysis, Approved Persons need to refer to the licences in question for details on antenna heights. If no heights are given, assume that the base station antenna height is 10 metres above ground level (AGL). Mobiles are always to be 2 metres AGL.

A common interference scenario for assessing a proposed land mobile repeater service against an existing land mobile repeater service is the following:

Inward interference

The common interference scenarios for inward interference are the following:

- Mobiles from an existing service causing interference to the base station receiver of the proposed service; and
- Base station from an existing service causing interference to mobiles of the proposed service within the coverage area.

Outward interference

The common interference scenarios for outward interference are the following:

- Mobiles of the proposed service causing interference to the receiver of the existing base station; and
- Base station of the proposed service causing interference to mobiles in the existing service within the continuous coverage area.

Adjacent channel criteria

Analogue and digital systems are designed to work on first adjacent channel with overlapping coverage. To clarify, the first adjacent channels to n are channels (n±1).

Licensing

Land mobile repeaters will only be licensed at specific fixed geographic locations (point-type locations in the Register). It is good practise to record the equipment and antenna details, but is not compulsory.

The following condition must go on all licences except Amplitude Modulation (AM) licences in A band (81 MHz - 87.5 MHz):
"A coded squelch or access code or unique addressing system or CTCSS tone (group X[7]) must be used by all radio apparatus covered by this licence".

[7] Tone groups and regions of the country where they can be allocated are specified in the appendix of *Mobile Service Bands in New Zealand* (PIB 23).

4.6 Trunked radio

Trunked radio is a system that consists of a minimum of three circuits (e.g. three voice circuits) controlled by a central computer system. Trunking is more spectrally efficient because it takes advantage of the probability that not every user will need to access the channel at the same time.

Two bands that have been dedicated for trunked radio and cannot be licensed for single discrete channel use:

- TD band (406.1 – 420 MHz): 6.25 kHz and 12.5 kHz channelling analogue or digital.
- TS band (813 – 863.7 MHz): 12.5 kHz and 25 kHz channelling analogue or digital.

The channel plans can be found in PIB 23.

4.6.1 Channel allocation

Channels are to be allocated in accordance with the appendix of PIB 23. The numbers listed in the tables are the channel numbers.

TD band

Channels will be licensed in blocks listed in PIB 23. The first channels for allocation for a site will be taken from a block. For example if Block 11 is chosen the first channels for allocation are TD 11, 31, 51. Subsequent channels to be allocated for a system should be chosen from the same block.

TS band

The first channels to be licensed will be taken from the group marked “Initial Allotment”. Once all channels in this grouping have been licensed, use will be made of those in the “First Extension” grouping, followed by the “Second Extension” and “Third Extension” groupings.

However, there may be occasions when this pattern cannot be followed. For example, where demand requires that two licensees share a given block, one licensee will be given channels from the “Initial Allotment” and “First Extension” groupings, while the other licensee will make use of the “Second Extension” and “Third Extension” groupings.

4.6.2 TDX and TX band simplex

There are a limited number of simplex channels available in the TDX and TX bands. Simplex is restricted to be used as a supplement to an existing trunked system. TDX is only available for users with a licence in the TD band. TX band is available for users with a licence or who take service from a TS band trunked system.

Interference threshold

The interference threshold for TDX and TX simplex bands is the same as the section 4.4.1 Shared simplex.

4.6.3 TD band (406 – 412 MHz and 414 – 420 MHz)

The TD band is for analogue and digital trunking systems. There are a number of incumbent fixed links still in service in this band that must be considered.

Interference thresholds

The interference threshold used for TD band services is the same as the repeater section. Please refer to and follow section 4.5 Repeaters.

4.6.4 TS band (813 – 819 MHz and 858 – 864 MHz)

The TS band is for analogue and digital trunking systems.

Some of the certification criteria for TS band are different from other land mobile services. TS band provides for three alternative trunked dispatch technologies to co-exist compatibly within the band. These are: analogue FM; TETRA; and APCO P25.

Coverage

For all systems except TETRA, the coverage area is defined by section 4.5.1 Coverage. This is a continuous contour equivalent to a signal level of -95 dBm.

For TETRA this is a theoretical coverage area with a radius of 58 km[8] or continuous contour equivalent to a signal level of -95 dBm, whichever is the smaller; refer to Figure 6 Case B.

Interference threshold

The interference thresholds are determined by reuse distances and carrier to interference (C/I), and are described as the following:

- Outward interference:

  The proposed service must protect existing services to a minimum C/I of 18 dB[9] at the edge of the existing coverage area; refer to Figure 6 Case B.

- Inward interference:

  The proposed service must be protected from existing services to a minimum C/I of 18 dB[10] at the edge of proposed coverage.

First adjacent channel

Unless a detailed engineering analysis can prove otherwise (guidelines are contained in the remainder of this section), first adjacent channel use between either TETRA and APCO or TETRA and Analogue is not permitted where there is overlapping coverage:

- First Adjacent channel between TETRA and Analogue (25 kHz); and
- First and second adjacent channel (12.5 kHz) between TETRA and APCO (12.5 kHz) or TETRA and Analogue (12.5 kHz).

[8] The 58 km radius takes into account the inherent maximum cell size for TETRA TDMA systems due to path delay (ETSI EN 300 392-2 V3.2.1).

[9] The C/I level of 18 dB has been obtained considering dynamic conditions (fading) for analogue, APCO and TETRA systems. This figure takes into account the C/I requirements to maintain a Delivered Audio Quality (DAQ) grade of 3.4 (as specified in TSB88.1, table A-1). This value is also used in ITU-R SM.337-6 (table 1), where a calculation example is given for determining frequency and distance separation between land mobile services in the UHF band.

[10] Ibid.

Engineering guidelines

Re-use distance is the distance required to ensure a suitable grade of service between co-channel services. Generally, the re-use distance is constrained by topographic obstructions.

In non-co-sited situations – with services sharing a substantial overlapping coverage area – it is recommended that between analogue FM, APCO and TETRA base stations, the new base station should be spaced at least 5km away from the edge of the coverage area of the existing service.

In situations where the local terrain and clutter provide sufficient obstruction loss, this measure can be relaxed, provided that an equivalent co-channel C/I of 18 dB is maintained by the proposed service at the edge of the coverage area of existing services.

Where the new service is TETRA, and has an adjacent channel leakage ratio (ACLR) of -55 dB, the C/I for the first and second adjacent channel is -37 dB, and where the proposed service is APCO P25, with an ACLR of -60 dB, the first and second adjacent channel C/I is -42 dB; refer to Figure 7**Error! Reference source not found.**.

Co-channel, first and second adjacent channels (etc.) in this document refer to the 25 kHz channelling raster, not the 12.5 kHz sub-channels.

Protected C/I

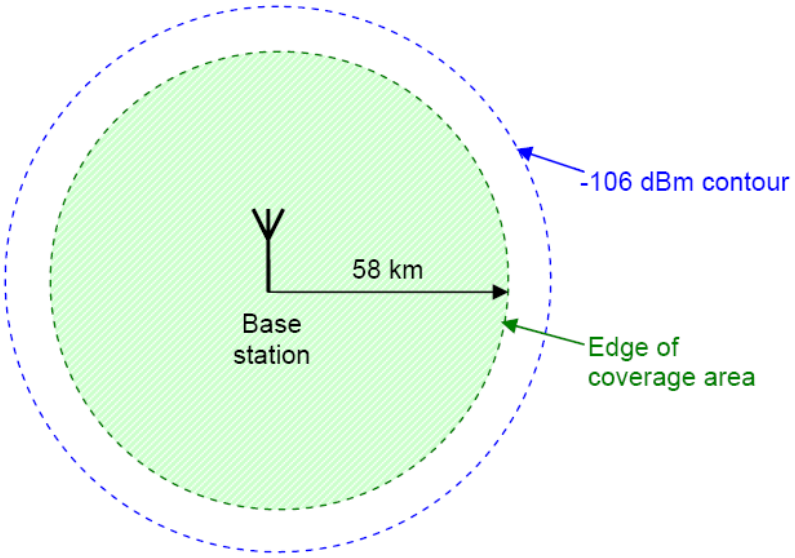
In some instances, these guidelines may not be optimal when considering specific characteristics of the local topography, especially in large and flat terrains. In such cases, the above distances can be adapted, provided that the proposed service complies with the minimum C/I of 18 dB at the edge of the coverage area of the existing service; refer to Figure 7**Error! Reference source not found.**, Case B.

Combined 25 kHz and 12.5 kHz channel plan

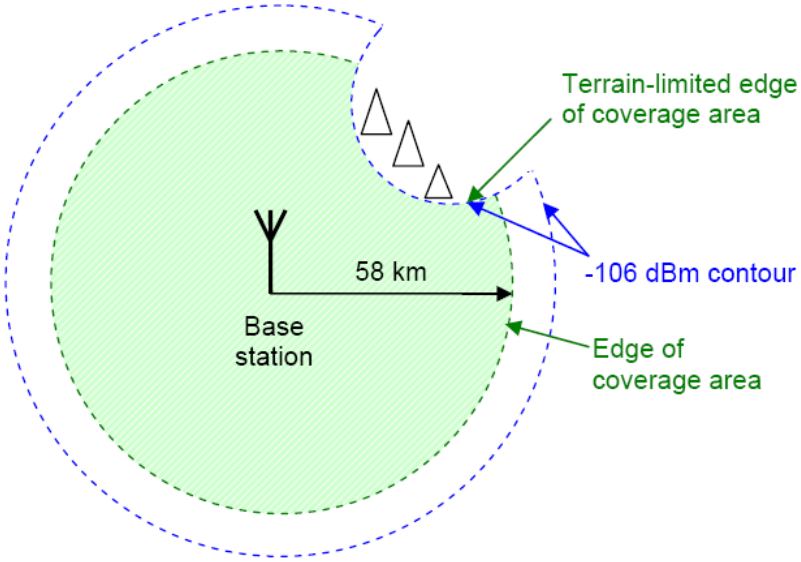
Channels based on 12.5 kHz spacing must be licensed on the 12.5 kHz raster of frequencies that are 6.25 kHz displaced from the 25 kHz raster; refer to Figure 9.

Table 8 – Detail of C/I specifications

Modulation type	Channel spacing	Static		DAQ 3.4	
		Reference	C/N	BER %	C/(I+N)
Analogue FM ± 5 kHz	25 kHz	12 dB SINAD	4 dB	n/a	20 dB
Analogue FM ± 4 kHz	25 kHz	12 dB SINAD	5 dB	n/a	22 dB
C4FM (IMBE)	12.5 kHz	5%	7.6 dB	2%	17.7 dB
CQPSK (IMBE)	12.5 kHz	5%	7.6 dB	2%	17.7 dB
CQPSK (IMBE)	6.25 kHz	5%	7.6 dB	2%	17.7 dB
TETRA	25 kHz	5%	8 dB	2%	16 dB



