RADIO SPECTRUM MANAGEMENT

Spectrum Licence Certification Rules for Crown Management Rights (PIB 39)

Engineering Rules and Information for Approved Radio Engineers

Issue 8.7 | April 2024

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

New Zealand Government

Contents

1. Introduction

1.1. Contents

This Public Information Brochure 'Spectrum Licence Certification Rules for Crown Management Rights (PIB 39)', specifies the requirements for the certification of spectrum licences for sound broadcasting, television broadcasting and fixed wireless access services (including regional broadband use) in Crown management right frequency bands. Such licences must also meet the requirements of the Radiocommunications Act 1989 (the Act) and its amendments. These rules are made by virtue of the Crown's ownership of the management rights.

Approved Radio Engineers are required to comply with these Rules when certifying spectrum licences relating to Crown management rights.

These Rules do not represent the entirety of the knowledge and expertise that an approved person must have when determining technical compatibility.

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 39).

1.3. Changes

Radio Spectrum Management (RSM) may change, delete or add to or otherwise amend information contained in the document from time to time to reflect evolving policies. 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 ambiguity to these Spectrum Licence Certification Rules. Such matters may be emailed to radio.spectrum@mbie.govt.nz. Correspondence received will be acknowledged, investigated and appropriate action taken.

1.5. Abbreviations and definitions summary

Abbreviation	Definition
3GPP	Third Generation Partnership Project
4G-LTE	Fourth-Generation Long-Term Evolution
5G-NR	Fifth-Generation New Radio
AFEL	Adjacent Frequency Emission Limit, applying to management rights
ARE	Approved Radio Engineer
BWA	Broadband Wireless Access
CPE	Customer Premise Equipment (used in the context of FWA services)
EIRP/E.I.R.P./e.i.r.p	Equivalent isotropic radiated power
ETSI	European Telecommunications Standards Institute
Eu	Usable Field Strength (use for MF-AM sky wave calculations)
FDD	Frequency-Division Duplex
FWA	Fixed Wireless Access
IRR	International Radio Regulations
GMDSS	Global Maritime Distress and Safety System
GURL-ET	General User Radio Licence for Emergency Transmitters
GURL-LPFMBC	General User Radio Licence for Low Power FM Broadcasting
IEEE	Institute of Electrical and Electronics Engineers
ITU	International Telecommunications Union
LINZ	Land Information New Zealand
MFS	Minimum Field Strength (use for protection location in the case of DTT)
MPIS	Maximum Permitted Interfering Signal
MR	Management Right
MSP	Managed Spectrum Park
MUFS	Minimum Usable Field Strength (use for FM and in the case of MF-AM, use for ground wave calculations)
NDB	Non-directional Beacon
OFDM	Orthogonal Frequency-Division Multiplexing
PF	Power Floor, applying to management rights
PL	Protection Limit, applying to management rights
PR	Protection Ratio (ratio of wanted to unwanted receive signal)
RL	Radio Licence
RSM	Radio Spectrum Management

Abbreviation	Definition
RRF	Register of Radio Frequencies
SAR	Search and Rescue
SL	Spectrum Licence
TDD	Time-Division Duplex
the Act	Radiocommunications Act 1989
The Ministry	The Ministry of Business, Innovation and Employment
The Regulations	Radiocommunications Regulations 2001
UEL	Unwanted Emissions and Unwanted Emission Limit, applying to spectrum licences.
UFS	Unwanted Field Strength (for interference analysis)
WFS	Wanted Field Strength (for interference analysis)

1.6. Amendment History

Issue	Date	Description of Amendment	Authorised by
1	28 September 2004	• Compilation of information for issue 1	
2	5 May 2005	• Editorial amendments (non-technical)	
3	January 2010	• Substantial revision	
4	October 2010	• Change to New Zealand TOPO50 • Corrected management right numbers and frequency limits • Added rule to allow licences to be certified in the presence of a crown reservation under certain conditions • Editorial amendments (non-technical)	
5	September 2014	• Update to section 2.2 Intermodulation. • Update to section 3.3 Aeronautical Radio Navigation • Updated section 3.4 Digital Television due to digital switch over • General editorial amendments	Len Starling
6	May 2015	• Addition of a new section 3.6 Television whitespace • Addition of a new section 3.7 Managed Spectrum Park (MSP)	Len Starling

Issue	Date	Description of Amendment	Authorised by
6.1	August 2016	• Removed the references to paper based form 7 and 8 • Editorial amendments including: Updating of Appendix numbering and Revision of table numbering • Added abbreviation and definition summary in Section 1 • Changed Introduction heading to Radio Spectrum • Reformatted headings, captions, and body text • Created links to some documents mentioned	Len Starling
7	August 2018	• Addition of Land Mobile Radio (LMR) rules new content in section 2.13 and new section 4.7 • Addition of an ITU-R Recommendation for propagation • Editorial amendments	Len Starling
8	February 2020	• Additional detail added around FM sound broadcasting synchronous licences and licences with frequency separation < 800 kHz • Modifications to Emission Designators in the G band for LMR use	Len Starling
8.1	March 2020	• Updated TV White Space section 4.5.2 to refer to MR 364 (commencement date 12 March 2020)	Len Starling
8.2	April 2023	• Addition of a new section 4.7 describing the Regional Broadband Use rules in 3.3 GHz • Addition of Appendix 10 outlining the Primary/Default Technical Conditions for 3 300 – 3 800 MHz frequency band • New content in section 3.10 to section 3.13 • Addition of relevant ITU-R Recommendations and 3GPP Technical Standards/Reports applicable to broadband access and relevant propagation models applicable to the 3 300 – 3 340 MHz frequency range • Editorial amendments	Daniel O'Grady

Issue	Date	Description of Amendment	Authorised by
8.3	May 2023	• Addition of "UEL for the FWA Base Station" in section 4.7 describing the Regional Broadband Use rules in 3.3 GHz • Editorial amendments	Daniel O'Grady
8.4	July 2023	• Updates to "Licence Authorisations" in section 4.7 describing the Regional Broadband Use rules in 3.3 GHz	Daniel O'Grady
8.5	August 2023	• Updates to the calculations under "Coverage" and simplification of text under "MPIS Level Determination" in section 4.7 describing the Regional Broadband Use rules in 3.3 GHz • Additional advice provided on defining coverage area in section 4.7 • Editorial amendments	Daniel O'Grady
8.6	November 2023	• Editorial amendments to reflect current MR bands. • Deletion of rules following expiry of VHFLMR management right	Daniel O'Grady
8.7	April 2024	• Amendment of 3.3 GHz to 3.34 GHz Regional Broadband Use rules in section 4.7, particularly with respect to the change to the licencing process in May 2024, but also including further criteria under the "Protection Areas" heading in 4.7.2 Engineering • Closure of the TV White Spaces (TVWS) interim licensing regime in section 4.5 • Editorial amendments	Daniel O'Grady

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2. General

2.1. Purpose

This Spectrum Licence Certification Rules for Crown Management Rights (PIB 39)(Rules) outlines the requirements of the Ministry of Business Innovation and Employment (the Ministry), acting as the Manager of the relevant Management Rights. These requirements must be followed when certifying new and modified spectrum licences in Crown management rights. These management rights are currently used for sound and television broadcasting services, and fixed wireless access services.

These rules include regulatory, policy and engineering aspects that an RSM Approved Radio Engineer must consider when undertaking engineering activities associated with the preparation and certification of spectrum licences in Crown management right bands.
The rules also include discussion of regulatory licensing matters and broadcasting processes, but do not purport to provide legal advice on the Act. Readers should take independent legal advice on such matters.
Where these rules include information on policy matters, they should be read in conjunction with Spectrum Licence Policy Rules for Crown Management Rights (PIB 59) If there appears to be a conflict between these rules and PIB 59, other matters that require clarification, email radio.spectrum@mbie.govt.nz.

These rules do not include all the engineering knowledge and expertise that an ARE requires for the preparation and certification of spectrum licences in Crown management right bands.

The rules may change from time to time and any new or modified licence registered shall be certified in accordance with the rules current at that time. Changes to the rules will not apply to spectrum licences certified and registered prior to those changes.

2.2. Radio Spectrum Management

The Ministry's Radio Spectrum Management role includes:

- Ensuring that use of the radio spectrum is economically, and technically efficient
- establishing and managing the regulatory aspects governing spectrum use
- planning spectrum allocation
- managing radio and spectrum licensing functions, including licence registration
- minimising interference to and from licences
- prescribing technical planning requirements for spectrum use
- managing the New Zealand government's radio spectrum international treaty obligations
- managing spectrum management rights reserved for assignment by the Crown.

A spectrum licence submitted for registration in Crown management rights must be certified by an ARE in accordance with the requirements of section 25(5) of the Act. In particular, a licence submitted must be technically compatible with existing radio licences and spectrum licences recorded in the Register of Radio Frequencies (the Register).
In these Rules:

- Section 2 outlines regulatory, policy and administrative issues common to radio frequency bands for which management rights have been created.

- Section 3 provides technical rules and related information common to the certification requirements for AM, FM and digital television broadcast bands, and Fixed Wireless Access (FWA) bands, including regional broadband use.
- Section 4 gives requirements for the particular services in bands under Crown management rights. It includes certification requirements, coordination processes and other information.
- The Appendices set out technical details and examples relevant to the content of the Rules.

2.3. Act, Regulations and Forms

Act and Regulations

The Act provides the contents, certification requirements, registration requirements and associated rules for spectrum licences and related matters. The Radiocommunications Regulations 2001 (the Regulations) contain requirements prescribed by Order in Council.

- The Radiocommunications Act (1989)
- The Radiocommunications Regulations (2001)

Forms

Schedule 7 of the Regulations prescribes the forms for the purposes of registering new spectrum licences (Form 7), their modification (Form 8), their transfer (Form 9) and cancellation (Form 10). Other Schedule 7 forms include matters such as spectrum licence mortgages, caveats and consents.

2.4. Interpretation, Terminology and Definitions

The interpretation and terminology contained in this document shall have the meanings as defined in the:

- Radiocommunications Act (1989) and its amendments
- Radiocommunications Regulations 2001 and its amendments
- International Radio Regulations (IRR) and ITU-R Recommendations
- Convention of International Civil Aviation (ICAO).

Terminology commonly used in this document and for which legal definitions are included in section 1 of the Act, include:

- Adjacent Frequency Emission Limit (AFEL), applying to management rights
- Co-channel emissions
- Equivalent isotropic radiated power (e.i.r.p)
- Interference, harmful interference and interfering equipment
- Power Floor (PF), applying to management rights
- Protection Areas (which includes Protection Locations, both applying to spectrum licences)
- Protection Limit (PL), applying to management rights
- Unwanted Emissions and Unwanted Emission Limit (UEL), applying to spectrum licences.

Some of these terms are shown diagrammatically in Appendix 1: Terminology for Management Right Spectrum Parameters of this document.