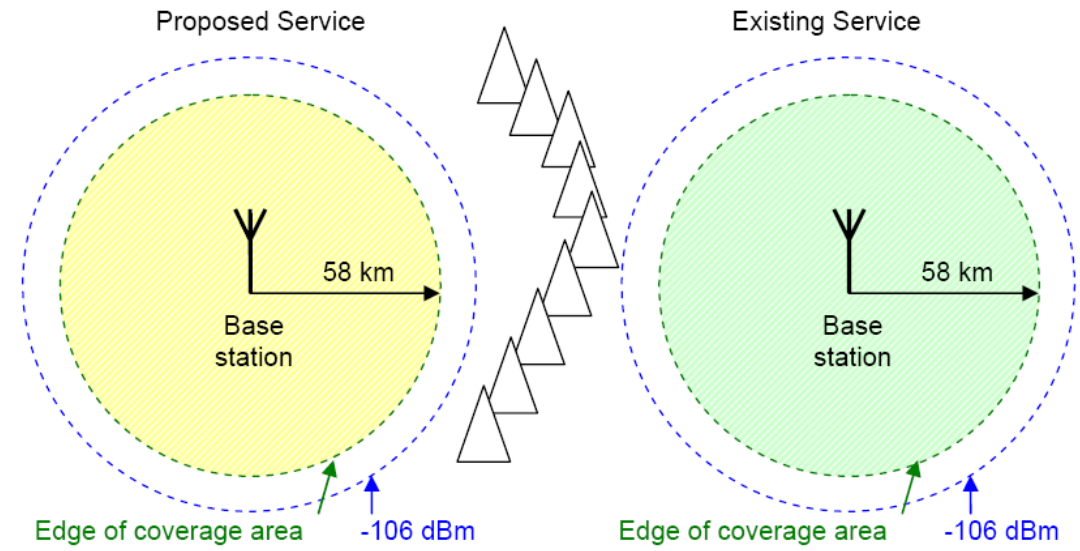
Case A



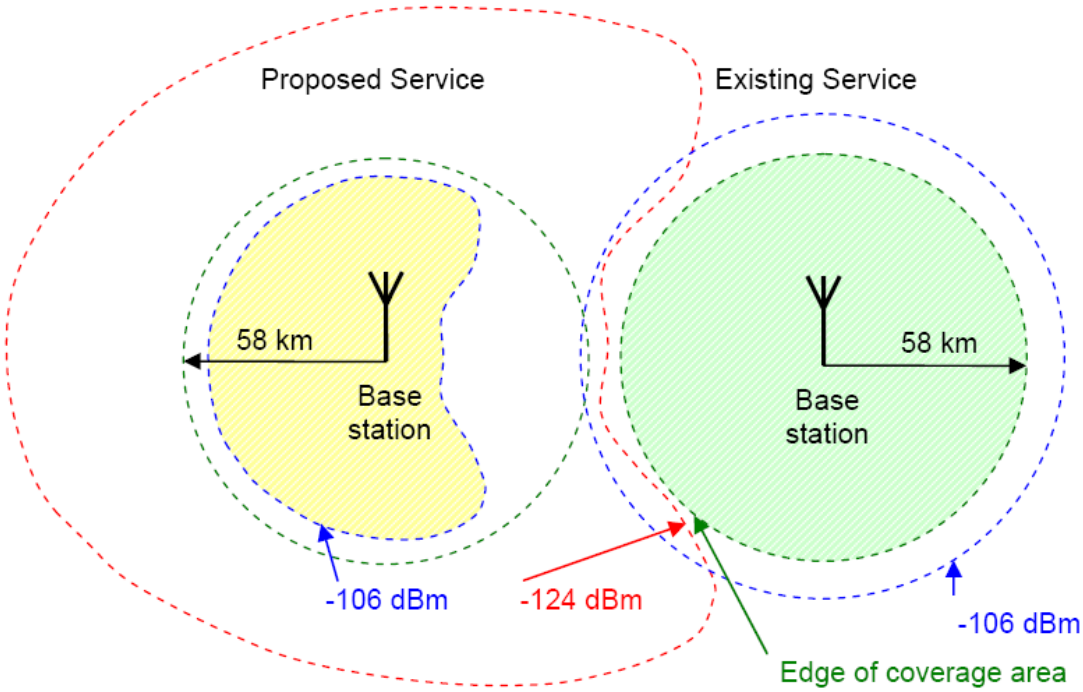
Case B

Figure 6 – Coverage

Case A: Without terrain limitation, a 58 km radius applies.
Case B: With terrain limitation, the smaller -106 dBm area applies.



Case A



Case B

Figure 7 – Re-use distance to protect existing co-channel services.

Case A: shows co-channel services isolated by topography.

Case B: does not have sufficient topographic obstruction. To comply with the minimum C/I of 18 dB at the edge of coverage of existing services, the proposed service must constrain the interfering impact of its transmission by other means. In this example, a modified horizontal radiation pattern (HRP) is used to achieve the required C/I.

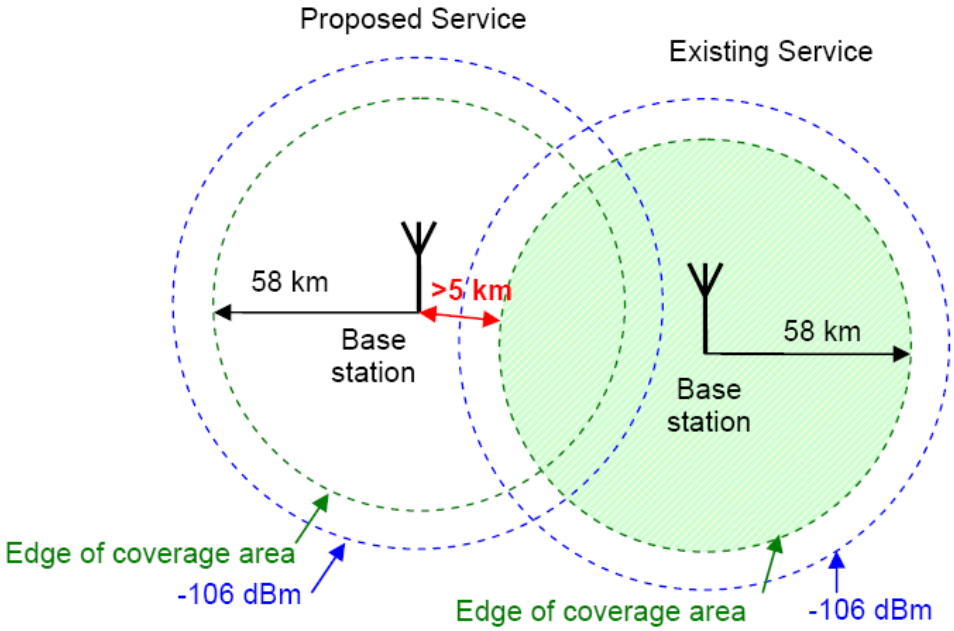


Figure 8 - Protecting existing first adjacent channel (±25 kHz) services.

The minimum unobstructed separation from edge of coverage is 5 km. With topographical obstruction, separation may be less, provided the net co-channel C/I exceeds 18 dB at the edge of coverage of the existing service when taking account of the proposed service's adjacent channel leakage ratio.

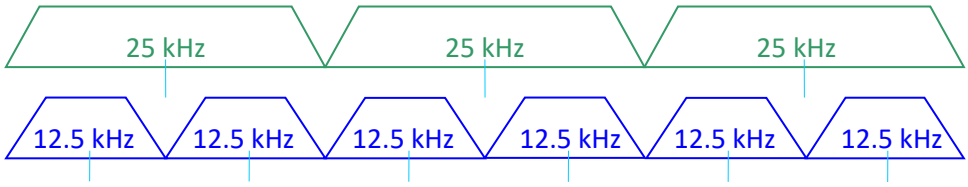


Figure 9 - Channel rasters for 25 kHz and 12.5 kHz.

The channel raster for 12.5 kHz ("TSN" channels) is offset 6.25 kHz from the 25 kHz TS raster in order to accommodate two 12.5 kHz channels within each 25 kHz channel.

5. Fixed Services

5.1 Introduction

This section covers Fixed Services. A Fixed Service is defined in the IRRs as a "radiocommunication service between specified fixed points". This covers a wide range of point-to-point and point-to-multipoint radio-communication applications. The term "microwave" is generally used to identify the frequencies between 3 GHz and 90 GHz. Another term, "radio-relay systems" is also commonly used to denote particular sub-types of microwave fixed systems with multiple hops.

These rules encompass analogue and digital fixed services as follows:

- VHF / UHF Services (narrow band systems below 3 GHz in the VHF and, UHF bands); and
- SHF / EHF services (services above 3 GHz long and short-haul radio relay).

In selecting a band in the Fixed Services, Approved Persons must give consideration to Section 3.2 Efficient use of the spectrum resource. Higher frequencies (particularly above 10 GHz) are subject to increased attenuation and link reliability problems caused by rain fade outages result in reduced hop lengths. These frequencies are also characterised by high frequency re-use potential and wide bandwidth, which provides for greater capacity. Thus the choice of frequency band is influenced by a number of factors, not the least being that the required capacity should be commensurate with the channelling and propagation characteristics of the band concerned.

Fixed Service channel and band plans can be found in:

Table of Radio Spectrum Usage in New Zealand (PIB 21) and

Fixed Service Bands in New Zealand (PIB 22).

For general link planning purposes, reference should be made to relevant publications such as the ITU-R Handbook – *Digital Radio-Relay Systems, Radio Communications Bureau Geneva 1996*, which provides detailed guidance on most aspects of fixed service planning and the ITU-R Recommendations.

All digital services are required to comply with a minimum spectrum efficiency of 2 bits per second per Hertz (bits/s/Hz). Some bands have restrictions and require equipment that has greater spectral efficiency.

Table 9 - Fixed Service frequency bands and antenna requirements

Band	Frequency Range	Minimum Antenna Requirements [3]			Allocated Use	Minimum Path Length (km)	RF Channel ITU-R Recommendation [1]
		XPD (min) dB	Type 1 [4] F/B (min) dB	Type 2 [4] F/B (min) dB			
EE[6]	162.2 – 170.31 MHz				Point-to-point & Point-to-multipoint		
I[6]	420 – 430 MHz				Point-to-point & Point-to-		

Band	Frequency Range	Minimum Antenna Requirements [3]			Allocated Use	Minimum Path Length (km)	RF Channel ITU-R Recommendation [1]
		XPD (min) dB	Type 1 [4] F/B (min) dB	Type 2 [4] F/B (min) dB			
					multipoint		
I	404 – 413.8 MHz (I1 – I18 & I1# - I15#)				Point to point uni-directional Studio to transmitter links	5	
JL[6]	440 – 449 MHz				Point-to-point & Point-to-multipoint Digital only		
JL	444 – 444.9 MHz				Point to point uni-directional Studio to transmitter links		
J[6]	450 – 470 MHz				Point-to-point & Point-to-multipoint		
KK	806 – 812 MHz 851 – 857 MHz		17	20	Point-to-point Digital only	5	
KL	841 – 851 MHz		17	20	Point to point uni-directional Studio to transmitter links		
K	928 – 935 MHz		17	20	Point-to-point uni-directional Studio-to-transmitter links		
L[6]	1 429 – 1 530 MHz				Point-to-point & Point-to-multipoint		
LL	1 427 – 1 525 MHz (1.8 m diameter antenna at high sites)	25	25	30	Point-to-point Digital only		
2 GHz[2]	2 025.5 – 2 081.5 MHz 2 200.5 – 2 256.5 MHz	25	25	30	Point-to-point Med Capacity Digital only		ITU-R F.1098-1
2.8 GHz	2 700 – 2 900 MHz				Itinerant linking (TVOB)		
5 GHz	4 400 – 5 000 MHz	30	60	60	Point-to-point High capacity	30	ITU-R Rec.F.1099

Band	Frequency Range	Minimum Antenna Requirements [3]			Allocated Use	Minimum Path Length (km)	RF Channel ITU-R Recommendation [1]
		XPD (min) dB	Type 1 [4] F/B (min) dB	Type 2 [4] F/B (min) dB			
					N+1 systems Digital only		
6 GHz	5 925 – 6 420 MHz	30	60	60	Point-to-point Med – high capacity Digital only	20	ITU-R Rec.F.383
7 GHz (Lower)	6 430 – 7 100 MHz	30	60	60	Point-to-point High capacity N+1 systems Digital only	20	ITU-R Rec.F.384
7 GHz (Middle)[7]	7 100 – 7 425 MHz	30	60	60	Point-to-point Low - high capacity Digital only	20	ITU-R Rec.F.385
7 GHz (Upper)[7]	7 425 – 7 725 MHz	30	60	60	Point-to-point Low - high capacity Digital only	20	ITU-R Rec.F.385
8 GHz (Lower)[7]	7 725 – 8 275 MHz	30	60	60	Point-to-point Medium - high capacity Digital only	20	ITU-R Rec.F.386
8 GHz (Upper)	8 275 – 8 500 MHz	30	60	60	Point-to-point Medium capacity Digital only	20	ITU-R Rec.F.386
10 GHz	10.5 – 10.68 GHz	30	45	55	Point-to-point Low - medium capacity Digital only	5	ITU-R Rec.F.747
11 GHz[8]	10.7 – 11.7 GHz	30	60	60	Point-to-point High capacity Digital only	5	ITU-R Rec.F.387
13 GHz[7]	12.75 – 13.25 GHz	30	45	60	Point-to-point Medium - high capacity Digital only	5	ITU-R Rec.F.497
15 GHz	14.5 – 15.35 GHz	30	45	60	Point-to-point Low – medium capacity Digital only	5	ITU-R Rec.F.636

Band	Frequency Range	Minimum Antenna Requirements [3]			Allocated Use	Minimum Path Length (km)	RF Channel ITU-R Recommendation [1]
		XPD (min) dB	Type 1 [4] F/B (min) dB	Type 2 [4] F/B (min) dB			
18 GHz	17.7 – 19.7 GHz	30	45	55	Point-to-point Low – medium capacity Digital only	2	ITU-R Rec.F.595
23 GHz	21.2 – 23.6 GHz	30	45	55	Point-to-point Low – medium capacity Digital only	-	ITU-R Rec.F.637
38 GHz[7]	37.0 – 40.0 GHz	30	45	55	Point-to-point Low – high capacity Digital only	-	ITU-R Rec.F.749
50 GHz	50.4 – 51.15 GHz	30	45	55	Point-to-point Low capacity Digital only	-	
80 GHz[5]	71 – 86 GHz	30	45	55	Point-to-point High capacity Digital only	-	-

(1) The ITU Recommendation is cited as a reference. Channel plans for fixed services are in PIB 22.

(2) This Band must be coordinated with the Satellite receive protection zones defined in 2 200 – 2 256.5 MHz service S Band.

(3) An explanation of the antenna performance types is given in Appendix B: Fixed service antenna compliance requirements.

(4) Radio paths within or transiting Defined Metropolitan Areas (DMAs) being Auckland, Hamilton, Tauranga, Palmerston North, Wellington, Christchurch and Dunedin. Require Type 2 antennas (see Appendix B: Fixed service antenna compliance requirements).

(5) The maximum permitted EIRP is 55 dBW. The maximum transmitter power is 3 W with a maximum spectral density of 150 mW / 100 MHz.

(6) Point to Multipoint systems are limited to the EE, I, JL, J and L Bands.

(7) The use of 56 MHz channels in these bands is restricted to digital microwave radio designed in accordance with section 5.10Performance standards and power to achieve a minimum spectral efficiency of 4 bits/s/Hz over a 56 MHz channel (224 Mbps).

(8) The use of 80 MHz channels in this band is restricted to digital microwave radio designed to achieve a minimum spectral efficiency of 4 bits/s/Hz over an 80 MHz channel (320 Mbps).

5.2 Minimum path length

In selecting a band, an Approved Person should bear in mind that line-of-sight losses increase with frequency. The path length achievable is a function of the system gain and the link performance objectives. Accordingly, the lower fixed microwave frequency bands should be assigned to long-haul paths where it may otherwise be difficult to achieve the necessary fade margin. Conversely, for shorter paths, higher frequency bands should be used in the interests of preserving the spectrum resource of the lower frequencies that are needed for longer paths.

The minimum path length defines the shortest end-to-end distance for a single-hop link which may be supported in a particular frequency band. Minimum path lengths apply to those services in the I STL band, KK band and above (>800 MHz), as indicated in Table 9. Requests for exemptions from the minimum path length rule will be considered on a case by case basis by the Licensing Manager.

5.3 Co-channel interference threshold

The procedures for evaluating interference into fixed service receivers (proposed or existing) uses a methodology based on the ITU-R Handbook on Digital Radio-Relay Systems, which relates to an increase in noise floor.

5.3.1 VHF and UHF services

When evaluating potential interference from terrestrial link transmitters in the VHF and UHF bands, calculated co-channel interfering signal must be less than or equal to -110 dBm at the receiver.

5.3.2 KK, LL, L, 2G, EHF and SHF band services

When evaluating potential interference from terrestrial link transmitters above 3 GHz, KK, L and LL bands, calculated co-channel interfering signal must be at least 6 dB (1 dB threshold degradation) below the receiver noise floor of the victim terrestrial link receiver. Where bands are shared between fixed and satellite services, the fixed service must be 10 dB (0.4 dB threshold degradation) below the receiver noise floor for satellite earth station receivers.

Co-channel interference is deemed to potentially exist in any situation in which the bandwidths of the victim receiver and interfering transmitter (as defined by their centre frequencies and channel bandwidths) overlap in part or in full.

5.4 Adjacent channel interference criteria

The interference target will be adjusted to account for the frequency offset between the victim and interfering services. This adjustment factor is known as the frequency dependent rejection (FDR). In the absence of actual FDR's obtained from manufacturers data sheets, a nominal set of conservative FDR's are to be used and are in Table 10.

Table 10 – Frequency Dependent Rejection

Channel offset	Frequency Dependent Rejection (FDR)
Co-Channel	0 dB
1st Adjacent Channel	30 dB
2nd Adjacent Channel	50 dB
> 2nd Adjacent Channel	Consideration not required

The “edge-to-edge frequency separation” between the emission bandwidths of victim and interfering services is used to determine the “Channel offset”. A “step distance”, being equal to the wider of the two emission bandwidths, is defined and applied as follows:

- Where the two emission bandwidths overlap, the co-channel FDR value (zero) is used;
- Where the edge-edge separation between the two emission bandwidths is 0 to less than 1 “step distance” then the 1st adjacent FDR value is used;
- Where the edge-edge separation between the two emission bandwidths is 1 to less than 2 “step distances” then the 2nd adjacent FDR value is used; and
- Where the edge-edge separation between the two emission bandwidths is equal to or greater than 2 “step distances” adjacent channel interference is not assessed.

For further information, refer to Appendices

Appendix A: Co-channel and adjacent channel relationship.

5.5 Antenna performance

Antennas are critical components within the overall interference management framework and their characteristics play a large part in determining overall frequency re-use.

It is essential that Approved Persons work with detailed radiation pattern envelope (RPE) data, both in the case of a discrete antenna and for systems with integrated antenna equipment. For future audit Approved Persons must keep a record of antenna parameters used in frequency co-ordination. The type, make, and model of the antenna are mandatory parameters that must be entered for all new licences. This information is necessary not only for the engineering of an initial radio licence, but also for the co-ordination of later licensing applications. In particular, care should be taken to record the make and model of the original equipment manufacturer of the antenna, not alternative designations that may be ascribed to the antenna by the associated radio equipment manufacturer.

Appendix B: Fixed service antenna compliance requirements, also provides advice regarding notional antenna performance characteristics to be used in coordination studies where make and model (hence the detailed antenna characteristics) of existing licensed services cannot be ascertained from the Register licensing records.

Antenna performance for VHF / UHF

Antenna front-to-back ratio: > 12 dB

Horizontal 3 dB beamwidth: < 60 degrees

Antenna performance for EHF / SHF

The requirements are set out in Table 9 - Fixed Service frequency bands and antenna requirements.

5.6 Calculation of receive signal levels

For coordination purposes, the received signal power will be calculated as:

Pr = Pt + Gt – Lt – Lp + Gr – Lr

Where:

Pr = RF signal power at the input to the receiver (dBm or dBW)

Pt = RF signal base power, i.e. at the output of the transmitter (dBm or dBW)

Gt = gain of transmitting antenna in the azimuth towards the receiver, relative to a hypothetical isotropic radiator (dBi)

Lt = feeder/branching losses associated with the transmitter (dB)

Lp = total transmission path loss between transmit and receive antennas (dB)

Gr = gain of receiving antenna in the azimuth towards the transmitter (dBi) relative to a hypothetical isotropic radiation.

Lr = feeder/branching losses associated with the receiver (dB)

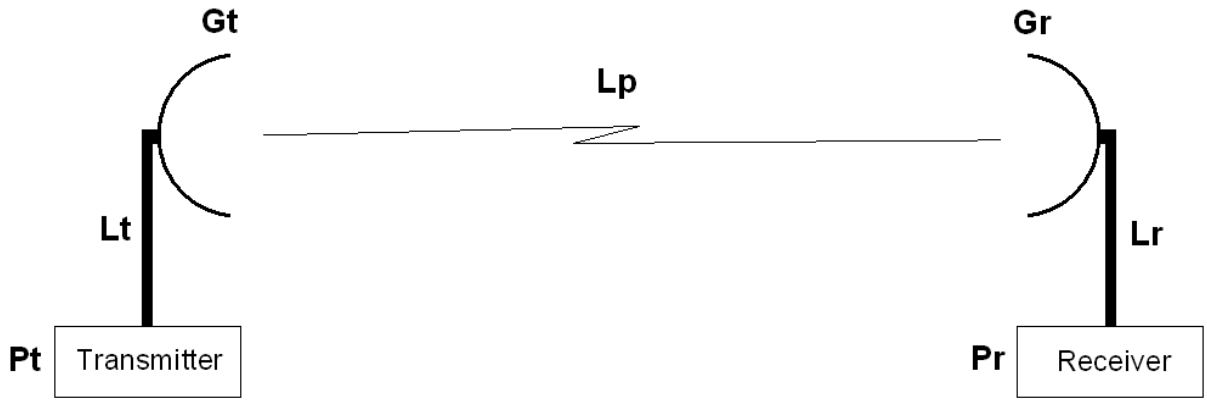


Figure 10 - This shows a simplified example of a transmitter to receiver path including the losses and gains in the system.

In the case of the wanted signal the total transmission path loss between transmit and receive antennas (Lp) shall be calculated as free space loss, plus atmospheric absorption loss in bands above 20 GHz. Wanted signal levels must be calculated in accordance with section 5.10 Performance standards and power. In the case of the unwanted signal, diffraction losses may be taken into account if necessary.

5.7 Path profiles and interference calculations

Approved Persons may exercise their judgment in which potential interference scenarios need to be considered and which can be dismissed. This may be done by relying on antenna discrimination and free space loss only on interference paths. In such cases no analysis of terrain profiles on the interference paths is required.

Calculation of the additional transmission losses attributed to terrain blocking on the interference path may be necessary for the analysis of interference scenarios that cannot be cleared by the simplifying assumption of free space loss. Commercial software is available that uses algorithms to calculate the additional losses. Such algorithms usually require the use of an "equivalent earth radius factor" (the "k-value") to estimate the extent of refractive bending of the radio beam, and hence the extent of clearance or otherwise over terrain obstructions. For coordination purposes, a reasonable worst case k-value of 2.0 (unwanted) shall be used for the evaluation of diffraction losses on potentially obstructed interference paths. Path profile information used for diffraction loss calculations must be retained for audit purposes.

Losses on potential interference paths due to buildings or other man-made obstacles may be taken into account; however the engineer must prove that the obstruction loss is sufficient to mitigate interference. This could be through one or more of the following methods:

- Field strength measurements with calculations showing the attenuation of the obstruction;
- Field engineering report and supporting calculations detailing the adequacy of the structure(s) to provide the necessary level of attenuation; and
- Modelling and calculations to obtain the value of attenuation the obstruction provides. Details of the man-made obstacle must be considered and recorded in the analysis.

5.8 Channel priority

There is no prescribed order that channels and bands are to be used, however Approved Persons must to apply Section 3.2 Efficient use of the spectrum resource when choosing fixed bands.

5.9 Polarisation

The coordination of fixed links must take into consideration the polarisation of the links involved in the particular coordination scenario. The calculation will require reference to the appropriate pattern (cross-polar or co-polar as the case may be) of the antenna RPE data. The method of calculation to be used whereby the co-polar and cross-polar components of the signal are combined to calculate a net interference effect is documented in Recommendation ITU-R F.699.

The polarisation of each link must be recorded in the Register as either "Vertical" or "Horizontal" such that this information will be available for subsequent coordination studies.

However if two independent co-channel fixed links operating over the same path under the one licence - one vertically polarised and the other horizontally polarised, then "Other" shall be recorded in the Register.

Similarly when a particular link operates on both polarisations over the same path as in Cross Polarisation Interference Cancelation (XPIC) operation then the polarisation shall be 'Other' as well.

5.10 Performance standards and power

This document seeks to manage interference between fixed services and requires services to be restricted to operate at power levels that are just sufficient to achieve a satisfactory level of performance. Failure to do so would unnecessarily reduce the reuse potential of the channel. For consistency the calculation of that maximum permissible EIRP requires the definition of a performance standard (the "satisfactory" level of performance) and a standard method by which that level of performance is calculated.

Power is calculated from the receiver to the transmitter to determine the required power.

5.10.1 VHF and UHF Services (below 3 GHz)

For licensing purposes the following performance standard in Table 11 will apply:

Table 11 – Performance standard for VHF and UHF Fixed Services

Receive signal level (bandwidth)	-90 dBm (less than or equal to 50 kHz)
	-80 dBm (≥12.5 kHz and spectral efficiency ≥6 bits/s/Hz)
	-70 dBm (greater than 50 kHz)
Maximum unwanted co-channel signal level	-110 dBm
Maximum path length	100 km
Minimum assignable EIRP	-3 dBW
Maximum assignable EIRP	23 dBW

VHF / UHF bands are to be engineered so that the wanted signal strengths at the receiver are -90 dBm (RL_N) for a single voice channel has 99.9% propagation availability.

The maximum and minimum assignable EIRP on any fixed VHF / UHF licence will be in the range ≤ 23 dBW, and ≥ -3.0 dBW. For example if a short radio path requires 20 dBm (-10 dBW) EIRP for reliable communications, it would be assigned -3.0 dBW (27 dBm / 500 mW) and this is the valve that will be shown on the licence. Similarly if a proposed radio path requires a greater power than 23 dBW for example: If 30 dBW is calculated for reliable communications the licensed power must only be 23 dBW.

When calculating the transmit power to be assigned to a fixed link, the following equation shall be used:

EIRP (dBW) = $L_P + F_M + L_R + RL_N - G_R + L_{EX} - 30$

RL_N (dBm) = Nominal receive level is that which has been determined to achieve 99.9% (in the worst month) propagation availability.