Particular definitions regarding the services outlined in this document are as follows:

- Broadcasting, as defined in the Broadcasting Act 1989, means any transmission of programmes, whether or not encrypted, by radio waves or other means of telecommunication for reception by the public by means of broadcasting receiving apparatus but does not include any such transmission of programmes:
    - made on the demand of a particular person for reception only by that person
    - made solely for performance or display in a public place.
- Fixed Wireless Access (FWA) services means short and medium range fixed radio services that can provide an alternative to cable reticulation services suitable for voice and internet communications.
- Broadband Wireless Access (BWA) services means short and medium range fixed and mobile radio services suitable for voice, internet and video communications.

The terms wanted signal and unwanted signals used in these Rules generally refer to the signals produced by the wanted transmitter and interfering transmitters respectively. Unless specified otherwise in later sections of this document, the definitions on transmitter spectra and bandwidths including necessary bandwidth, occupied bandwidth, out-of-band emissions, spurious emissions and unwanted emissions are given in the ITU-R International Radio Regulations, **1.152**, **1.153**, **1.144**, **1.145**, **1.146**, **1.146A**, **1.146B** and **1.147**. Details of these emission parameters, where applicable, can be found in the ITU-R Recommendations SM.328 and SM.329.

The Register of Radio Frequencies is the legal repository for records of all management rights and spectrum licences as required in section 5 of the Act. The Register of Radio Frequencies is also the name of an online database system, which includes: the formal Register, associated reference data, radio spectrum client records and facilities for record maintenance, licence billing and payment, licence application and assignment, and other administration and information facilities. These records are accessible through the RSM website www.rsm.govt.nz.

Some facilities are accessible by the general public and others are available only to AREs and clients via a username and password.

2.5. Crown Management Rights

The requirements of this document apply to all frequencies within the management rights used for AM and FM radio and digital television broadcasting, and FWA management rights, one of which is administered as a Managed Spectrum Park. The frequency bands for these services are defined in the Table of Radio Spectrum Usage in New Zealand (PIB 21) and summarised in table 1.

Table 1: Crown Management Right Frequency Bands

Management Right	Service	Frequency Band
MR 206	MF – AM Sound Broadcasting	521 – 1,612 kHz
MR 207	VHF – FM Sound Broadcasting	88.4 – 106.63 MHz
MR 364	UHF – TV Television Broadcasting	510 – 606 MHz
MR 363	UHF – TV Television Broadcasting	622 – 703 MHz
MR 258	Managed Spectrum Park	2 575 – 2 620 MHz
MR 514	Fixed Wireless Access (for Regional Broadband Use up to 3 340 MHz)	3 300 – 3 3 400

The 606 – 622 MHz (MR 369, channels DTV 38 – DTV 39) frequency range is allocated for Māori Television Broadcasting. The management right for this frequency range is owned by Te Mātāwai.

Parameters for the management rights can be located in the Register and using “Search - Licences” and “Search - Management Rights”.

Band plans for Crown management rights which are used for broadcasting purposes can be found in Crown Management Right Band Plans (PIB 24).

2.6. Policies for Spectrum Licences in Crown Management rights

The Spectrum Licence Policy Rules for Crown Management Rights (PIB 59) prescribes operational policy rules and the associated processes for new and modified spectrum licences issued in Crown management rights that must be completed before the licences will be approved for registration under the Act. All spectrum licence applications being presented for granting in Crown management rights must comply with PIB 59.

2.7. Ministry Processes for Engineered Spectrum Licences

Spectrum licence Form 7s (new licences) and Form 8s (modified licences) for registration in Crown management rights, that have been engineered by AREs, are received by RSM and checked to ensure compliance with the current policy requirements, outlined in PIB 59 and/or to determine resource value payments for new and modified licences.
Applications for the registration of spectrum licence instruments received by RSM shall include:

- any applicable fees,
- a completed online Form 7 (spectrum licence) or Form 8,
- a certificate from an ARE.

Instruments received by RSM that are appropriately completed, meet the policy requirements, and are accompanied by resource payments (if appropriate) will be transferred to the Registrar of Radio Frequencies for registration. Those not meeting the requirements are returned to the applicant. Should any of these forms raise issues not currently addressed in these rules they will be discussed with the applicant.

Instructions for presenting a spectrum licence instrument for registration are available on the RSM website.

2.8. Types of Spectrum Licence

Section 48(1) of the Act specifies that there are three types of spectrum licence that "Where a manager (of management right) intends to reserve for himself or herself or grant to any other person -

(a) the right to transmit on a frequency band, and the right to have no harmful interference from co-channel emissions in the protected area on the frequency band within the range of frequencies specified in the manager's record of management rights; or

(b) the right to transmit on a frequency band within the range of frequencies specified in the manager's record of management rights; or

(c) the right to have no harmful interference from co-channel emissions in the protected area on the frequency band within the range of frequencies specified in the manager's record of management rights,-

(d) that manager may execute for the purposes of registration a spectrum licence in the form prescribed for spectrum licence."

Section 48(2) of the Act states that a spectrum licence is not valid until that licence is registered in the Register.
Most of the spectrum licences issued in the Crown management right bands are granted under section 48(1)(a) of the Act.

2.9. Spectrum Licence Certification Requirements

Spectrum licences must be certified in accordance with the requirements of section 25(4) of the Act. That section states that:

> "The registrar must not register any spectrum licence unless the Registrar receives a certificate from an approved radio engineer (being a person approved by the Secretary) dated not more than 3 months before the receipt of that certificate by the Registrar".

Section 57D(4) of the Act identifies the same requirement for modified spectrum licences. Sections 25(5) and 57D(5) of the Act, which relate to new and modified licences respectively, require that:
"The radio engineer's certificate must certify that, in the opinion of that engineer, the exercise of rights to which the spectrum licence relates-

(a) will not endanger the functioning of any radio navigation services; and

(b) will not endanger the functioning of any radio service essential to the protection of life and 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 radio licences; and

(e) will sufficiently define the protection area and the nature and characteristics of the proposed transmissions to enable subsequent spectrum and radio licences to be coordinated with exercise of rights to which the spectrum licence relates for the purpose of avoiding harmful interference."

In addition, section 25A of the Act, which relate to new and modified licences, which concerns matters relevant to a radio engineer's certificate, requires that:
"A radio engineer issuing a certificate under section 25-

(a) must, before issuing the certificate, have regard to-

   i. the nature and characteristics of the rights described in the spectrum licence; and

   ii. the International Radio Regulations; and

   iii. the ITU-R reports and recommendations; and

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

   v. the International Convention for the Safety of Life at Sea; and

   vi. the nature of the service proposed to be operated under the spectrum licence; and

   vii. any relevant reference standards issued by the Secretary, but

(b) must not, in considering whether to the issuing of the certificate, have regard to the reception of radio waves by inappropriate receivers."

With regard to the phrase 'existing spectrum and radio licences' in sections 25(5)(c) and 57D(5)(c), for the purposes of certifying licences in Crown management rights, the meaning of the word "existing" shall include current and planned licences as recorded in the Register.

The requirements of sections 25, 25A, 57D and 57E of the Act are embodied in the certificate used by AREs, a copy of which is included in Appendix 2: Sample Approved Engineer's Certificate of this document.

An ARE may certify a licence that does not appear to be technically compatible with a Crown reservation[1] licence only when the intended use of that licence is the same as the reservation and meets policy rules.

2.10. Spectrum Licence Contents

A Registrar of Radio Frequencies receiving a spectrum licence for registration is responsible for ensuring that the licence is accompanied by a certificate issued by an ARE that confirms that the content of the spectrum licence conform to the requirements of the Act and the parameters and/or restrictions stated in the associated management right.

The Act specifies the minimum contents of a spectrum licence in section 49(1).

Every spectrum licence must specify-

(a) the name and address of the rightholder; and

(b) the frequency band within which radio waves may be transmitted; and

(c) except for licences granted or reserved under section 48(1)(b), the protected area; and,

(d) except for licences granted or reserved under section 48(1)(c), any unwanted emission limits applying to emissions from a radio transmitter or transmitters; and,

(e) the commencement date of the spectrum licence, being a date not earlier than the commencement date of the record on management rights to which the spectrum licence relates; and

(f) the expiry date of the spectrum licence, being a date not later than the expiry date of the record on management rights to which the spectrum licence relates; and,

(g) whether the spectrum licence may be transferred to another person by the rightholder with or without the consent of the manager; and

(h) whether the spectrum licence may be cancelled by 1 or more of the rightholder, the manager, or the rightholder and manager together; and

(i) whether the spectrum licence may be modified by 1 or more of the rightholder, the manager, or the rightholder and manager together; and

(j) any conditions on the exercise of the right to transmit radio waves or the right to have no harmful interference under the spectrum licence, being conditions that do not contravene the conditions specified in the record of management rights to which the spectrum licence relates; and

(k) any other matters that may be specified by the Regulations made under this Act."

[1] A Crown reservation is a licence in the name of the crown recorded in the Register but may not have an actual transmitter. The licence must be considered by AREs and is there to protect crown broadcasting interests.

2.11. Spectrum Licence Parameters

The parameters used in spectrum licences presented to the Registrar of Radio frequencies for registration shall comply with those identified in the Form 7 Schedule included in the Regulations and in particular with the requirements as follows:

- Maximum power of emissions and emission powers associate with horizontal and vertical radiation patterns stated in a licence shall mean the total power in dBW of the emissions in the necessary bandwidth, i.e. total power is the mean power integrated across the bandwidth. Parameters based on Power Density Function (PDF) values, e.g. dBW/Hz, do not meet this requirement. Where an ARE needs to identify the PDF values these may be included in the licence conditions.
- Emission powers associated with Protection Limits (PL), Power Floors, Adjacent Frequency Emission Limits (AFEL), and Unwanted Emission Limits (UEL) may be in dBW with measurement reference bandwidths as stated in the licence conditions. Where reference bandwidths are not so stated the bandwidth shall be as identified in Table 2 below:

Table 2: Reference Bandwidths

Frequency Range	Reference Bandwidth
< 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
> 1 GHz	1 MHz

Note that digital terrestrial television in New Zealand uses a 1 MHz reference bandwidth for all relevant management rights and the unwanted emission limit on spectrum licences. Particular requirements for specific radio service types are included in section 4 Engineering Issues Relating to Particular Management Rights of this document.

2.12. Spectrum Licence Conditions and Other Content Specified by the Act

Section 49(1)(j) of the Act provides for the recording in a spectrum licence any conditions on the exercise of the right to transmit radio waves or the right to have no harmful interference under the spectrum licence, being conditions that do not contravene the conditions specified in the record of management rights to which the spectrum licence relates. These conditions may include:

- restrictions on the purpose of transmissions (for example service evaluation) and requirements to cease operation when required by the Ministry;
- restrictions on types of equipment used pursuant to the operation of the licence;
- restrictions that prohibit operation while emissions are generated in accordance with another licence;
- exceptions in relation to the right to have no interference;
- restrictions relating to the hours of operation;

- restrictions on program content as might relate to licences allocated non-commercially; and,
- restrictions to applicability of Maximum Permitted Interfering Signal (MPIS) levels in relation to other licences to facilitate synchronous operation.