L_P (dB) = Free space path loss between isotropic antennas.
$L_P = 32.4 + 20 \log F + 20 \log D$ (F = frequency in MHz and D = distance in km)

G_R (dBi) = Receive antenna gain.

L_R (dB) = Receive transmission line system losses

L_{EX} (dB) = External loss factors that will attenuate the signal not included in L_P, e.g. obstruction, vegetation, etc.

F_M (dB) = Fade margin, the amount by which the received signal level may be reduced without causing system performance to fall below the specified threshold value. For VHF / UHF services Multipath Fade is the only significant fade type and the

only fade type to be considered. The following equation is to be used when calculating the fade margin:

F_M = 10 log FD (F = frequency in GHz and D = distance in km)

5.10.2 KK, LL, L, 2G, EHF and SHF band services

For licensing purposes, the following performance standard will apply:

- EIRP shall be limited to a level such that a BER of 10^{-6} attributable to propagation shall be only just achieved for. The multipath fade margin must be calculated for a reliability of 99.999% for the worst month.

The following procedures and parameters will be used in the calculation of the minimum necessary EIRP:

- The calculation method for determining the necessary fade margin is published in Recommendation ITU-R P.530-17 (or most recent edition);
- The calculation shall be done assuming the link operating without diversity, irrespective of whether or not diversity is actually in use;
- The calculation of EIRP shall take into account the transmitter power setting, any external attenuation, estimated line losses (branching, filters, feeders), and the manufacturers stated mid-band antenna gain;
- The calculation of the wanted receive signal level will assume free space loss propagation between the transmitting and the receiving antennas, plus atmospheric absorption loss for bands above 20 GHz;
- For calculation purposes the rain rate for the region in question shall be obtained from Recommendation ITU-R P.837 as the minimum or from http://cliflo.niwa.co.nz/ for rain rate data produced by the National Institute of Water & Atmospheric Research (NIWA); and
- For calculation purposes (other figures may be used where more accurate information can be obtained) a single value multi-path factor (PL) of 10 will be used for all paths.

Power limiting is not mandated for bands 10 GHz and above. However, licensees are encouraged to limit EIRP to levels consistent with their own performance objectives. This rule may require review in the event that unlimited EIRP eventually gives rise to spectrum denial in these bands.

5.11 Fixed services in VHF EE band (162.2 - 170.3 MHz)

EE-band is limited to obstructed paths, and where it has been shown the UHF linking is unsuitable. Approved Persons must write an explanatory letter, justifying the need for VHF and upload it against the licence or application in the Register. 25 kHz channels (EEW) are only available for high data rate systems using digital modulation.

5.12 Adaptive Transmit Power Control (ATPC)

Systems using Adaptive Transmit Power Control (ATPC) must operate in accordance with the International Radio Regulations (IRRs) and ITU-R Recommendations. No more than the minimum necessary power, commensurate with reasonable guarantee of service levels, should be used.

Transmitter power for ATPC systems will be calculated to achieve the same EIRP limits as are applicable to non-ATPC systems following section 5.9Performance standards and power. In ATPC terminology this power level is known as the “coordinated power”. Under normal ATPC operation the actual transmitter power may vary above and below this coordinated power according to propagation conditions on the wanted path. For the majority of time it will sit a level well below the coordinated power, and for very short periods of time during deep fading it will rise above the coordinated power. The maximum output power of the transmitter must be limited however such that under ATPC the output power can never exceed the coordinated power by more than 10 dB.

Where the ATPC capability of equipment is disabled for any reason, the output power of the transmitter must be set permanently to the coordinated power level.

The coordinated power will be the power level recorded for ATPC systems for licensing purposes, whether the ATPC function is activated or otherwise. Consequently, when coordinating against existing ATPC systems, the coordinated power will be used for interference calculation purposes.

5.13 Link diversity

Several diversity methods are used to improve system performance, typically to combat the effects of multi-path fading and to achieve performance objectives over hops with difficult propagation conditions.

Space diversity is usually implemented using multiple receiver antennas with a vertical separation sufficient to provide separate signal paths in which the effects of multi-path fading are sufficiently un-correlated.

Frequency diversity uses two or more frequencies transmitting identical information over the same path. The frequency separation between transmitters must be large enough to ensure that the effects of multi-path fading on the two discrete signals are sufficiently un-correlated. The use of frequency diversity can represent an inefficient use of spectrum; hence the application of space diversity techniques should be used in preference to frequency diversity.

Multiple bearer systems, transmitting different information on a number of channels, usually share a single protection channel. Such “n + 1” protection systems are more spectrally efficient than simple frequency diversity systems, which could be described as “1 + 1” protection systems. Frequency diversity systems operating on a “n + 1” basis where “n” is greater than one may be licensed as required, however “1 + 1” systems must be approved by the Manager Licensing, RSM.

5.14 Passive repeaters

Fixed links may use passive repeaters in their system configuration. Such configurations include back-to-back antenna “passives” and “billboard” reflectors. These arrangements contain no frequency translation devices.

The two hops of a system involving a passive repeater should be licensed as two separate fixed links, the transmit power of the second fixed link being the receive power of the first and vice-versa. The EIRP calculation however should take into account the overall (i.e. two-hop end-to-end) performance requirement. When licensing a passive repeater the following must be included:

- Persons shall include the parameters of any passive reflectors used in systems being registered through the Register to ensure that such systems are able to be protected from subsequent systems. The link budget must be calculated in accordance with Performance standards and power (section 5.10) and including any losses or gains the passive introduces;
- The recording of antenna details for systems using back-to-back parabolas will be identical to that for normal (i.e. single hop) systems. Where "billboard" reflectors are involved, the make and model should be recorded in the Register simply as "Billboard L x H", where "L" and "H" (in metres) are the length and height of the reflector;
- Each passive repeater shall always have its own location record that must begin with the word Passive, for example PASSIVE BROOKLYN; and
- The power on the spectrum record for passive licences must be -90 dBW[11]. Please note that if this power is not recorded on the passive licence the Register will automatically charge a fee.

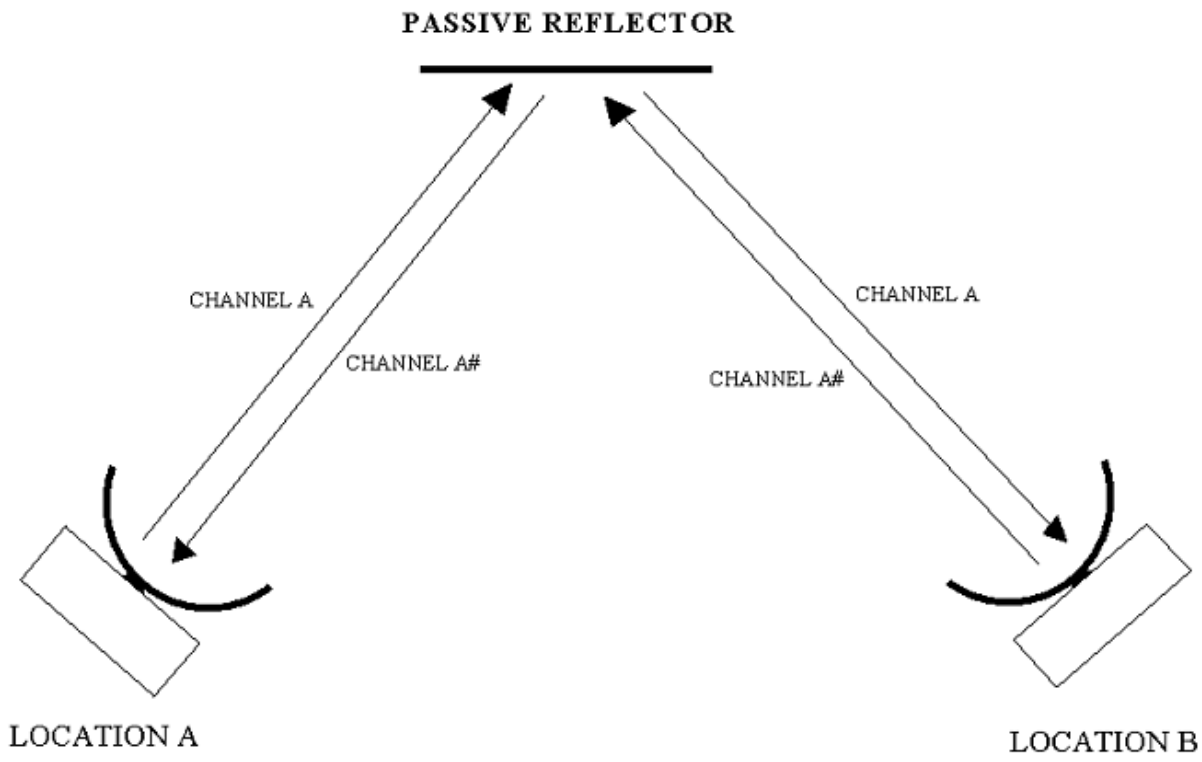


Figure 11 – This diagram shows a typical arrangement for licensing a fixed link using a passive repeater.

A pair of licences from location A, to and from the passive reflector and a pair of licences to and from the reflector from location B is shown. In total there are 4 licences for this passive reflector installation. Note that in this diagram, the passive repeater is shown as a billboard reflector; however, back to back antennas and other methods can be used.

[11] This is the lowest EIRP that can be recorded in the Register. This EIRP will appear on some passive repeater records.

The net gain of a billboard reflector can be estimated by the formula:

$$G = 21.45 + 20 \log (f) + 10 \log [A \cos(\phi/2)]$$

Where:

G = Gain (dBi)

f = frequency in GHz

A = actual area of the reflector in m^2; (i.e. L x H) and

ϕ = angle between the incident and reflected beams

The above gain G combines physics of the incident and reflection processes.

Being a non-frequency translating arrangement there will be an inherent "mixed" site sense at the passive repeater. Passive repeaters should therefore not be used at locations where other services are likely to be operating. No protection from interference will be afforded to a passive system in situations where operators choose to co-locate passive repeaters with other services.

5.15 Protecting the biomedical telemetry band in the 444 – 444.925 MHz JL band

Biomedical telemetry operates within hospitals. Where an Approved Person is considering certification of a licence in the 444 – 444.925 MHz (JL band) they must:

- Show that there are no emissions greater than -75 dBm at the boundary of the hospital grounds listed in the schedule of hospitals in Table 12; and
- Use a victim antenna height of the tallest occupied building in the hospital grounds or, if unknown, a height of 20 metres.

Analysis may be required to ensure Fixed Services in the 444 – 444.925 MHz band do not receive harmful interference from biomedical telemetry systems operating under the *General User Radio Licence for Short Range Devices* (GURL-SRD).

Table 12 – Schedule of Hospitals

Hospital	NZTopo50 Reference
Whangarei, Maunu Road.	AX30 178 446
North Shore, Shakespeare Road	BA32 567 280
Waitakere, Lincoln Road	BA31 452 184
Auckland, Park Road	BA32 578 191
Starship Children's, Park Road	BA32 578 192
Greenlane, Greenlane West	BA32 587 154
National Woman's, Claude Road	BA32 586 152
Middlemore, Hospital Road	BB32 639 076
Waikato, Pembroke Street	BD33 010 134

Hospital	NZTopo50 Reference
Tauranga, Cameron Road	BD37 775 219
Rotorua, Pukeroa Street	BE37 847 747
Gisborne, Ormond Street	BG43 357 116
Taranaki Base, David Street	BH29 913 747
Hawke's Bay, Omahu Road	BK39 283 065
Wanganui, Heads Road	BL32 741 766
Palmerston North, Ruahine Street	BM34 225 315
Hutt, High Street	BQ32 614 368
Wellington, Riddiford Street	BQ31 490 254
Nelson, Tipahi Street	BQ26 228 293
Grey Base, High Street	BU19 514 972
Christchurch, Riccarton Avenue	BX24 698 798
Christchurch Woman's, Colombo Street	BX24 705 811
Burwood, Mairehau Road	BX24 745 858
The Princess Margaret, Cashmere Road	BX24 694 757
Timaru, Corner Queen and High Streets	CA19 612 812
Dunedin, Great King Street	CE17 066 175
Southland, Kew Road	CG10 433 467

5.16 Protection of GSO satellite services from fixed services in the UHF and SHF bands

A significant number of the fixed bands above 1 GHz are shared with satellite services.

To facilitate spectrum sharing between fixed services and Geostationary Satellite Orbit (GSO) space services, and comply with New Zealand's obligations to the ITU, Approved Persons must be aware of, and apply the provisions of the IRR and ITU-R Recommendations regarding protection of the geo-stationary orbit. These provisions require the calculation of "separation angles" between proposed new terrestrial fixed links, the geo-stationary orbit and the application of EIRP limits depending on the separation angles calculated.

Approved Persons are required to undertake the necessary calculations for all proposed fixed service licensing to confirm that these limits are observed and records of those calculations must be retained.

Generally, the EIRP limits applicable for various separation angles and frequency ranges are set out in Article 21 of the IRR. The method for calculating separation angles is defined in Annex 2 of Recommendation ITU-R SF.765.

Different limits apply to the frequency bands 2 025 – 2 081.5 MHz, 2 200 – 2 256.5 MHz, and 25.25-27.50 GHz. The relevant limits and calculation procedures for these bands can be found in ITU-R Recommendations F.1247 and F.1249.

There are a few sites with multiple earth station receive licences in the band 2 200 – 2 290 MHz. To protect the services in these sites, satellite protection zones have been established. They are noted in Section 6.6.3.

5.17 Television Outside Broadcast Service

This is a point-to-point and point-to-multipoint fixed service for itinerant fixed linking used to support Television Outside Broadcast (TVOB) services. These are addressed in *'Radio Licence Policy Rules'* (PIB 58). The two bands available for TVOB are at 2.8 GHz and 7 GHz. TVOB is managed among users on a nationwide basis.

5.18 Studio to Transmitter Links

Studio to Transmitter Links (STL) are a type of fixed service used for linking a sound broadcasting studio to a sound broadcasting transmit site. Specific bands have been set aside for STL use and there are specific rules applying to STLs. This section must be read in conjunction with the *Radio Licence Policy Rules* (PIB 58); and *Fixed Service Bands in New Zealand* (PIB 22). For the purpose of certification, STLs are to be treated as conventional fixed links. STLs may be deployed as either analogue or digital links.

Table 13 – STL bands and status

Band	Status	Details
444 – 444.9 MHz JL band	Open for licensing	
404 – 413.8 MHz I band (I1 – I18 & I1# - I15#)	Open for licensing	
841 – 851 MHz KL band	Open for licensing	841 – 849 MHz has additional technical compatibility assessment requirements. There are a number of licences reserved for transition from the 915 – 921 MHz band. Specific details are in PIB 58
915 – 921 MHz K band	Band is closed for new licences	Current licences have lost their interference protection as of 24 December 2015. Transition licences on frequencies in other bands have been reserved. Specific details are in PIB 58 and on the RSM website (www.rsm.govt.nz).
928 – 935 MHz K band	Open for licensing	There are a number of licences reserved for transition from the 915 – 921 MHz band. Specific details are in PIB 58

Point to multipoint use

The STL bands are open for point to point use only. Users wishing to use a point to multi point system need to seek permission from RSM Licensing. The approval must be uploaded against the Register. High gain directional antennas will be required for point-to-multipoint links.

5.18.1 KL band 841 – 851 MHz

Special consideration must be given for assessing the technical compatibility of a proposed STL licence in the 841 – 849 MHz portion of the KL band. There are also specific rules for licence creation in this band.

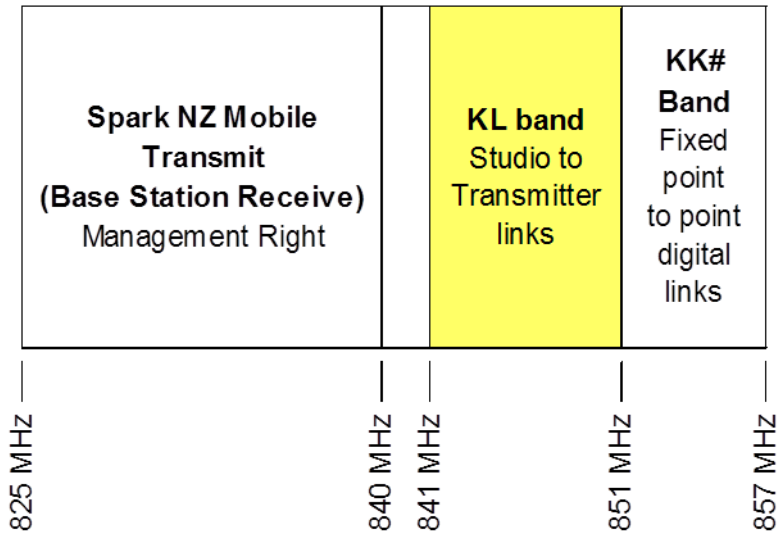


Figure 12 – This is a chart of the KL band and the adjacent bands

5.18.1.1 *Special technical consideration for 841 – 849 MHz*

In addition to the general assessment requirements outlined in this document, Approved Persons must ensure that a proposed licence in 841 – 849 MHz portion of the KL band is technically compatible with the adjacent cellular systems. The adjacent cellular system to be protected is in management right 288 (MR 288) for the frequency range 825 – 840 MHz. This is owned by Spark New Zealand Trading Limited and used for Cellular Mobile transmit (base station receive). MR 288 is paired with MR 289, for the frequency range 870 – 885 MHz, which are used for base transmit (mobile receive).

Using the principles from section 3.3.5 Off-site compatibility, Outward interference', Approved Persons must consider the susceptibility of the cellular base station receiver and if the proposed STL licence will cause interference. The following formula gives a simple method for assessing received signal power at the cellular base station. The parameters of the formula are given in Table 14.

$$Pr = EIRP_{STL} - Ad_T - Lp + Gr - Ad_R - Lr - ACS - Lf \text{ (must be less than -110 dBm)}$$

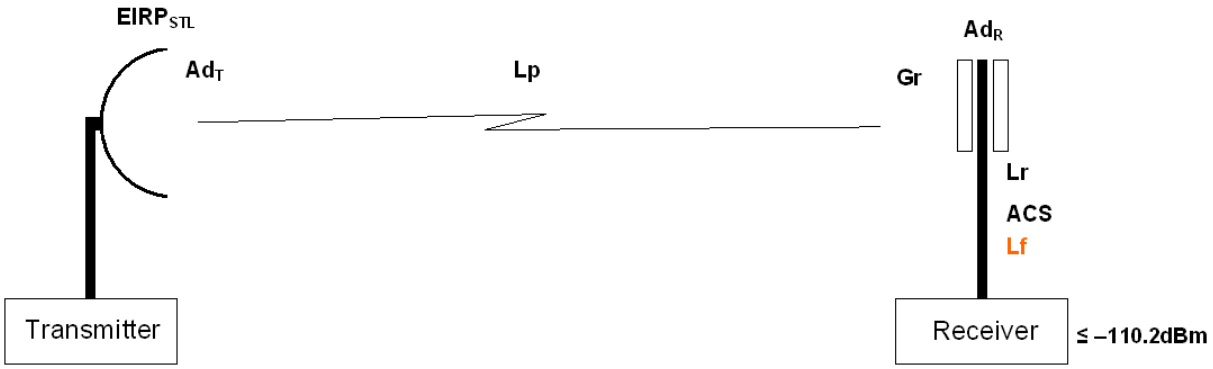


Figure 13 – This shows a simple example of an STL transmitter to cellular base station receiver path including losses and gains in the system.

Table 14 – Parameters used for assessing received signal power at the cellular base station

Parameter		Value	Detail
Pr	Receive power	Calculated	RF signal power at the input to the receiver (dBm).
$EIRP_{STL}$	Licence EIRP of the STL	Calculated	The EIRP calculated in accordance with section 5.10 and will be specified on the licence.
Ad_T	Antenna discrimination		This is expressed in dB below the bore sight EIRP. The antenna discrimination can be derived from the RPE.
Lp	Path loss	Calculated	Total transmission path loss between transmit and receive antennas (dB).
Gr	Nominal base station antenna gain	13 dBi	In the absence of an antenna gain specified on the Spark licence assume the nominal value.
Ad_R	Nominal RPE	Omni	In the absence RPE specified on the Spark licence assume the nominal value.
Lr	Nominal base station feeder loss	3 dB	In the absence configuration losses specified on the Spark licence assume the nominal value.

Parameter		Value	Detail
ACS	Adjacent Channel Selectivity (ACS)	63 dB	This is the amount of attenuation that the cellular base station receiver will provide to signals in the 841 – 849 MHz band.
Lf	Filter attenuation	23 dB	This filter can be fitted to the cellular base station and provide 23 dB of attenuation above 843.5 MHz. This filter is not normally installed on the cellular base station and if the filter is required for an STL licence to be certified then refer to 'Adjacent Channel Selectivity and filter attenuation'.
	Base station receiver noise floor	-104 dBm	The base station receiver noise floor is this value; any interfering signals have to be 6 dB below this level.
	Maximum interfering signal level	-110 dBm	Signals from STL transmitters must not exceed this level at the input to the cellular base station receiver. This level achieves a 1 dB threshold degradation.

Adjacent Channel Selectivity and filter attenuation

The Spark base station receiver has an Adjacent Channel Selectivity (ACS) of 63 dB. This means that 63 dB of attenuation will be provided to signals from an STL transmitter in the 841 – 849 MHz band. ACS is considered to be flat across the band up to 849 MHz.

If calculations show that ACS alone is not enough to ensure signals are less than or equal to -110 dBm, then a filter may be considered. The filter will provide 23 dB of attenuation to STL transmissions above 843.5 MHz and the filter is considered to have a flat performance up to 849 MHz. The filter will provide no attenuation below 843.5 MHz. If a filter is required for technical compatibility, then prior to certification of a licence the following steps must be completed:

- A notification must be sent to Spark giving details of the proposed STL transmitter and the cellular base station receiver that could be affected. A copy of this notification must be uploaded to the events summary in the Register.

  SPARK NEW ZEALAND TRADING LIMITED contact details, including an email address, are available in the Register under client ID 134563.

- The licence must have a commencement date that is 60 days after the certification (delayed start date).

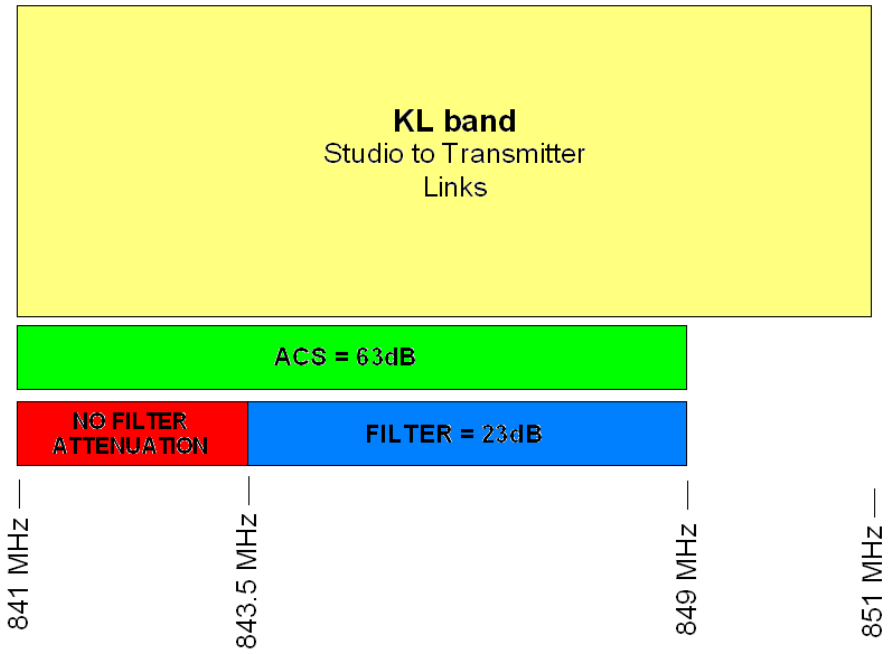


Figure 14 – This is a diagram showing how ACS and a filter apply to the 841 – 849 MHz portion of the KL band

5.18.1.2 *Transition frequencies and licences*

Transition frequencies in alternative bands have been reserved for current licensees in the 915 – 921 MHz band. Licensees may take up a replacement licence(s) for their reserved frequency(s) anytime until December 2017. Please note that for licensees in the 915 – 921 MHz band, protection from interference from short range devices is no longer afforded as of 24 December 2015.

A licensee wishing to take up a replacement licence must contact the Radio Spectrum Management Licensing Team at rsmlicensing@mbie.govt.nz. Replacement licences must be transferred into the name of the licensee and the technical details of the licence must be updated with the correct parameters such as power, antenna and equipment details before any transmissions are permitted.

The reserved transition frequencies can be viewed in the following ways:

- All reserved transition frequencies can be viewed at www.rsm.govt.nz.
- Replacement licences in the 845 – 851 MHz and 928 – 935 MHz bands can be viewed in the Register and are associated with the current licence in 915 – 921 MHz.

5.18.1.3 *Emission mask*

The 841 – 849 MHz band has an emission mask to limit the level of spurious emissions from STLs and to provide protection to cellular services below 840 MHz. The limit specified in this mask is more stringent than the RFS37 standard[12] at the lower end. Every licence in the 841 – 849 MHz band must have this mask added to the licence conditions as a 'specific condition'.