The licence conditions may also be used to record technical information to clarify or define parameters in the licence such as measurement or reference bandwidths.

Appendix 4: Standard Spectrum Licence Conditions provides examples of typical standard spectrum licences. Additional conditions may be required by the Manager.

2.13. Spectrum Licence Authorities

Sections 49(1)(g), 49(1)(h) and 49(1)(i) of the Act identify spectrum licence conditions that are referred to as the Authorities of a spectrum licence. They are included in the spectrum licence to record the agreement reached between the management rightholder (the Manager) and the spectrum licence rightholder (the Rightholder) in regard to who has the authority to transfer, modify and cancel the spectrum licence.
The authorities to transfer, cancel and modify broadcasting spectrum licences registered in Crown management rights shall be in accordance with the following table.

Table 3: Authorities Required for Broadcasting Spectrum Licences in Crown Management Rights

Spectrum Licence Authorities	Commercial	Reserved	Temporary	Evaluation
Transfer S49(1)(g)	Rightholder Alone	Manager and Rightholder Together	Manager and Rightholder Together	Manager and Rightholder Together
Modify S49(1)(I)	Manager and Rightholder Together	Manager and Rightholder Together	Manager and Rightholder Together	Manager and Rightholder Together
Cancel S49(1)(h)	Rightholder Alone	Manager Alone	Manager Alone	Manager Alone

In respect of table 3, the definitions are:

- Commercial: means a long term spectrum licence usually allocated by auction.
- Reserved: means a long term spectrum licence granted without any resource payment to the Crown being required. Such licences may be subject to contractual arrangements in regard to purpose and use of the licence for public radio, promotion of the Māori language and culture, parliamentary broadcasting or other purposes in accordance with Government policy.
- Temporary: means a short term or limited term spectrum licence, usually less than 12 months.
- Evaluation: means a short term spectrum licence granted for the purposes of testing compatibility with existing services.

Note that an additional authority requirement based on ‘Manager or Rightholder’ is used in spectrum licences for some FWA services in Crown management rights. This authority can be used in respect of a Cancel authority to permit either the Rightholder to cancel or the Manager to cancel. This authority might be exercised by the Manager, for example, should the Rightholder not comply with agreements established prior to the granting of a spectrum licence to the Rightholder.

2.14. Simultaneous Certification of Licences

It is possible for two or more persons acting independently to apply for spectrum licences in the same area resulting in incompatible spectrum licences in Crown management rights. Should that occur, the licence that shall have precedence shall be that determined by the Crown Spectrum Asset Manager. This decision shall normally be made on the basis of first in time delivery and shall be determined based on the dates and times recorded as follows:

- in the case of Form 8 (modification) online applications, by the Register application date and time
- in the case of all Form 7 (new licence) applications, by the Register "Planned status date and time".

For determining the first in time between licences, the decision of the Ministry shall be final and may be to not grant either licence. A suitable licence may be placed in the next available public spectrum auction.

Should any incompatible spectrum licences become registered, the Ministry will determine which licence was first in time right using the principles outlined above and the rightholder associated with the licence not first in time shall arrange for provision of an appropriate Form 10 to the Registrar for cancellation of that licence.

A complete licence application, Form 7 or Form 8, means an online form:

- in the Register as prescribed for the purpose in the Regulations;
- that includes all requested information.

Licence applications entered into the Register and not moved to planned status within one month are automatically discarded in the Register and will lose first in time rights. Similarly, planned licences whose certificates have expired (after three months) are expired in the Register and will lose first in time rights.

2.15. Requirements for Certifying Engineers

AREs must be thoroughly conversant with the requirements of the Act relating to the issuing of certificates required under sections 25, 25A, 57D and 57E. They should also be familiar with the Act in general, including current amendments, the Regulations and amendments, and PIB 59 relating to Crown management rights.

The RSM publication, Applications and Requirements for Approved Radio Engineers and Approved Certifiers (PIB 34), provides all necessary information for people seeking to become an ARE.

2.16. Records of Certification and their Retention

The certification documentation associated with the planning and coordination of a proposed radio service in a Crown Management Right is required to be retained for audit purposes. The actual documentation retained would be at the certifying engineer's discretion but would likely include:

- an overall summary report of the coordination calculations and any usage and policy assumptions made;
- a record on the transmitter and receiver parameters, frequency, antenna radiation patterns, site details, out of band emissions, receive protection areas, protection locations and MPIS values of all existing and planned assignments likely to impact upon or by impacted by the proposed licence for co-channel and adjacent channel services;
- copies of path profile, path loss calculations and assumptions made in the analysis of interference paths;
- copies of calculations and/or assumptions relating to miscellaneous matters such as synchronisation, RDS/SCA, protection ratios and urban coverage issues;
- copies of calculations and assumptions related to intermodulation and safety of life interference issues, e.g. FM Broadcasting (FMBC) to aeronautical calculations;
- assumptions relating to compatibility between services; and
- anything else that is considered for the certification of the licence.

Calculations detailing the use of cross-polar antenna discrimination, standard or precision offsets and other engineering techniques to ensure transmissions comply with the MPIS requirements are to be retained with the licence engineering certification documentation.

The certification documentation is to be retained by the ARE and made available for audit purposes for the period of five years from the date of certification of the licence. Certification documentation is to be made available within 10 working days of a request by RSM.

3. Compatibility and other Technical Issues

3.1. Technical Compatibility

The principle of technical compatibility is embodied in Article 3.3 of the International Radio Regulations (IRR) where it 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 certifying engineers 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 sections 25(5) and 57D(5) of the Act in relation to the certification of spectrum licences, is not defined in the Act, 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 one or more emissions, radiations, or inductions, or any combinations of these things, on the reception of radiocommunications".
- 'Harmful interference' is defined under the Act as meaning "interference which endangers the functioning of a radionavigation service, or other safety services, or seriously degrades, obstructs or repeatedly interrupts radiocommunications." Hence interference is deemed harmful if it prevents the operation of a radiocommunications service functioning at an appropriate usable level.

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

ITU-R Recommendations relating to broadcast services include minimum usable field strengths and minimum receiver performance requirements in order to provide a satisfactory service for general reception. Broadcasting services operate with high powers and on a continuing basis and therefore need to be carefully considered in assessment of potential interference to distress and safety communications.

3.2. Intermodulation

Intermodulation is where the energy from two or more frequency sources combine or mix to produce another frequency.
There are three basic sources of intermodulation:

- **Transmitter generated:**
  Two or more signals mix in a non-linear output stage of a transmitter (typically one signal is the transmitter wanted signal and other signals are coupled into the transmitter through the transmit antenna).
- **Receiver generated:**
  Two or more signals mix in a receiver (often because one signal is at a high level, causing the receiver to act outside its linear design range).
- **Passive generated:**
  Two or more signals inducing voltages across joints between conducting metals which are poorly bonded. Corrosion such as rust can create crude diode junctions 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 placed 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 and separation;
- 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 potential intermodulation interference on particular frequencies is predictable through calculations, the extent that it actually occurs is dependent upon the site management practises applied.

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 undertaken is by agreement between the parties concerned.

3.3. Distress and Safety Communications

The International Radio Regulations (IRR), in particular Articles 30 to 34 relating to Distress and Safety Communications, contain the provisions for the operational use of the global maritime distress and safety system (GMDSS), and also similar aeronautical and land mobile provisions. The key distress and safety services operating in New Zealand are based on these provisions, and include voice and data messaging, and maritime and aeronautical navigational services.

The voice and data services that must be considered by certifying engineers are the frequencies included in the General User Radio Licence for Emergency Transmitters (GURL-ET) which identifies frequencies for avalanche beacons, survival craft radiotelephone transmitters, emergency position indicating radio beacons, and 'search and rescue' (SAR) calling and transponder frequencies.

Consideration should be given to potential intermodulation and de-sensitisation of distress and safety communications receivers on these frequencies.

GMDSS

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

Table 5 below contains a list of those frequencies from Appendix **15** of the IRR that are denoted with an asterisk (*) that are applicable in New Zealand. The following clause from Appendix **15** if the IRR applies to those frequencies.

> "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".

Approved Persons in the certification of a licence must give special consideration to the frequencies in Table 5 regarding potential third-order transmitter intermodulation products and victim receiver de-sensitisation issues. The third-order intermodulation products include both two frequency and three frequency products as below:

$2f_1 - f_2$

$2f_2 - f_1$

$f_1 + f_2 - f_3$

$f_1 - f_2 + f_3$

$-f_1 + f_2 + f_3$

Table 5: GMDSS frequencies for special consideration

Frequency	Channel designators	Service	International Reference
2.1745 MHz	NBDP-COM	International distress and safety communication for narrowband direct-printing telegraphy	IRR Article **5**, footnote **5.110**, Article **31** & Appendix **15**
2.182 MHz		Maritime – International distress safety and calling	IRR Article **5**, footnote **5.108**, Article **31** & Appendix **15**
2.1875 MHz		Survival craft stations	IRR Article **31** & Appendix **15**
4.125 MHz		Maritime – International distress safety and calling	IRR Articles **31**, **52** & Appendix **15**
4.1775 MHz	NBDP-COM	International distress and safety communication for narrowband direct-printing telegraphy	IRR Article **5**, footnote **5.110**, Article **31** & Appendix **15**
4.2075 MHz	DSC		IRR Appendix **15**
6.215 MHz		Maritime – International distress safety and calling	IRR Articles **31**, **52** & Appendix **15**
6.268 MHz	NBDP-COM	International distress and safety communication for narrowband direct-printing telegraphy	IRR Article **5**, footnote **5.110**, Article **31** & Appendix **15**
6.312 MHz	DSC		IRR Appendix **15**
8.291 MHz		Maritime – International distress safety and calling	IRR Articles **31**, **52** & Appendix **15**
8.4145 MHz		Survival craft stations	IRR Articles **31** & Appendix **15**
12.290 MHz		Maritime – International distress safety and calling	IRR Articles **31**, **52** & Appendix **15**
16.420 MHz		Maritime – International distress safety and calling	IRR Articles **31**, **52** & Appendix **15**
121.5 MHz		Aeronautical emergency frequency	IRR Article **5**, footnote **5.200**, Article **31** & Appendix **15**.
156.525 MHz	MM70	Maritime – Digital selective calling for distress safety and calling	IRR Articles **31**, **52**, Appendices **15** & **18**
156.800 MHz	MM16	Maritime – International distress safety and calling	IRR Articles **31**, **52**, Appendices **15** & **18**