When creating a licence Approved Persons must add one of the following conditions (depending on the channel being licensed):

Licences for 500 kHz channels:

[12] This is a standard gazetted in the Radiocommunications (Radio Standards) Notice.

":1. Transmissions in accordance with this licence must meet the following additional requirements:

2) *a)Limits applying to emissions below the reference frequency (Fc):*

Emissions must not exceed:

0 dBc from the reference frequency to Fc-128 kHz;

-6 dBc from Fc-128 kHz to Fc-157.5 kHz;

-26 dBc from Fc-157.5 kHz to Fc-250 kHz;

-70 dBc (but not less than -20 dBm) from Fc-250 kHz to 841 MHz;

-20 dBm from 841.0 MHz to 840.5 MHz;

-20 dBm from 840.5 MHz to -49 dBm at 840.0 MHz;

-49 dBm from 840.0 MHz to 825.0 MHz.

b) Limits applying to emissions above the reference frequency (Fc):

Emissions must not exceed:

0 dBc from the reference frequency to Fc+128 kHz;

-6 dBc from Fc+128 kHz to Fc+157.5 kHz;

-26 dBc from Fc+157.5 kHz to Fc+250 kHz;

-70 dBc (but no less than -20 dBm) from Fc+250 kHz to 851 MHz.

c) The emission limits are described in accordance with the formula y = mx + C, where: y = dBm, x = MHz, m = dy/dx, C = the value of y where x = 0 (the y intercept).

d) Emissions within Fc ± 250 kHz are described with a reference bandwidth using the necessary bandwidth described on the designation of emissions. Emissions outside Fc ± 250 kHz are described with a reference bandwidth of 100 kHz."

Licences for 250 kHz channels:

"1. Transmissions in accordance with this licence must meet the following additional requirements:

2) *a)Limits applying to emissions below the reference frequency (Fc):*

Emissions must not exceed:

0 dBc from the reference frequency to Fc-63.0 kHz;

-6 dBc from Fc-63.0 kHz to Fc-125.0 kHz;

-70 dBc (but not less than -20 dBm) from Fc-125.0 kHz to 841.0 MHz;

-20 dBm from 841.0 MHz to 840.5 MHz;

-20 dBm from 840.5 MHz to -49 dBm at 840.0 MHz;

-49 dBm from 840.0 MHz to 825.0 MHz.

b) Limits applying to emissions above the reference frequency (Fc):

Emissions must not exceed:

0 dBc from the reference frequency to Fc+63.0 kHz;

-6 dBc from Fc+63.0 kHz to Fc+125.0 kHz;

-70 dBc (but no less than -20 dBm) from Fc+125.0 kHz to 851 MHz.

c) The emission limits are described in accordance with the formula y = mx + C, where: y = dBm, x = MHz, m = dy/dx, C = the value of y where x = 0 (the y intercept).

d) Emissions within Fc ± 125.0 kHz are described with a reference bandwidth using the necessary bandwidth described on the designation of emissions. Emissions outside Fc ± 125.0 kHz are described with a reference bandwidth of 100 kHz."

5.19 Telecommand and Telemetry service

The Telecommand and Telemetry service (TT service) is defined as a telecommunications service for the transmission of signals to initiate, modify or terminate functions of equipment at a distance or for automatically indicating or recording measurements at a distance from the measuring instrument. The TT service is shared where there may be other users on the same channel. Services should use a form of unique addressing to ensure that interference does not cause false activation, control, information corruption, or any other uncontrolled event.

The TT service is a single frequency point to point and point to multi point service. Each transmitter in a system must be licensed at a specific fixed location. The channel plans can be found in PIB 23.

Approved Persons need to be aware that some of the channels in the TT bands overlap with General User Radio Licences (GURL) licensed for a lower power.

Interference threshold

The TT service is shared with no interference threshold or protection and it is expected that users may experience some level of interference. Some of the interference is self-managing due to infrequent transmission and unique addressing. Approved Persons shall identify a suitable channel by taking into account issues such as the following:

- Individual channel loading;
- Co-ordinate between other areas where nominated service areas overlap;
- The use of coded squelch and unique addressing; and
- Technical, equipment and licensee constraints.

Approved Persons should be aware of low power GURLs along with the channelling and EIRP power requirement detailed in PIB 23.

Area Licences must not be issued for TT and may only be licences for fixed locations in a point-to-point or point-to-multipoint topology.

6. Satellite Service

This section covers Satellite Earth Stations (SES) communicating through the following space radiocommunication services as defined in the IRR and relevant ITU-R Recommendations:

- Amateur-satellite service (AmSS)
- Broadcasting-satellite service (BSS)
- Earth exploration-satellite service (EESS)
- Fixed-satellite service (FSS)
- Inter-satellite service (ISS)
- Meteorological-satellite service (MetSS)
- Mobile-satellite service (MSS), including aeronautical/maritime mobile-satellite services (AMSS / MMSS)
- Radio astronomy service (RAS)
- Radiodetermination-satellite service (RDSS)
- Radiolocation-satellite service (RLSS)
- Radionavigation-satellite service (RNSS), including aeronautical/maritime radionavigation-satellite services (ARNS / MRNS)
- Space operation service (SOS)
- Space research service (SRS)
- Standard frequency and time signal-satellite service (SFTSS)

The communication is between a SES at a specific fixed location in New Zealand and a satellite system in the outer space. Satellite downlink transmissions consistent with the IRR are permitted by international treaties – they are not considered to need individual licences in New Zealand, unless receive protection is required. All SESs must be licensed to transmit. The satellite bands open to Approved Persons outside the Ministry are listed in the following table:

Table 15 – Satellite bands open to all Approved Persons

Satellite Band	Up-link Frequency Range	Down-link Frequency range
S	2 025-2 110 MHz	2 200-2 290 MHz
C	5 925-6 425 MHz	3 800-4 200 MHz
Ku	14.0-14.5 GHz	11.7-12.75 GHz

The Ka band frequency ranges are 17.7-20.2 GHz (downlink) and 27.5-30.0 GHz (up-link). Applications for licences the Ka band will be considered on a case by case basis and require a dispensation in accordance with section 2.6 of PIB 58. Some Kuand Ka band SESs are covered by the General User Radio Licence for satellite services (GURL-SS). When considering operating in those bands, Approved Persons are to check the GURL-SS first to see if the proposed service is covered. Please note that the GURL does not offer interference protection. All C and S band SESs must be individually licensed and are not covered by the GURL-SS. Application of licences for SES operating in any other frequency ranges also allocated to space radiocommunication services as contained in PIB 21 will be considered on a case-by-case basis.

When considering the licensing of an SES an Approved Person needs to be aware of the nature of the service and needs to consider the following:

- Uplink frequencies;
- Downlink frequencies;

- Transmit and receive operation;
- Transmit only; and
- Receive only.

6.1 Power calculations

The minimum required power (EIRP) must be assigned. As the power may be defined by agreement between a satellite provider and end user, it is acceptable for this power to be considered as the minimum required power.

6.2 Site assessment

Special care needs to be taken in the site assessment for SESs as they have a very high transmit power and a very sensitive receiver. Consideration needs to be given to adjacent bands and, in particular, their distance and frequency separation from the SES. Refer to section 3.3.3 Onsite compatibility.

6.3 Interference assessment

The procedures for evaluating interference for the satellites are similar to that for fixed services where the SES can be thought of as a fixed link that points at the sky.

Table 16 – Common co-banded Satellite and Terrestrial services

Satellite Band	Terrestrial services vs Uplink frequencies	Terrestrial services vs Downlink frequencies
S	Fixed service 2 GHz band	Fixed service 2 GHz band
C	Fixed services 6 GHz band	No co-channel terrestrial services
Ku	No co-channel terrestrial services	No co-channel terrestrial services
Ka		Fixed 18 GHz band

6.3.1 Calculation of receive signal levels

For coordination purposes the received signal power will be calculated as:

Unwanted

$$Pr = Pt + Gt - Lt - Lb + Gr - Lr$$

Where:

Pr = RF signal power at the input to the receiver (dBm or dBW)

Pt = RF signal base power, i.e. at the output of the transmitter (dBm or dBW)

Gt = gain of transmitting antenna in the azimuth towards the receiver, relative to a hypothetical isotropic radiator (dBi)

Lt = feeder/branching losses associated with the transmitter (dB)

Lb = total transmission path loss between transmit and receive antennas (dB)

Gr = gain of receiving antenna in the azimuth towards the transmitter (dBi)

Lr = feeder/branching losses associated with the receiver (dB)

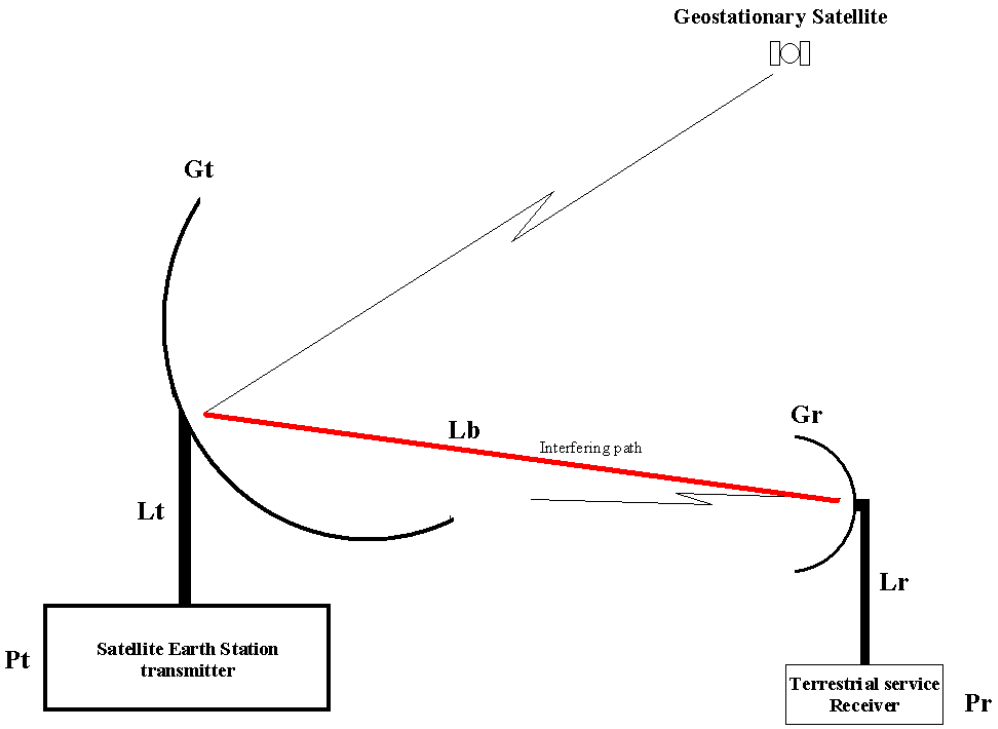


Figure 15 – This shows a simplified interference scenario between a terrestrial service and a SES at a known azimuth/elevation angle when communicating with a geostationary satellite. It also shows losses and gains to be considered

6.3.2 Antenna angle and discrimination

When assessing an interference scenario involving a FSS and a terrestrial service the Approved Person must consider the following:

Compound angle

The discrimination angle between a SES antenna and a terrestrial service involves both azimuth and elevation making it a compound angle. The compound angle must be used to give the true angle to derive the antenna discrimination figure.

Antenna discrimination for SES antennas

The antenna discrimination for SES antennas are derived using Recommendation ITU-R S.465.

Antenna discrimination for Fixed Service antennas

The antenna discrimination for fixed service antennas is derived by sourcing the RPE for the antenna specified on the Register licence record of the fixed service in question.

6.4 Co-channel interference criteria

When evaluating potential interference to and from terrestrial services, the calculated co-channel interfering signal must be at least:

- 6 dB below the receiver noise floor of the victim terrestrial receiver; and
- 10 dB below the receiver noise floor for satellite earth station receivers.

A co-channel interferer is deemed to exist in any situation in which the bandwidths of the victim receiver and interfering transmitter (as defined by their centre frequencies and channel bandwidths) overlap in part or in full.

6.5 Adjacent channel interference criteria

Approved Persons will adjust the interferer to account for the frequency offset between the victim and interfering services. This adjustment factor is known as the frequency dependent rejection (FDR). In the absence of a more rigorous procedure a nominal set of conservative FDR's are in Table 17.

Table 17 – Frequency dependent rejection for Satellite Services

Channel offset	Frequency Dependent Rejection (FDR)
Co-Channel	0 dB
1st Adjacent Channel	30 dB
2nd Adjacent Channel	50 dB
> 2nd Adjacent Channel	Consideration not required

The "edge-to-edge frequency separation" between the emission bandwidths of victim and interfering services is used to determine the "channel offset". A "step distance", being equal to the wider of the two emission bandwidths, is defined and applied as follows:

- Where the two emission bandwidths overlap, the co-channel FDR value (zero) is used;
- Where the edge-edge separation between the two emission bandwidths is 0 to less than 1 "step distance" then the 1st adjacent FDR value is used;
- Where the edge-edge separation between the two emission bandwidths is 1 to less than 2 "step distances" then the 2nd adjacent FDR value is used; and
- Where the edge-edge separation between the two emission bandwidths is equal to or greater than 2 "step distances" adjacent channel interference is not assessed.

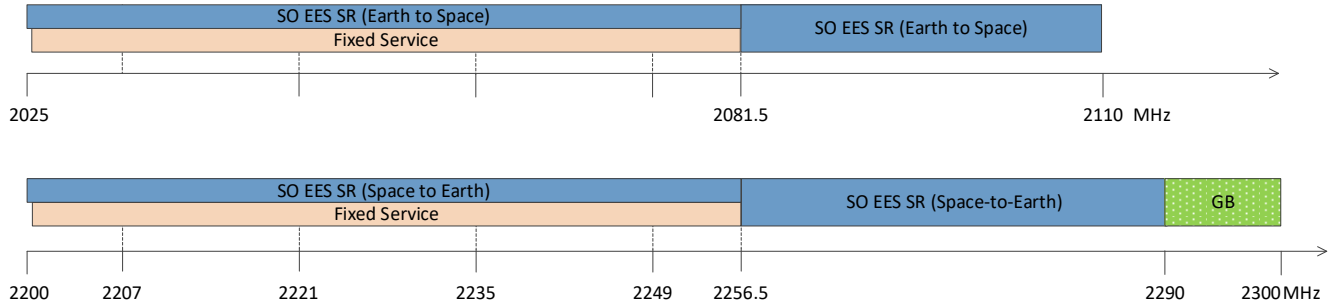
For further information, refer to Appendices

Appendix A: Co-channel and adjacent channel relationship.

6.6 Space service coordination with terrestrial service

6.6.1 Space service in S-band sharing with terrestrial service

The lower part of the band 2 025–2 110 MHz/2 200–2 290 MHz is shared use between space and fixed service.



2025 – 2081.5 MHz and 2200 – 2256.5 MHz is on a sharing use between terrestrial and non-terrestrial service
2081.5 – 2110 MHz and 2256.5 – 2290 MHz is exclusivity allocated to non-terrestrial service

Figure 16 – 2 025–2 110 / 2 200-2 290 MHz band plan

2 025.0-2 081.5 MHz and 2 200.0-2 256.5 MHz is available for shared use between space and fixed services.

2 081.5–2 110.0 MHz (Earth-to-space) and 2 256.5–2 290.0 MHz (space-to-Earth) are allocated to the space service exclusively.

6.6.2 Earth Station transmitter requirement

For space services sharing frequency bands above 1 GHz with terrestrial service, IRR Article 21 provides a set of rules for space earth stations to allow sharing to take place.

EIRP limits for earth stations

Power flux spectral density (EIRP / reference bandwidth) transmitted in any direction towards the horizon shall not exceed the limits in Table 18.The limits are derived from Article 21.8 of the IRR.

Table 18 – EIRP limits derived from Article 21.8 of the IRR

Band	Elevation angle $\theta \leq 0^o$	Elevation angle $0^o < \theta \leq 5^o$
Between 1 GHz and 15 GHz	40 dBW in any 4 kHz band	40 dBW + 3xθ in any 4 kHz band
Above 15 GHz	64 dBW in any 1 MHz band	64 dBW + 3xθ in any 1 MHz band

Where:

θ = the angle of elevation of the horizon viewed from the centre of radiation of the antenna of the earth station, and measured as positive above the horizontal plain and negative below.

In addition to Article 21 of the IRR, SES's operation in the frequency range of 2 025.0 – 2 081.5 MHz should not exceed an EIRP of 27 dBW / 100 kHz towards horizon (θ = 0°).

Minimum angle of elevation of earth stations

Earth station antennas shall not transmit at elevation angles of less than 3° measured from the horizontal plane to the direction of maximum radiation. Earth station antennas in the space research service (near Earth) shall not be employed for transmission at elevation angles of less than 5°, and earth station antennas in the space research service (deep space) shall not be employed for transmission at elevation angles of less than 10°, both angles being those measured from the horizontal plane to the direction of maximum radiation.

6.6.3 Earth Station receive coordination zone

There are a number of coordination zones allocated for space services with the following parameters:

1. Each coordination zone is centred on a point location, as shown in Table 19;**Error! Reference source not found.**
2. Each coordination zone has a radius of 2 km from that point location; and
3. The coordination frequency range is 2 200 – 2 290 MHz.

The permissible interference level from terrestrial services in 2 200 – 2 290 within the coordination area shall be less than -154 dBW/MHz[13].

Table 19 Satellite Earth Station receive protection zones

Location Name	Geo-reference (NZGD2000/WGS84)	Protection area radius (km)
Warkworth Earth Station	-36.43235 174.66834	2
Awarua Earth Station	-46.52864 168.37913	2
Mahia Peninsula	-39.24054 177.87585	2

[13] The permissible interference power and calculation parameters are derived from ITU Radio Regulation 2020 Appendix 7 Table 8b "Parameters required for the determination of coordination distance for a receiving earth station".

7. Other Services

7.1 Aeronautical services

Aeronautical services have been identified by the ITU and most Aeronautical Services are covered by the General User Radio Licence for Aeronautical Purposes (GURL AP). Where a service is not coved by a General User Radio Licensing, individual licensing is required.

Table 20 - Licence codes for radio licences for aeronautical services

Type	Licence Code	Remarks
Aeronautical Land	A5	Aeronautical Base – for control of airspace at international, domestic (served by scheduled airlines) and military airports.
Aeronautical Land	A6	Other aeronautical bases, such as aero clubs, companies, farm strips etc.
Repeater	A8	

7.1.1 Route and off-route frequencies

Frequencies allocated in the IRR for aeronautical communications are separated into two groups:

1. **Route:** An aeronautical mobile service reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes; and

2. **Off-route:** An aeronautical mobile service intended for communication, including those relating to flight co-ordination, primarily outside national civil air routes.

On route and off route frequency bands are identified within ITU-R Recommendations. Frequencies for specific purposes such as surface movements[14], repeaters, ballooning, fish spotting, etc., have and are listed in the General User Radio Licence for Aeronautical Purposes (GURL-AP) on the RSM website www.rsm.govt.nz.

Approved Persons may conduct engineering analysis for licences for both route and off-route services, however all licence applications for aeronautical mobile services will be referred to the Civil Aviation Authority (CAA) for approval via the Register.

Interference threshold

Interference analysis must be conducted in accordance with the requirements of Annex 10 to the Convention on International Civil Aviation.

[14] Surface movement is otherwise known as ground movement control and relates to voice communications between air traffic control and people, vehicles and aircraft in the airport perimeter.

7.2 Maritime services

Maritime services have been identified by ITU and most Maritime Services are covered by the General User Radio Licence for Maritime Purposes (GURL MP). Where a service is not coved by a General User Radio Licensing, individual licensing is required.

In the GURL-MP, some schedules designate the use of channels. Approved Persons must refer to these schedules when considering certification of radio licences.

7.2.1 Coast stations

Remotely activated VHF land based coast stations, coast stations below 30 MHz and all repeaters are excluded from the GURL-MP, and must be individually licensed.

For licence applications that include a repeater channel that already is licensed to another licensee in the area, the applicant must supply a letter from the current licensee that gives permission to the new applicant for use of the channel. A copy of this letter must be uploaded to the Register against the licence or application and retained by the Approved Person for auditing.

The coast station licence shall include the following conditions:

> *"Use of channel MMXX, LOCATION, TOPO50 GRID REFERENCE is permitted only when authorised by the licensee of the repeater: NAME OF LICENCE, NAME OF REPEATER."*

Any application requesting a simplex channel (or channels), or more than one duplex channel, will be assigned channel MM16 and the licensee will be required to equip the apparatus to operate on this channel for distress and safety purposes. Where the apparatus has digital selective calling facilities, the applicant needs a Maritime Mobile Service Identity (MMSI) code to enable this facility. RSM will issue an appropriate code number.

Interference threshold

Coast stations frequencies / channels are shared and often users want particular channels to communicate among each other. Approved Persons shall identify a suitable channel by taking into account issues such as the following:

- Individual channel loading;
- Co-ordinate between other areas where nominated service areas overlap; and
- Technical, equipment and licensee constraints.

7.2.2 Repeaters

Interference threshold

The interference threshold for maritime repeaters is the same as for land mobile repeaters. Refer to section 4.5 Repeaters.

7.3 Personal Radio Services Repeaters

Personal Radio Services (PRS), also known as UHF Citizen Band 476.425-477.400 MHz, has a number of simplex and two frequency repeater channels allocated. Simplex PRS operation is covered under the General User Radio Licence for Citizen Band Radio (GURL-CB) and does not require additional licensing action.

The two frequency repeater channels must be individually licensed for a specific fixed location and in accordance with PIB 58. The interference threshold for PRS repeaters is the 100 km separation rule specified in PIB 58.

General User Radio Licence for Citizen Band Radio (GURL-CB)

Radio Licence Policy Rules (PIB 58)

7.4 Radio paging

Radio paging is a one way radio service that broadcasts a short message within its coverage area. The service consists of infrequent data messages broadcast to receive-only mobile equipment. Paging services are licensed for a single fixed location and should use unique addressing to ensure that pagers receive only their intended messages. Paging is often used in complexes such as hospitals.

View Mobile service bands in New Zealand (PIB 23).

7.4.1 Local area radio paging

This is the most common type of radio paging. Due to the 7 dBW EIRP restriction on power, it is most suited to complexes such as hospitals, factories, etc. Local area paging is a shared service, as a channel can be shared among multiple licensees in an area.

Interference threshold

Local area paging is shared with no interference threshold or protection and it is expected that users may experience some level of interference. Interference can be "self-managing" due to the infrequent transmissions and unique addressing. Approved Persons shall identify a suitable channel by taking into account issues such as the following:

- Individual channel loading;
- Co-ordinate between other areas where nominated service areas overlap;
- The use of unique addressing; and
- Technical, equipment and licensee constraints.

7.4.2 Wide area radio paging

Wide area paging is a paging system used to broadcast paging messages to a wide area. This paging band is 157.6 MHz to 158.07 MHz, and is adjacent to the international VHF Maritime mobile band. Where the coverage areas of both services overlap the potential exists for intermodulation interference to occur in the maritime receiver.

Power calculations

It is expected that Approved Persons will allocate the minimum required power to provide required reception within the coverage area. The maximum power that can be allocated to a wide area paging transmitter is 23 dBW EIRP.

Coverage

The coverage of wide area paging is considered to be a continuous contour at -95 dBm. Anything below -95 dBm or outside the continuous coverage is considered fortuitous coverage. Fortuitous coverage is not protected from interference. A further description of coverage can be found in section 4.5.1 Coverage.

Interference threshold

The interference threshold for wide area paging is -106 dBm.

Inward interference

When assessing inward interference an existing transmitter must not put a signal higher that -106 dBm into the coverage area of the proposed service.

Outward interference

When assessing outward interference from the proposed wide are paging service must not put a signal greater than or equal to -106 dBm into the coverage of any other wide area paging system or radio reporter system.

Intermodulation

Approved Persons must conduct an assessment to ensure that the potential for intermodulation in maritime receivers is reduced. The requirement is that the paging transmitter's mean field strength shall not exceed 77 dBµV/m measured at a reference height of 10 metres above sea level within any of the following areas (where appropriate):

1. Otago Harbour VHF Maritime Protection Area;
2. Lyttelton Harbour VHF Maritime Protection Area;
3. Greymouth VHF Maritime Protection Area;
4. Picton VHF Maritime Protection Area;
5. Nelson VHF Maritime Protection Area;
6. Wellington Harbour VHF Maritime Protection Area;
7. Auckland VHF Maritime Protection Area;
8. Napier VHF Maritime Protection Area; and
9. Tauranga VHF Maritime Protection Area;

These areas are defined in the Register as multipoint locations. It is expected that where a proposed wide area paging service coverage area overlaps one of these areas that a full analysis proving that this requirement can be meet.

Licensing

Licences should contain all details about transmitter and antenna. Licences must have the following condition on them:

'The transmissions that this licence permits shall not exceed a mean field strength of 77 dBµV/m at a reference height of 10 metres above sea level within any of the following areas:

1. Otago Harbour VHF Maritime Protection Area;
2. Lyttelton Harbour VHF Maritime Protection Area;
3. Greymouth VHF Maritime Protection Area;
4. Picton VHF Maritime Protection Area;
5. Nelson VHF Maritime Protection Area;
6. Wellington Harbour VHF Maritime Protection Area;
7. Auckland VHF Maritime Protection Area;
8. Napier VHF Maritime Protection Area; and
9. Tauranga VHF Maritime Protection Area.