Frequency	Channel designators	Service	International Reference
161.975 MHz	AIS 1	Automatic Identification System (AIS) and AIS search and rescue	IRR Appendices **15** & **18**
162.025 MHz	AIS 2	Automatic Identification System (AIS) and AIS search and rescue	IRR Appendices **15** & **18**
243.00 MHz		Distress beacons/Survival craft	IRR Article **5** footnote **5.256**, Article **31** & Appendix **15**
406.00 MHz – 406.1 MHz		Satellite distress beacons	IRR Article **5** footnotes **5.266** & **5.267**, Article **31** & Appendix **15**

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 6 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). The following third-order intermodulation products are generally the most problematic:

$2f_1 - f_2$
$2f_2 - f_1$
$f_1 + f_2 - f_3$
$f_1 - f_2 + f_3$
$-f_1 + f_2 + f_3$

Table 6: 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 – 1215 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. Aeronautical Navigational Services

Aeronautical navigation services are used for aircraft landing, route navigation and aircraft identification services, and are key to the safe operation of aircraft and regulatory of flight. The services requiring special attention in respect to spectrum in crown management rights are:

- Non-directional beacon (NDB) services operate in the band 285 to 415 kHz at regional airports and other key locations. Special care is required with the certification of new high powered broadcast transmitters in the band 521 to 1,612 kHz, close to aircraft landing routes at airports using low frequency NDBs. Aircraft receivers are susceptible to overloading when subject to high field strengths (for example when at low altitudes closer to terrestrial transmitters). Evaluation of new MF-AM licences near airports requires thorough awareness of frequencies in use in the area and analysis of the potential for receiver de-sensing and intermodulation along aircraft landing approaches.
- The localiser (Horizontal) component of Instrument Landing Services (ILS) operates in the band 108 to 114 MHz at Whenuapai, Auckland, Ohakea, Wellington, Christchurch and Dunedin airports to facilitate aircraft landing in low cloud conditions. Special care is required with the certification of licences for new high powered FM broadcast transmitters close to aircraft landing routes at those airports. The Aero-FMBC Coordination Process, available on at www.rsm.govt.nz, outlines the issues and the details of the analysis required that are given in Recommendation ITU-R SM.1009. The analysis also requires knowledge of related ICAO requirements and New Zealand aeronautical frequency usage.
- Variable Omni-Range Radio (VOR) services operate in the band 108 to 117.95 MHz at major airports and some remote sites to provide route guidance for aircraft.

These matters are further outlined in relation to particular broadcast services in section 4 Engineering Issues Relating to Particular Management Rights of this document.

3.5. Transmitters in Urban Areas

When broadcasting services are to be located in or close to an urban environment it is important to consider their ability to co-exist with other existing licensed services already in the local area. In particular receivers (especially lower cost receivers) can be susceptible to de-sensitisation and blocking in areas close to multiple high power transmitters or if adjacent to a single high power transmitter.

In urban areas, if transmitter antennas are mounted at high levels, then antennas with a suitable vertical radiation patterns and the use of relatively low radiated power levels will reduce potential local blocking and de-sensitisation issues at VHF and UHF. High power transmitters should be located away from urban areas.

There are specific requirements for FM Broadcasting, please refer to section 4.3.2 Engineering for details.

3.6. Equipment and Site Issues

While AREs are responsible for certification requirements being met for harmful interference and technical compatibility aspects, the Rightholder is responsible to ensure that the installation complies with the spectrum licence.

Where known, certifying engineers should also advise the Rightholder 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.

Site standards

There are no compulsory site standards, but the voluntary site standard AS/NZS 5070 is available for sites in New Zealand. Site issues and resolutions are a commercial arrangement between the licensee, site manager, owner, users and other interested parties.

Co-siting with safety services

Consideration is required for the safety bands and frequencies listed in section 3.3 Distress and Safety Communications. 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.

3.7. Services in Adjacent Frequency Bands

Certifying engineers need to consider whether a proposed licence is compatible with existing radio and spectrum licences using adjacent frequency bands in the same area. In particular, careful consideration of wanted and unwanted emissions, receive protection limits and receiver performance is important. For example the use of mobile transmitters with moderate transmit power levels and unwanted emissions have been known to be incompatible with receivers designed for low power density wideband signals. This required introduction of greater frequency separation.

Consideration should include evaluation of potential for interference to and from, co-channel and adjacent channel services.

3.8. Protection Locations

This section discusses the requirements for defining and selecting protection locations for MF-AM, FM and DTV licences. Protection locations are to be identified using New Zealand Transverse Mercator 2000 (NZTM2000) or New Zealand Topo50 (NZTopo50).
See section 3.14 (“

Site Naming Conventions and Geographic Coordinates").

The principles used for selecting the number of protection locations for new or replacement broadcast spectrum licences should be based upon the following:

- For licences with large geographic coverage areas there shall be at least three but may be up to six or eight protection locations.
- For licences with small coverage areas there should be two or three protection locations though for small, isolated coverage areas (probably surrounded by steep terrain) one protection location may be sufficient.
- For MF-AM and FM licences, a number of protection locations should be chosen to be representative of the outer edges of the prime coverage area for the service, i.e. where the field strength is not significantly greater than the minimum usable field strength (MUFS) engineering values noted in Appendix 5: Minimum Usable Field Strengths for Broadcast Service Protection Areas and Minimum Field Strengths for Protection Locations of this document.
- For DTV licences, a number of protection locations should be chosen within the prime coverage area for the service, i.e. where the field strength is above the minimum field strength (MFS) engineering values as noted in Appendix 5: Minimum Usable Field Strengths for Broadcast Service Protection Areas and Minimum Field Strengths for Protection Locations.
- Protection locations used in current spectrum licences should be used except where those locations are considered unsatisfactory. For example, where the protection location does not meet the principles for site selection included below.
- Protection locations should not be in areas that are exposed to co-channel interference such as hill tops or isolated areas that are not representative of the populated coverage area.
- Protection locations must be identifiable points for practical field measurement. Preferred locations are parks, school playgrounds, or cemeteries. Inaccessible places such as forest, lakes, and private property should not be chosen.
- Protection locations shall not be in areas heavily shaded or obscured by geographical features, which are not typical of the general area.
- Some protection locations may be in or near a significant area of population where the resulting reception conditions would be representative of those typical for local viewers or listeners.
- Protection locations should be located clear of power lines and away from steel structures or steel clad buildings.
- Protection locations should be chosen so that the radio path between the protection location and wanted transmitter should be free, to the extent possible, of obstructions and large radio signal reflection sources.

Alternative protection locations to those already adopted for broadcasting services and in regard to a particular transmission location may be selected. However, use of existing protection locations can provide comparisons with earlier measurements and reduce the need for multiple site visits for future measurements.
Guidelines for establishing new protection locations are as follows:

- estimate the approximate coverage area of a new assignment;
- select the appropriate number of proposed protection locations;

- identify protection locations on any existing assignments with a similar coverage area using the Register;
- check that protection locations provide effective representation of the coverage area;
- verify grid references using NZTM2000 / NZTopo50; and
- evaluate the protection locations against the applicable criteria below.

Evaluation Criteria for a Protection Location

The quality of each protection location shall be evaluated against the seven criteria below, using a three point scale as follows:

Rating = 1 Problematic
Rating = 2 Adequate
Rating = 3 Very Good

Every acceptable protection location should rate two or higher for each criteria identified below. A rating of one indicates the protection location is unsuitable and an alternative should be found unless local terrain restricts choice.

The criteria, with associated ratings, are as follows:

(a) The protection location is line of sight with the wanted station.
   i. Heavily obstructed path.
   ii. Slightly obstructed path, but field strength unlikely to vary significantly over time.
   iii. Clear line of sight with wanted station.

(b) The signal from the wanted station exceeds the minimum useable field strength and is representative of the area.
   i. Wanted field strength is well below minimum useable level.
   ii. Wanted field strength is within ±3 dB of minimum level, and viewers/listeners in the area are in a slightly worse (better) location than the protection locations.
   iii. Wanted field strength clearly exceeds minimum level and is typical of the area.

(c) The protection location is an electrically acceptable measuring point with no high voltage lines, or large metal reflectors like tanks, fences, or piping installations, in the foreground or vicinity.
   i. Very noisy and/or severe reflections.
   ii. Some electrical noise or reflections, but not sufficient to invalidate results.
   iii. Electrically quiet and no major reflection sources.

(d) The protection location is easily accessible for the measurement vehicle.
   i. Poor or hazardous access or access prohibited.
   ii. Site access or ownership creates difficulties or inconvenience.
   iii. Good, safe access on public property.

(e) The protection location is a practical and safe measurement location with level ground and no overhead obstructions.
   i. Sloping or boggy ground and/or overhead obstructions.
   ii. Weather dependent site or requires skill in finding suitable flat area.

iii. Level site on firm ground and no overhead obstructions.

(f) The exact measurement location is easily found.

i. Description of site is non-specific and difficult to revisit within +/- 50m.

ii. Difficult to identify exact location but description enables a revisit to within +/- 50m.

iii. Well described with unique features allowing a revisit to within +/- 10m.

(g) The protection location characteristics are unlikely to change drastically in the foreseeable future. Path obstruction, electrical, and physical suitability is unlikely to be compromised by natural or other development.

i. Existing industrial development or electrical plant construction in the vicinity.

ii. Signs of residential development or young trees unlikely to have adverse effects.

iii. No signs of any development or adverse changes due to natural phenomena.

The exception to these requirements concerns the identification of protection locations required for night time E_u calculations and measurements for MF-AM services. See section 4.2 MF-AM Sound Broadcasting Services below.

RSM reserves the right to determine whether a proposed protection location is satisfactory.

3.9. Maximum Permitted Interfering Signal Level Requirements

Maximum Permitted Interfering Signal (MPIS) (within the operating frequency band) levels are a limit on the right to receive no harmful interference from co-channel emissions. The form for registration of a spectrum licence (Form 7) has provision for recording MPIS's.

Proposed spectrum licences shall not create unwanted signal levels that exceed the MPIS levels of existing (or planned) spectrum licences at the protection location of those existing (or planned) licences.

Proposed spectrum licences for broadcasting services shall identify an MPIS level for each protection location. MPIS levels for the proposed licence shall be calculated on the basis of the wanted signal level less an appropriate protection ratio.

If either of these requirements is not met, the proposed licence should not be certified. Specific exceptions to this requirement may be made for synchronous or single frequency networks (SFN) if the other policy and technical conditions for an SFN have been met.

Specific information for required MPIS levels and protection ratios applicable for particular service types in Crown Management Right bands is given in section 4 Engineering Issues Relating to Particular Management Rights of this document.

The calculations of MPIS associated with television services for spectrum licences must incorporate appropriate cross polar and receive antenna discrimination. These parameters are not applicable for calculations of MPIS levels for MF-AM or FMBC services.

Although the Register allows a choice of units for MPIS when registering a spectrum licence, dBµV/m is the required unit as the Form 7 only allows the use of dBµV/m within the necessary bandwidth of the service being licensed.

3.10. Signal Strength Calculations

Calculation of both wanted and unwanted field strengths requires use of propagation models, path profiles and standard processes. RSM 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 engineer.

Field measurements, if available for the appropriate band and service type, can be used to assist in validating and calibrating the use of signal strength calculation provided that measurement accuracy, including potential sources of errors, can be identified and appropriately taken into account.

RSM 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.368 Ground-wave propagation curves for frequencies between 10 kHz and 40 MHz.
- P. 452 Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz.
- P.525 Calculation of free-space attenuation.
- P.526 Propagation by diffraction.
- P.832 World atlas of ground conductivities.
- P.1147 Prediction of skywave field strength at frequencies between 150 and 1,700 kHz.
- P.1812 A path specific propagation prediction method for point-to-area terrestrial services in the frequency range 30 MHz to 6 000 MHz.
- P.2108 Prediction of clutter loss.

It is noted that there is a variety of software available on the ITU-Radiocommunications Sector (ITU-R) Study Group 3 “Software, Data and Validation examples for ionospheric and tropospheric radio wave propagation and radio noise”, which could be used for the completion of path profiles and the assessment of signal strengths. The information provided in this section gives general guidance and settings for use by AREs for the services applicable to the Crown MRs. Where applicable and appropriate, more specific guidelines on the signal strength calculations are given in section 4 Engineering issues relating to particular Management Rights discussed in this document.

RSM currently uses commercially available software for path profiles and calculating signal strengths associated with VHF and UHF radio and television services, with the following parameters, models and settings:

- K Factor: 4/3 for wanted and 2.0 for unwanted signal strength analysis.
- Prediction: 50% of locations and 50% of the time (50/50).
- Recommendations ITU-R P.525/P.526 Model and Deygout 94 Diffraction geometry for wanted and unwanted interference profiles.
- Standard subpath attenuation loss is included. This relates to Fresnel obstruction loss and Foreground loss.
- Fresnel zone 0.6.
- Clutter loss not included.

For the purposes of this document the term clutter loss is defined as loss due to, or associated with, trees or buildings only. A further term, known as Epstein Peterson Clutter Loss (EPCL)

includes an assessment of loss associated with terrain. That is, the effect of terrain on the Fresnel zone of an emission. Assessment of wanted and unwanted path profiles should include the use of EPCL where this is an option in the software used.

The calculation of field strengths on either a signal path profile basis, or multiple paths for the assessment of coverage can be complex. Prediction software, whether it is produced in-house or purchased commercially, can produce varying results. Accordingly, some configuration of the software may be required.

The determination of the MPIS level for each protection location may require use of both Continuous and Tropospheric propagation models.

An ARE should carry out comprehensive signal strength calculations at as many locations as necessary to properly assess harmful interference and technical compatibility. Such assessment is likely to involve methods based on computer software. For the purpose of conducting the relevant calculations, RSM does not recommend any particular software tool.

AREs considering the acquisition of a software package may wish to note the following:

- Modern comprehensive computer based area coverage prediction tools can quickly and efficiently calculate estimated protection ratios and compare these against the minimum recommended. Such tools enable the inspection of thousands, or millions, of points for compatibility. Though such tools can be costly, interference limited coverage can be quickly assessed.
- Pixel based tools that can provide coverage predictions are available. With such tools two coverage predictions can be made and overlaid. Correctly used, coverage predictions will quickly indicate areas at high risk of technical incompatibility.
- If no area coverage prediction tool is available to the ARE, then a sufficiently large set of points to adequately describe the primary coverage area should be selected for point-to-point calculation of MPIS levels and achieved protection ratios for the service under consideration, keeping in mind the frequency band of operation and the corresponding technical conditions.
- Care should be taken with digital terrain models (DTM) that the terrain resolution and algorithms are sufficient to produce the required prediction accuracy. DTM pixel size should not exceed 100m. Height resolution of more than 25m cannot be expected to provide accurate results. Vertical resolution accuracy should be sufficient to ensure mountain and hill tops are not ‘flattened’. It is noted that hilltop data is available for purchase from Land Information New Zealand (LINZ).
- Accuracy of predictions made on a radial basis will vary depending upon the angular interval between radio path profiles and the distance from the transmitter.

When an engineer is creating a licence modification for commercial purposes, the client may wish estimates of the increased population coverage to be undertaken. This matter is outside the certification requirements of the Act, but might conveniently be completed using the same software tools as used for certification.

3.11. Parameter and Reference Bandwidths

Parameter definition, calculation and measurement frequently require the identification of a bandwidth for reference. Historically, transmitter power has been defined without reference to a bandwidth and the levels stated in the appropriate specifications and measurement has often been considered to relate to total power of the emission. This practice may create difficulties when considering interference between services of different bandwidths.

The increasing number of services with different bandwidths, power levels and equipment characteristics, has meant a need for more precise definition of emission and interference power levels and bandwidths. The Recommendations ITU-R SM.328 and SM.329 define a number of standard terms for emission parameters in relation to several common emission types.

In New Zealand both radio and spectrum licences shall state the effective transmit power which can be defined as: "the integrated power in the necessary bandwidth for continuous signal emissions, and peak envelope power for pulse emissions".

RSM uses reference bandwidths for some equipment standards as identified in the radio equipment standards on the RSM website www.rsm.govt.nz. Where it is necessary to use a measuring (or resolution) bandwidth that is different from the reference bandwidth for the frequency range of a licence, the measured value should be converted to the equivalent level for the reference bandwidth. Note that the conversion method differs for continuous spectral components, and discrete or narrow band spectral components. ITU-R Recommendation SM.329 describes the conversion methodology. Those reference bandwidths are shown in Table 7.

Table 7: Reference Bandwidths

Frequency Range	Reference Bandwidth
9 kHz to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
Above 1 GHz	1 MHz

Note that digital terrestrial television in New Zealand uses a 1 MHz reference bandwidth for all relevant management right and spectrum licence parameters.

3.12. Frequency Offset and Time Delay

The use of precision time delays and frequency offsets can significantly reduce the effects of co-channel interference. Details of any advantage gained from these or other benefits must be retained with the licence engineering certification documentation.
The ITU-R Recommendations dealing with these matters for certain applicable services include:

- MF–AM Broadcast services, Rec. ITU-R BS.598
- VHF FMBC Broadcast services, Rec. ITU-R BS.412
- Digital TV Digital Terrestrial Television, Rec. ITU-R BT.1368

Note that digital television can use carrier and data frame synchronisation to facilitate common frequency usage as well as time delay adjustments to synchronize incoming signals in overlapping receive coverage areas. Single Frequency Networks (SFNs) use these techniques.

3.13. Antenna Radiation Patterns

Transmit antenna

Antenna gain and discrimination have key roles in the engineering of licences and the reduction of interference when coordinating licences. The reliable recording of antenna data is therefore a key component of spectrum licences.

For instance, broadcast transmit antennas must have their horizontal radiation patterns recorded on the spectrum licence. Vertical radiation patterns should also be recorded for transmitters in urban areas and other areas where special requirements exist, e.g., directional antennas within the designated coverage areas for instrument landing services at Whenuapai, Auckland, Ohakea, Wellington, Christchurch and Dunedin airports.

Radiation pattern data is to be recorded in dBW with steps of typically 2 to 4 dB, as appropriate and except where sharp nulls exist within an azimuth of 30 degrees or less, where the maximum null is to be identified at the maximum null azimuth. At least one azimuth shall be included at the full licensed transmit power.

The coordination of broadcast licensing requires use of transmitter antenna radiation pattern data for the determination of services coverage and also the limiting of that coverage when there is potential for interference to other services.

Receive antenna

By way of example, when engineering television services, the radiation pattern discrimination of the receive antenna shall be taken into account using ITU-R BT.419 *Directivity and polarisation discrimination of antennas in the reception of television signals*.

3.14. Site Naming Conventions and Geographic Coordinates

Site naming conventions need to be simple and flexible. Unless there is a reasonably standard format the occurrence of multiple names for the same site in the Register will continue to grow, ensuring search tools will return significant, perhaps unmanageable, numbers of different names for the same site.

The site names in the Register should use the following convention:

- If a current site used in the Register is suitable, it is preferable that it is used.
- If the site is named by LINZ on a NZTopo50 series map, 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. Also, because of the propensity to use the same road names in different towns/areas, a street name and number should also 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 should be followed by a building name or reference number. Generic names for large sites such as a Marae, park, factory, hospital name, etc. that are not on a map can also be used.
- 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 (a map reference search facility may be added to the Register, which will often provide a suitable site name choice. Currently the entering of a street or other name in the Transmitter Location field of the Spectrum Online Radio/Spectrum Licence Search will locate all licences with that name in their site location field. Once a licence local to the required site is identified and opened, a further search field is available based on area search radius. This may provide further site names in the area from which a choice can be made.

The coordination of any radio service is predicated on the accurate determination of the relative spatial (distance and azimuth) relationships between potential victim and interfering services.

It is important that the transmitter and protection location coordinates are derived and recorded accurately. The location point is defined as the co-ordinates at the centre or main axis of the antenna support structure (i.e. pole or tower). In the case of particularly large support structures, where the radial distance from the antenna to the support structure's axis is greater than 10 metres the coordinates of the actual antenna are to be recorded in a resolution of 1 metre using New Zealand Transverse Mercator 2000 (NZTM2000), or New Zealand Topo50 (NZTopo50). For example, a location should be in the form NZTM2000 1755766E 5419463N, or NZTopo50 BQ31 557.66 194.63. 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). For further information and conversion calculator see the LINZ website www.linz.govt.nz.

4. Engineering Issues Relating to Particular Management Rights

4.1. Introduction

This section identifies specific engineering requirements that are required for spectrum licences proposed for broadcasting services and other services/uses of Crown MRs. The section also discusses in general terms the key coordination and other matters that should be considered prior to certification of a licence. The description assumes an understanding of the general processes required in order to engineer a new radio service and in particular the requirements for establishing the required coverage area, the transmitter site, the transmitter power and antenna radiation pattern, receive protection locations and identifying a suitable frequency.

Some of the parameters in existing spectrum licences, such as protection ratios and MPIS requirements are based on previous engineering rules. It is therefore necessary for engineers planning and certifying new and modified licences to ensure that coordination for the new or modified licence takes into account the actual MPIS and other licence parameters and conditions that exist on the current licences.
New and modified licences shall meet the requirements of these rules. Certifying engineers shall complete the requirements included in section 2.15 Requirements for Certifying Engineers of this document.

Departures from the rules for particular purposes shall require the written approval of Manager Licensing and shall be addressed via email to radio.spectrum@mbie.govt.nz.