Appendices

Appendix A: Co-channel and adjacent channel relationship

There are many possible frequency relationships between the interfering transmitter (culprit) and service receiving the harmful interference (victim). The case where the culprit and victim channels partly overlap illustrates the three main mechanisms for interference. The level of the total interference is the sum of all power from each of the three interference mechanisms, calculated in terms of the power entering the receive pass-band.

The first of the three interference mechanisms is *co-channel interference* (CCI). The other two are two separate mechanisms of *adjacent channel interference*, one due to the culprit transmitter ACLR, and the other due to the victim receiver filter's adjacent channel selectivity (ACS). The three mechanisms are:

(a) I_{CCI} Co-channel interference (CCI);

(b) $I_{ACLR-Tx}$ Interference from the ACLR of the culprit transmitter; and

(c) I_{ACS-Rx} Unwanted adjacent channel reception by the victim receiver, due to its ACS

In cases where the culprit and victim channels overlap totally, CCI becomes dominant, and when their channels do not overlap, one or both of the two adjacent channel interference mechanisms become dominant. Note that in interference analysis, the term "adjacent channel interference" is not restricted to the immediately adjacent channel in the channel raster of the victim's system, but includes any range of spectrum which lies outside the victim's channel.

Where the culprit and victim channels partly overlap, all three mechanisms may contribute similar levels of interference, and their aggregate will need to be analysed. The case of partly overlapping channels is illustrated in the following Figure 17 showing the areas of interference mechanisms: (a), (b) and (c).

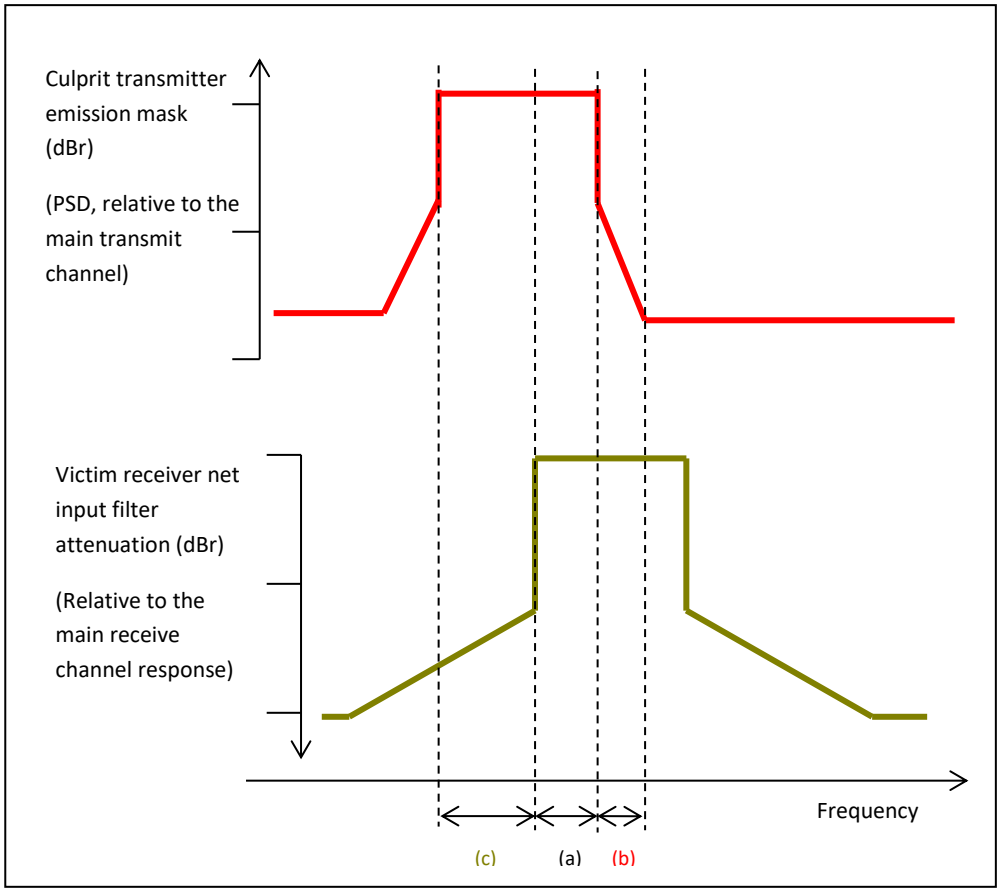


Figure 17 - Example showing areas of three types of interference mechanism.

The first two interference mechanisms: (a) I_{CCI} and (b) $I_{ACLR\text{-}Tx}$ clearly represent interference power within the pass-band of the victim receiver; however it may be less obvious than the interference power due to the third mechanism. The third interference mechanism (c) $I_{ACS\text{-}Rx}$ also represents unwanted power in the receive pass-band because it is power affecting the receiver demodulator. $I_{ACS\text{-}Rx}$ is calculated as the product of the received power of the unwanted signal in the unwanted channel, times the rejection ratio of the receiver's net filter response to that channel, known as ACS. Because these interference powers all occur or are equivalent to power within the receive pass band, their net effect can be determined by addition in the linear domain.

Appendix B: Fixed service antenna compliance requirements

This appendix sets out the compliance requirements for antennas used in point-to-point microwave fixed service frequency bands. The objective is to ensure that antennas with the acceptable performance are always used.

Antenna compliance is determined by reference, to the antenna front-to-back (F/B) ratio and antenna cross-polar discrimination (XPD) stated by the product manufacturer. These values are then compared to **Error! Reference source not found.** which provides the minimum acceptable antenna performance requirements based on F/B ratios and XPD for each band. In the event that the manufacturer's stated F/B or XPD figures do not accord with the values obtained from the manufacturer's published RPE, the values contained in the RPE shall take precedence.

Minimum antenna performance requirements

Licensees are required to use antennas with characteristics that meet or exceed those specified in Table 21. In some instances, in order to achieve coordination in a difficult area, RSM may require that antennas with performance exceeding that specified in Table 21 be used in order to facilitate coordination and maximise spectrum utilisation.

The minimum antenna requirements depend on the location of the fixed service:

- Within Defined Metropolitan Areas (DMAs), point-to-point fixed service antennas must meet the minimum XPD performance and the minimum F/B ratio set out in the "Type 2" column of Table 21.
- Outside Defined Metropolitan Areas (DMAs), point-to-point fixed service antennas must meet the minimum XPD performance and the minimum F/B ratio set out in the "Type 1" column of Table 21**Error! Reference source not found.**.

The DMAs are: Auckland; Hamilton; Tauranga; Palmerston North; Wellington; Christchurch; and Dunedin. The DMAs are specified in as circles of specified radius around a nominated location.

Table 21 – Minimum acceptable antenna performance requirements

NZ Band	Band GHz	XPD (min) dB	Type 1 F/B (min) dB	Type 2 F/B (min) dB
LL	1.5	25	25	30
2 GHz	2	25	25	30
5 GHz	5	30	60	60
6 GHz	6	30	60	60
7 GHz (Lower)	6.7	30	60	60
7 GHz (Middle and Upper)	7.5	30	60	60
8 GHz (Lower and Upper)	8	30	60	60
10 GHz	10	30	45	55
11 GHz	11	30	60	60
13 GHz	13	30	45	60
15 GHz	15	30	45	60

NZ Band	Band GHz	XPD (min) dB	Type 1 F/B (min) dB	Type 2 F/B (min) dB
18 GHz	18	30	45	55
23 GHz	22	30	45	55
38 GHz	38	30	45	55
50 GHz	50	30	45	55
80 GHz	80	30	45	55

The "Types" of antennas as defined are differentiated on the basis of their F/B ratio. Essentially, standard (STD) antennas are Type 1 and high performance (HP) antennas are Type 2.

Note 1: The use of parabolic antennas is assumed in deriving the values included in Table 21. Other types, such as 'patch' antennas, may be used if they conform to the requirement of having a single main axis of radiation and they meet the other relevant criteria specified for each band.

Table 22: Defined Metropolitan Areas (DMAs)

Location	NZTopo50	NZTM2000		Radius (km)
		Easting	Northing	
Auckland	BA32 576 203	1757564	5920302	40
Wellington	BQ32 580 353	1757978	5435286	30
Christchurch	BX24 710 804	1570999	5180388	15
Dunedin	CE17 062 174	1406208	4917351	15
Hamilton	BD33 008 154	1800755	5815371	15
Palmerston North	BM34 220 293	1821988	5529295	15
Tauranga	BD37 788 235	1878779	5823498	15

Note 1: The geodetic datum for the coordinate specified in Table 22 is NZGD2000 / WGS84.

Coordination Requirements

RSM requires that frequency coordination studies be performed using manufacturers actual antenna RPE data for all proposed new services and for existing services, whenever the make and model of the antennas of existing services are identifiable and the relevant RPE is available.

An Approved Person can create new antenna records in the Register. The Approved Person must enter the following details into the Register:

- Make and model;
- Type;
- Low frequency;
- High frequency;
- Low band gain;
- Mid band gain;
- High band gain;

- Beam width;
- Front to back ratio;
- Size; and
- Cross polar discrimination.

For assignments that were licensed prior to the introduction of these antenna regulatory arrangements, manufacturers' RPE data may not be available. In such cases, the use of the reference radiation pattern described in Recommendation ITU-R F.699 is to be used.

Links Crossing DMA boundaries

Fixed service point-to-point microwave links, where both ends of a link are outside Defined Metropolitan Area (DMA), will not be considered to be within the DMA even if the path partially crosses a DMA. However, if one end of a link is located inside a DMA and the other is outside, then both ends of the link will need to conform to the requirements for antennas within the DMA for that band.

Re-use of existing antennas

It is not intended that the antenna requirements of this Appendix be applied retrospectively, i.e. there is no requirement for the existing antennas of existing licensed services to be upgraded if they do not currently comply with these Appendix B: Fixed service antenna compliance requirements. However, the intent of this Appendix in the long term is to bring all antennas up to this standard, therefore the redeployment of old non-complying antennas will not be permitted.

Redeployment in this context means the reuse of an antenna on any path other than the path on which it is currently licensed and operating. Reorienting a link by changing the location of just one end therefore constitutes redeployment. Redeployment in this context involves the physical moving of an antenna and involves cost or effort beyond the cost of the antenna itself. Amendments to licences that do not involve the physical relocation or re-orientation of existing non-compliant antennas will be permitted.

Appendix C: Reference documents

PIB 21 '*Table of Radio Spectrum Usage in New Zealand'*

PIB 22 *'Fixed Service Bands in New Zealand'*

PIB 23 *'Mobile Service Bands in New Zealand'*

PIB 34 *'Approved Radio Engineers & Approved Certifiers'*

PIB 40 *'Audit Procedures for Engineering Certificates'*

PIB 58 *'Radio Licence Policy Rules'*

ITU-R International Radio Regulations (IRRs)

Radiocommunications Act 1989 (the Act)

Radiocommunications Regulations 2001 (the Regulations)

ITU-R Handbook – *'Digital Radio-Relays Systems'*, ITU-R, Geneva 1996

ITU-R Reports and Recommendations

Annex 10 to the convention on International Civil Aviation (ICAO Annex 10)

Appendix D: Certificate

Radio Licence Certificate for Licence ID XXXXXX

Certificate Issued Pursuant to Regulation 12(2) of the Radiocommunications Regulations 2001

I, XXXXXXXXXX XXXXXXXX, Approved Radio Engineer, having regard to -

a. the International Radio Regulations; and

b. the ITU-R reports and recommendations; and

c. Annex 10 to the Convention on International Civil Aviation; and

d. the International Convention for the Safety of Life at sea; and

e. the nature of the service proposed to be operated under the radio licence; and

f. publication PIB 38 issued by the Chief Executive

but not having regard to the reception of radio waves by inappropriate receivers

hereby certify that in my opinion the authority to transmit radio waves conferred by the radio licence to which this certificate relates, being the radio licence identified by **licence ID XXXXXX**

a. will not endanger the functioning of any radionavigation service; and

b. will not endanger the functioning of any radio service essential to the protection of life or property; and

c. will not cause harmful interference to rights conferred by registered spectrum or radio licences; and

d. is technically compatible with services authorised to be operated under existing spectrum licences and

e. radio licences; and

f. will sufficiently define the nature and characteristics of the proposed transmissions to enable subsequent spectrum licences and radio licences to be co-ordinated for the purpose of avoiding harmful interference

Approved Radio Engineer Number: ARXXXX

Dated: XX-XXX-XXXX