Throughout this section, the following abbreviations are widely used:

Eu	Usable Field Strength (use for MF-AM sky wave calculations);
MPIS	Maximum Permitted Interfering Signal;
MUFS	Minimum Usable Field Strength (use for FM and in the case of MF-AM, use for ground wave calculations);
MFS	Minimum Field Strength (use for protection location in the case of DTT);
PR	Protection Ratio (ratio of wanted to unwanted receive signal);
WFS	Wanted Field Strength (for interference analysis);
UFS	Unwanted Field Strength (for interference analysis).

In the case for the appropriate broadcasting services, it is to be noted that Recommendation ITU-R BS.638 identifies E_u as referencing the Usable Field Strength. In these rules E_u relates to the night-time usable field strength for MF-AM services. That recommendation also identifies a definition for Minimum Usable Field Strength as the minimum value of the field strength necessary to permit a desired reception quality, under specified receiving conditions, in the presence of natural and man-made noise, but in the absence of interference from other transmitters.

4.2. MF-AM Sound Broadcasting Services

4.2.1. Planning

The MF-AM sound broadcasting service in New Zealand is allocated spectrum in the band 521 to 1,612 kHz and has the following significant planning parameters:

- The MF-AM frequency band is 521 to 1,612 kHz;
- Occupied bandwidth is 20 kHz;
- Emission designation is 20K0A3EGN;
- Channel allocation is on a 9 kHz raster;
- Channel assignments for services that are co-sited or have significantly common ground wave coverage shall have a minimum of 54 kHz separation; and
- Services can be synchronous or non-synchronous.

Planning of MF-AM services has historically been based on the processes detailed in the Final Acts of the Regional Administration LF/MF Broadcasting Conference (Regions 1 and 3) Geneva 1975. These processes have been updated and information on MF broadcasting extended in the following ITU-R Recommendations:

- BS.560, Radio Frequency Protection Ratios in LF, MF and HF Broadcasting.
- BS.415-2, Minimum performance specifications for low-cost sound broadcast receivers.
- BS.598, Factors influencing the limits of amplitude-modulation sound broadcasting in band 6 (MF).
- BS.703, Characteristics of AM sound broadcast reference receiver for planning purposes.
- P.368, Groundwave propagation curves for frequencies between 10 kHz and 30 MHz.
- P.832, World Atlas of Ground Conductivities (New Zealand Figure 40).
- P.1147, The prediction of sky-wave field strength at frequencies between 150 and 1,700 kHz.
- P.1321, Propagation factors affecting systems using digital modulation techniques at LF and MF.

International planning methods involve the calculation of E_u values for aggregate night time interference. National licensing requirements do not readily incorporate the prescription of an E_u value, but the E_u value is used as a WFS to calculate a night time MPIS level with appropriate licence conditions.

Conditions on licences serve, under the legislation to limit the rights and obligations of the Rightholder. An E_u value does not provide such a limit, but the derivation of an MPIS value based on calculated E_u value and protection ratios is used to ensure that the licences meet the legislative requirements.

4.2.2. Engineering

When engineering a MF-AM broadcasting service the following tasks must be undertaken to confirm compatibility and suitability of a proposed frequency for use as a MF-AM broadcast service. These are based upon the ITU-R Reports and Recommendations noted above and include requirements for key parameters.

Identify New Service Parameters

This includes identifying the transmitter site, required coverage area, appropriate protection locations, transmit frequency, transmitter power and transmit antenna characteristics.

Channel Search

The purpose of this task is to find all existing and planned transmitters within +/- 6 channels (+/- 54 kHz) of the proposed frequency for a new service, at the proposed service transmitter site and within New Zealand. AREs can obtain this search from the Register by selecting Search the Register and then Select licence. This search is required to identify other services with which the proposed new service will require Groundwave coordination (see task below).

International Search

The purpose of this task is to find all existing and planned transmitters within +/- 1 channel (+/- 9 kHz) of the proposed service transmitter site, within New Zealand, Australia and the local Pacific Islands (Identifying planned licences outside New Zealand is not easily achieved.) This will require a search of the Register and the current ITU-R International Frequency Information Circular, Terrestrial Services BR IFIC. (This circular can be viewed by appointment with Manager Licensing at 15 Stout Street, Wellington.) This area search is required to enable the Sky Wave Coordination calculation task (see task below).

Coverage Prediction

The purpose of this task is to provide a prediction of coverage for purposes of population count and identifying sites for protection locations and for MF-AM services is based on ground-wave coverage.

The task requires use of Recommendation ITU-R P.368, *Ground-wave propagation curves for frequencies between 10 kHz and 30 MHz*; and Recommendation ITU-R P.832, *World Atlas of Ground Conductivities* (New Zealand Figure 40) to estimate the limits of the minimum wanted field strength (MUFS) contour.

The ITU-R Groundwave Propagation curves will provide the extent of coverage based upon a uniform flat earth. However, experience indicates that where terrain has very low conductivity coverage is limited and accurate prediction not possible. Accurate determination of actual coverage may then require field measurements.

There should be no common ground wave coverage for services within +/- 54 kHz of the required frequency.

Groundwave Coordination

The purpose of this task is to make an assessment of the day-time influence of existing and planned NZ stations that may impact on, or be impacted by, the proposed MF-AM service. The assessment would involve using the Local Area Search results and Coverage Prediction processes above.

Skywave Coordination

The purpose of this task is to make an assessment of the night-time influence of the proposed service on all existing co-channel and adjacent channel NZ, Australian and local Pacific Island stations. The task also enables the determination of the impact of those current services on the proposed new service and may affect the viability of that proposed service. The assessment would use the International Area Search results, the processes that are detailed in Recommendation ITU-R P.1147, *Prediction of skywave field strength at frequencies between 150 and 1,700 kHz*.

Wanted Signal Levels

The minimum usable field strength (MUFS) for wanted signal levels that are to be protected within protection areas are based on ITU-R Recommendations. They are:

- For daytime operation the MUFS is 66 dBµV/m
- For night time operation the MUFS is 74 dBµV/m

Interference Levels

Maximum permitted interfering co-channel signal levels (MPIS) within protection areas shall be based upon the following formula:

- For daytime operation MPIS = MUFS – PR ≥ 36 dBµV/m
- For night-time operation MPIS = Eu – PR = 44 dBµV/m

Daytime interference

The assessment of the effect of daytime interference shall be based upon the effect of individual daytime interferers and if the unwanted field strength level from any single interfering MF-AM service exceeds the MPIS then compatibility cannot be assumed.

Maximum permitted interfering signal levels (MPIS) are based upon protection ratios given in ITU-R BS.560-3. These are shown in Table 8:

Table 8: Protection Ratios for MF-AM

Channel Spacing (kHz)	Protection Ratio (dB)
0 (Co-channel)	30
9 (1st Adj.Ch)	9
18 (2nd Adj.Ch)	-25*
27 (3rd Adj.Ch)	-27*
> 27	-27*

* These values are used only when analysing possible sites where common ground wave coverage could occur. The maximum permitted interfering signal level shall be 36 dBµV/m for a single daytime co-channel interferer.

Night-time interference

Night-time coverage is nearly always restricted by unwanted skywave interfering signals. The assessment of the effect of night-time interferers shall be based upon the effect of the six most significant co-channel and adjacent channel night-time skywave interferers using the following formula as specified in GE-75. Please note that E_u is linear in this formula but should be converted and expressed in dBµV/m.

$$E_u = \sqrt{[\sum_i (a_i E_{ni})^2 + E_{min}^2]} \qquad (\mu V/m)$$

Where:

- E_u is the night-time useable field strength for skywave signals at a site in linear µV/m in the above formula, although E_u and is normally expressed in dBµV/m.
- E_{ni} is the night-time field strength of the i-th transmitter linear in µV/m.
- a_i is the radio frequency protection ratio (PR) associated with the i-th unwanted transmitter (interferer) expressed as the linear ratio of the field strengths in the above formula $a_i = 10^{(PR/20)}$, where PR is given in dB.

- i is 1 to 6, i.e., the six most significant night-time skywave interferers.
- E_{min} is the minimum usable field strength of the wanted service in linear µV/m in the above formula, although it is normally expressed in dBµV/m.

The required maximum permitted value for E_u shall be 74 dBµV/m and therefore for night-time reception the equivalent night-time MPIS shall be 44 dBµV/m.
Few current MF-AM licences meet this E_u requirement and it is likely that no new MF-AM licence can be established that will meet the requirement.

Synchronous Operation

The protection ratio for synchronous operation of co-channel MF-AM broadcast services shall be 8 dB. Refer to Annex 2 of Recommendation ITU-R BS.598-1.

Polarisation

Vertical polarisation is used for MF-AM broadcasting.

Unwanted Emission Limits

UELs are outlined in Appendix 3: Unwanted Emission Limits of this document and maybe selected from the spectrum masks in the Register by selecting Reference Data from the menu, then Spectrum, with the identifier AM and description AM 530 kHz – 1,650 kHz.

Coordination with Aeronautical Services

Aeronautical Non-directional Beacons (NDB) operate in the bands 200 to 450 kHz and 1,515 to 1,600 kHz to provide reliable navigational guidance for both en-route and landing aircraft. Aircraft receivers for these services can be overloaded and/or generate receiver intermodulation by adjacent high power MF-AM transmissions, particularly when MF-AM transmitter sites have multiple services. Harmful interference can result in aircraft direction guidance errors.

The Register MPIS Records

Spectrum licence MPIS details shall be identified in the Register and Forms for registration as follows:

- One Protection Location shall be identified at the transmit location. This is generally the first Protection Location and shall contain an MPIS value based on the night-time Eu value. The protection location is nominal and any measurements required at the location shall be completed sufficiently remote from the antenna or similar large structures so that their effect in terms of obstruction and induction are minimised.
- The second (and any other) Receive Protection Location shall have daytime MPIS values included on the forms for registration.

International Coordination

MF-AM broadcast services have the potential to deliver substantial signal levels over very long distances and there is potential for co-channel and adjacent channel interference to be received from and caused to services managed by other administrations.

MF-AM frequencies are therefore assigned by the ITU-R in accordance with the Final Acts of the Regional Administrative Conference (Regions 1 and 3) Geneva, 1975. This is a treaty-level document to which New Zealand is a signatory, also referred to as the GE-75 plan. Any changes to the plan can only take effect by following the procedures outline in that plan.

The implementation of a new broadcast frequency, or the variation of an existing licence, cannot be confirmed until:

- the initial coordination with any affected overseas countries to gain acceptance;
- the proposal is incorporated into the Final Acts of the Regional Administrative Conference (Regions 1 and 3) Geneva, 1975, and distributed by the ITU-R for comment; and
- the new or modified assignment is registered by the ITU-R in the International Frequency List.

Initial inspection of the MPIS calculations will determine if coordination with other administration is necessary. Where there is a chance that the Eu of any foreign co-channel broadcast service could be increased by more than 0.5 dB coordination will be required. Parameters to be used in the coordination procedure are:

- Frequency
- EMRP (Effective Monopole Radiated Power = e.i.r.p – 5 dB)
- Longitude and latitude
- Antenna horizontal radiation pattern
- Antenna height
- Antenna polarisation
- Distance to coast.

Once agreement has been reached with an affected administration, the application can be sent to the ITU-R. RSM is responsible for coordination with other overseas spectrum administrations and ITU-R. Requirements for this coordination will be determined by the Manager Licensing at rsmlicensing@mbie.govt.nz.

4.3. VHF FM Sound Broadcasting Services

4.3.1. Planning

VHF FM Sound Broadcasting (FMBC) services are allocated spectrum in the band 87.5 to 108 MHz. The band 88.4 to 106.63 MHz is administered under the Crown management right MR207, while the two bands: 87.5 to 88.4 MHz and 106.63 to 107.7 MHz bands are available only for low-power FM broadcasting under the General User Radio Licence for Low Power FM Broadcasting (GURL-LPFMBC).

FMBC licences shall be based on analogue services only, with restrictions in the conditions of current long term licences to limit any digital use. There have been no decisions to date on digital radio broadcasting or preferred digital standards in New Zealand.

The FMBC broadcasting service in New Zealand has the following significant planning parameters:

- Bands for high power services under spectrum licences: 88.4 to 106.63 MHz – see above.
- Bands for low-power services under a GURL: 87.5 to 88.4 MHz and 106.63 to 107.7 MHz.
- Necessary bandwidth is 256 kHz.
- Emission designation for analogue services with RDS is 256KF9EHW. Other digital services are not permitted.
- Channel allocation is on an 800 kHz raster.

- Channel assignments for services that are co-sited or have significantly common coverage shall have a spacing of 800 kHz. In a few areas the use of 400 kHz spacing has been tested and approved, but licences with common coverage in any new areas, with spacing less than 800 kHz, require engineering evidence to be submitted to support the application and specific Ministry approval.
- Any application for a synchronous licence must be supported by engineering evidence to show that it would not be possible for a Third Party to broadcast in the area at the frequency in question. Given RSM's preference for competitive allocation of licences, this assessment should include a wide variety of third party options. Specifically, the assessment is not limited to the site, power and radiation pattern chosen by the primary applicant. It must consider other feasible options, to the satisfaction of RSM.
- Assessments of common coverage must be made at signal strengths ≥ 66 dBµV/m and demonstrate overlap in areas of contiguous coverage (areas of overlapping interference pertaining to fortuitous coverage are not to be included). This is explained in Figure 1 below:

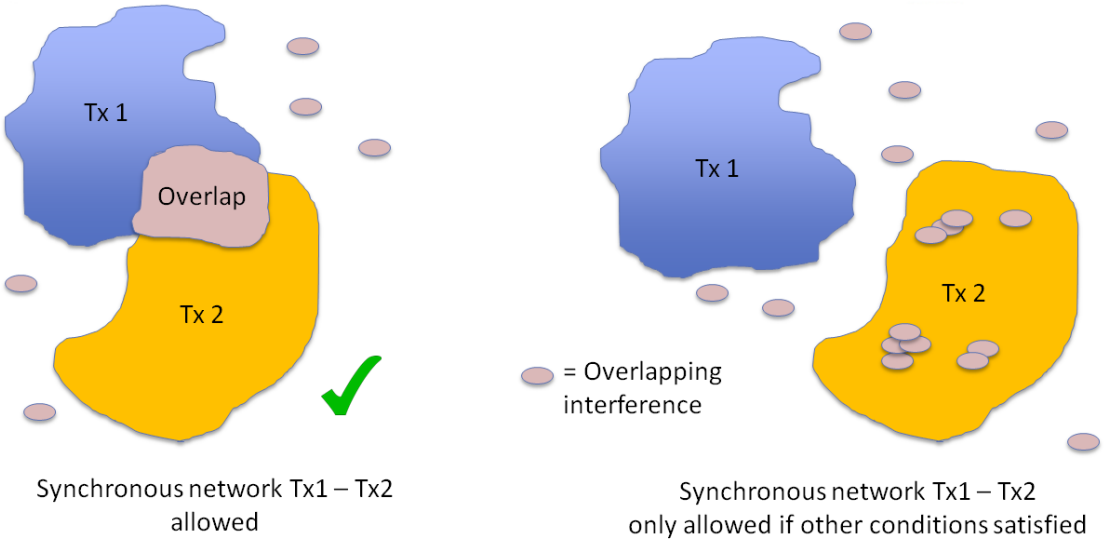


Figure 1: Coverage assessment for synchronous networks

- Licences parameters allow either stereophonic or monophonic transmission to be used.
- Frequency deviation is + /- 75 kHz.

Planning of FMBC services in New Zealand has been based on the processes detailed in the following ITU-R Recommendations:

- BS.412 Planning standards for terrestrial FM sound broadcasting.
- BS.415 Minimum performance standards for low cost sound broadcasting receivers.
- BS.450 Transmission standards for FM sound broadcasting at VHF.
- BS.642 Limiters for High-Quality Sound Programme Signals.
- BS.643 Radio data system for automatic tuning and other applications in FM radio receivers for use with the pilot tone system.

- BS.704 Characteristics of FM Sound Broadcasting Reference receivers for Planning Purposes.

FMBC usage in New Zealand, and in many overseas countries, is based on a minimum frequency separation of 800 kHz between licences at the same transmitting site. This is known as an "800 kHz raster" and is consistent with ITU-R technical standards. It recognises the typical quality of receivers in use, and the efficient practice of multiplexing transmitters to a common antenna.

It is generally inefficient to use frequencies suitable for a main transmission site for coverage infill, or extension. Such infill coverage is generally provided on frequencies offset from the raster of the main transmission site, but it is necessary to ensure satisfactory reception is possible in any areas of common coverage from the main and infill site. Typically, incompatibilities are minimised when the infill site has a 400 kHz separation from the main coverage site. However, this arrangement can only be satisfactory when there are no listeners in the immediate vicinity of either transmission site and the required protection ratios are met in any common coverage areas.

RSM treats applications involving narrow frequency separations (400 kHz) on a case by case basis with the over-riding objective of protecting a long term frequency plan, currently based on a separation of 800 kHz at any given site, or at different sites which serve common coverage areas.

Any applications submitted with a frequency separation of less than 800 kHz, in areas of common coverage, must be supported by a comprehensive engineering analysis, proving how interference cases are to be avoided. If modelling shows acceptable results, RSM is likely to also require test transmissions before agreeing to a long term licence.

4.3.2. Engineering

When engineering a FMBC service the following tasks must be undertaken to confirm compatibility and suitability of a proposed frequency for use as a FMBC. The tasks below are based upon the ITU-R Recommendations noted above, and include requirements for key parameters.

Identify New Service Parameters

This includes identifying the transmitter site, required coverage area, appropriate protection locations, transmit frequency, transmitter power and antenna characteristics.

Area Search

To find the frequencies and other parameters of all transmitters at a given site or within a small specific area, and wide frequency range. This information is available in the Register. The information is to be used to identify transmitters and receivers on a site. The search results will also determine which of the eight “800 kHz raster’s” are designated for the geographical area.

Initial Co-channel and Adjacent Channel Impact Analysis

To determine the likely impact of a proposed frequency on or by other broadcast assignments the engineer needs to identify all co-channel and adjacent channel assignments within +/- 800 kHz from the proposed frequency. The process includes determining outgoing field strength calculations based on the relevant ITU-R curves from the wanted assignment to other co-channel and adjacent channel licence protection areas. The process also includes determining the incoming field strength calculations based on the relevant ITU-R curves from

the adjacent assignment to the proposed assignment protection areas. A search tool can be obtained by AREs from the Register and selecting Search the Register and then Select licence.

Detailed Co-channel and Adjacent Channel Impact Analysis

Interference issues identified by the initial co-channel and adjacent channel impact analysis require further analysis using path profiles from the relevant transmitters to the appropriate protection locations. The associated radio path losses also need to be determined.

Interference Analysis Report

The co-channel and adjacent channel impact analyses are combined with transmitter power, Protection Ratio and MPIS data to provide a summary of incoming and outgoing interference. When necessary, additional test points, other than protection locations can be used to assist in determining technical compatibility with existing spectrum and radio licences. Radiation pattern data must be included. An Interference Analysis Report needs to accompany an application for a new synchronous licence or a licence providing in-fill coverage on a frequency offset by 400 kHz from the main raster. Such applications will only be granted with specific Ministry approval.

Coverage Map

Predicted coverage for FM Broadcast services can be uncertain due to varying topographic factors. Practical field strength measurements may assist in confirming predicted coverage if computer generated algorithms are relied upon for prediction.

Interference Levels

Maximum permitted interfering signal level requirements are based on Recommendation ITU-R BS.412.
Licences are to be engineered on the basis of:

MPIS level = WFS – PR

Spectrum licences must at least include one co-channel MPIS value for the proposed FMBC assignment.

The interference levels for protection locations are established for steady interference conditions using the Protection Ratios indicated in Table 9.

Table 9: Protection Ratios for FM

Channel Spacing (kHz)	Protection Ratio (dB)	Interference Level (dBµV/m)
0 (Co-channel)	45	WFS - 45
100 (1st Adj.Ch)	33	WFS - 33
200 (2nd Adj.Ch)	7	WFS - 7
300 (3rd Adj.Ch)	-7	WFS - (-7)
400 (4th Adj. Ch)	-20	WFS - (-20)
> 400	-20	WFS - (-20)

See section 3.8 Protection Locations in relation to defining and selecting protection locations.

If the unwanted field strength level from another FM assignment exceeds the MPIS then compatibility cannot be assumed. Note that the MPIS parameter refers to co-channel

unwanted signals, i.e. where there is an overlap between the frequency range of the wanted and unwanted signals' licences. Hence the protection ratios for: co-channel, 1st adjacent and 2nd adjacent channels apply directly to MPIS, whereas 3rd, and 4th adjacent protection ratios do not apply directly to meeting MPIS. However the need for a proposed licence to be technically compatible with existing licences means that the ARE must take into account the above 3rd and 4th adjacent channel protection ratios.
MPIS levels are measured at 10 metres above the ground.

Urban Sites

When engineering an FMBC services in an urban environment it is important to consider the ability for the proposed transmissions to co-exist with other licensed services already with coverage established or planned in the local area. This is relevant when it is proposed to establish a site which would result in significantly different signal levels from two different sites in a common coverage area. In particular, no new licence should be introduced to an urban area that may cause broadcast receiver de-sensitisation or intermodulation that can lead to interference to existing services. AREs certifying FMBC spectrum licences must ensure that the following requirements are met:

- Radio receiver apparatus of no more than 1 % of the population in that area coverage should be subject to a field strength of greater than 110 dBµV/m
- No new transmission in the same frequency range should present a field strength to a radio receiver apparatus, within the same coverage area, that exceeds the field strength of existing transmissions for more than 10 % of the coverage area by:
    - 24 dB if the frequency on the new licence is within 2 MHz of the frequency on the existing licence
    - In all other cases 40 dB.

AREs should also consider Annex 2 of Recommendation ITU-R BS.412-9, in particular, section 5 of this annex notes the reduction of Protection Ratios in receivers due to high signal levels. Where urban services are proposed, antennas should be mounted at high levels and antenna vertical radiation patterns provided to minimise local receiver overloading. Proposals to exceed a maximum assigned power output in build-up areas of 100 Watts or 20 dBW e.i.r.p. are to be referred to RSM for consideration. However, applications for licences as low as 10 dBW or less may be declined due to the potential for harmful interference to adjacent channels or services within short distances.

Coordination with other Services

When certifying an FMBC licence, the ARE in meeting the requirements of the Act, must respect the rights of other licensed services to have no harmful co-channel interference. In addition, the ARE must ensure technical compatibility with other services, and that requirement goes beyond simply ensuring co-channel compatibility.

The ARE must take into account the effects on other services in adjacent and near-adjacent bands, such as: the direct effects of unwanted emissions, and the adjacent channel selectivity of victim receivers, the harmonics of the transmitter frequency; the indirect effects of intermodulation of the transmitter with other transmitters both at the site and at nearby sites. The Act also makes special mention (sections 25A, 106 etc.), of the ARE's responsibility to protect safety of life services when certifying spectrum licences.

FMBC spectrum licences services have the capacity to cause interference with land mobile services in the adjacent A Band below 88 MHz and bands above 141 MHz. In particular, higher power FMBC spectrum licences services can cause receiver overload leading to receiver de-

sensing, blocking and intermodulation. Care must be taken to ensure new FMBC spectrum licences do not cause significant issues for land mobile service repeater sites and mobiles.

Similarly, FMBC spectrum licence services can cause interference to aeronautical navigation services in the adjacent 108 to 117.975 MHz band. Aeronautical services in that band are used during the landing and general navigation of aircraft. These are safety of life services and must be coordinated with FMBC services in accordance with Recommendation ITU-R SM.1009. A monologue on coordination between FMBC and aeronautical services has been published Aero-FMBC Coordination Processes at www.rsm.govt.nz.

Recommendation ITU-R SM.1009 indicates a need for separate calculations to cover both Montreal and ICAO Annex 10 1998 aircraft receivers. It is sufficient to consider only the Montreal receiver type as this represents the worst case scenario in the frequency band up to 106.63 MHz, the upper limit of the high power FMBC band.

Recommendation ITU-R SM.1009 also indicates a need for multiple (up to 50) test points at which comprehensive analysis is required. A careful review of distribution of field strength and locations of FMBC transmitters will identify a reduced number of points that require analysis.

Recommendation ITU-R SM.1009 does not provide a comprehensive method of determining A1 type interference. Current practice is to identify maximum levels of unwanted emissions from high power broadcast transmitters that ensure that the level of spurious emissions arriving at an aircraft receiver in an ILS Designated Coverage Area (DOC) are significantly less than the minimum level of ILS signal of 32 dBµV/m.

The rules for coordinating new FMBC, ILS and VOR services are as follows:

- Coordination shall be based on the latest version of Recommendation ITU-R SM.1009.
- Coordination shall include analysis of Type B1 and B2 interference.
- Coordination shall be based on use of the Montreal receiver potential incompatibility formulae in section 4.2 of Recommendation ITU-R SM.1009.
- Where the General Assessment Method (GAM) is used, individual intermodulation component potential incompatibilities as calculated using formulae (3) and (4) in section 4.2.3.1 of Recommendation ITU-R SM.1009 shall be less than 0 dB.
- Where actual FMBC field strength measurements are used for all FMBC signals contributing to significant intermodulation components, the power summation of individual potential incompatibilities shall be less than 0 dB.
- Coordination required for new ILS and VOR services shall consider all existing FMBC services that provide received signal strengths that are not less than the Recommendation ITU-R SM.1009 cut off levels within the services area of the ILS or VOR service.
- Coordination required for new FMBC services shall include all ILS and VOR services where the signal strength provided by the new services are not less than the Recommendation ITU-R SM.1009 cut off levels.
- Coordination for new ILS, VOR and FMBC services shall include all possible services operating pursuant to the 'General User Licence for Low powered FM Broadcasting short range devices' at each test point required by Recommendation ITU-R SM.1009.
- Coordination shall take into account all likely locations of aeroplanes when on aerodrome landing approaches and normal flight routes based on Civil Aviation Authority (CAA) information.
- Calculation of minimum test point clearance heights over LPFM and FMBC transmitters shall be based on use of AIP Aerodrome Landing Charts. The MAPt point identified in

those charts is to be used for the test point closest to the landing threshold and on the runway extended centre-line; and replaces test point E in the ILS DOC shown in Figure 4 of Recommendation ITU-R SM.1009, Annex 2.

- Airways and NZDF field strength measurements of ILS services and published on www.rsm.govt.nz shall be used for determination of ILS Lc values and wanted signal level calculations.
- ILS signal levels used for determination of Lc frequency correction factors shall be reduced 3 dB below values extrapolated from aerodrome calibration flight measured values to allow for low transmit power levels.

Generally any FMBC on raster at the current FMBC sites present a low interference risk to Aeronautical Navigational Services. However, AREs may wish to conduct their own analysis in accordance with Recommendation ITU-R SM.1009 to ensure that harmful interference does not occur.

More detailed information on coordination between FMBC and ILS/VOR services is available in the Aero-FMBC Coordination Processes available at www.rsm.govt.nz.

Polarisation

FMBC spectrum licences are generally given a vertical, mixed or linear polarisation. A few spectrum licences have been given a circular polarisation. When determining the e.i.r.p of a transmission, the measuring antenna is assumed to have matched polarisation.

When considering interference, the victim receiver polarisation must be assumed to be linear. Where an unwanted circular polarised field strength impacts on a wanted vertical, mixed or linear signal, the effective power output of the circular polarised transmitter can be reduced by 3 dB for interference calculations.

Transmit Antennas

The antenna polar diagrams are generally required to be provided as part of the engineering certification documentation and included on a new or proposed spectrum licence. Provision of a horizontal radiation pattern is mandatory while a vertical radiation pattern must be supplied for antennas in urban or city areas, or when requested by the Ministry.

Band Expanders

Section 46A of the Regulations effectively declares band expanders and receivers not designed to receive the New Zealand FMBC band (for example receivers designed to receive the frequency band used in Japan) to be an inappropriate receiver in accordance with section 134(1B) of the Act and such devices must not be taken into account when certifying licences in the band 88.4 MHz to 106.63 MHz. This is consistent with an earlier High Court judgment that determined that such receivers need not be considered when engineering and certifying spectrum licences.

RDS

The use of RDS systems is permitted, provided the transmitted spectrum is maintained within the permitted necessary bandwidth of 256 kHz as shown on the licence.
A list of RDS program code allocations is maintained by the Radio Broadcasters Association .

Unwanted Emission Limits

These shall conform to the relevant mask included in Appendix 3: Unwanted Emission Limits of this document.

Licensing

Refer to

Appendix 4: Standard Spectrum Licence Conditions of this document for standard conditions for FMBC licences.

4.4. Television Broadcasting

4.4.1. Planning

Frequency bands

The frequency band 510 to 606 MHz is allocated for Digital Terrestrial Television (DTT) licensing and is planned for use with an 8 MHz channel bandwidth.
The VHF bands previously used for analogue television are no longer available for television licensing.

Management rights

Digital Terrestrial Television management rights administered by the Crown are in:

MR365 510 – 606 MHz Channels: DTV26 – DTV37

Current management rights MR365 and MR367 expire on 11 March 2020, but subsequent management rights MR364 have been registered from 12 March 2020 to 30 November 2033.

Frequencies above 622 MHz while part of a management right are not in use for DTT.
A separate management right number 369 for the frequency band 606 MHz to 622 MHz is managed by Te Mātāwai for Māori television broadcasting. The use of this right is governed by the Māori Television Service Act and agreements with the Crown.

Antenna polarisation and directivity discrimination

The transmit antenna effective radiated power characteristic and receive antenna polarisation and/or directivity shall be included in calculations to determine technical compatibility with other licences. The receive antenna directivity and polarisation figures can be obtained from Recommendation ITU-R BT.419-3. This recommendation provides for either 16 dB discrimination for an orthogonal polarisation, or up to 16 dB for direction discrimination depending on the discrimination angle. But note that polarisation and directional discrimination cannot both be used in compatibility analysis.

Either horizontal or vertical polarisation should be specified on the licence depending on either the existing DTT licences at the transmission site or, in the case of a new site, compatibility requirements.

Digital Television

Planning criteria for digital television is based on:

- Digital Video Broadcasting – Terrestrial DVB-T conforming to ETSI standard ETS 300 744.
- Digital Video Broadcasting – Terrestrial DVB-T2 conforming to ETSI standard EN 302 755.
- Recommendation ITU-R BT.1206-1 Spectrum shaping limits for digital terrestrial television broadcasting.
- Recommendation ITU-R BT.1368-11 Planning criteria for digital terrestrial television services in the VHF/UHF bands.

Table 10 outlines the system parameters of DVB T and DVB T2 transmission standards that are current in use in New Zealand.

Table 10: System Parameters of DVB-T and DVB-T2 transmission standards

Standard	DVB-T	DVB-T2
Carriers	8 k	32 k
Carrier mode	n/a	Extended
Emission designation	7M77D7WWW	7M77D7WWW
Frequency tolerance	+/-500 Hz	+/-500 Hz
Pilot pattern	n/a	PP6
Modulation	64QAM, not rotated	256QAM, rotated
Forward error correction	3/4	2/3
Guard interval	1/16	1/32
Source coding	MPEG-4	MPEG-4
Conditional access	Free to air	Yes (IRDETO)

The parameters for DVB-T2 were chosen to achieve comparable minimum carrier to interference (C/I) and protection ratios to existing DVB-T operating with the above parameters. This gives generally the same coverage area as the DVB-T services achieve. DTT licences can be created for Single Frequency Networks (SFN) which use carrier and data frame synchronisation to facilitate co channel frequency usage. A time delay adjustment enables reception in target areas where normal protection ratios are not met. Such licences shall include a suitable condition to identify the SFN expectation. Details of actual timing required in any particular situation fall outside of the licence certification requirements.

The need for compatible Service Information (SI) parameters within the DVB data stream is addressed in the “required conditions” of DTT spectrum licences set out in

Appendix 4: Standard Spectrum Licence Conditions of this document.

The choice of System Parameters is normally determined by the capacity and coverage required for the licence. In most cases the parameters are selected to be compatible with the existing licences and therefore be readily receivable.

4.4.2. Engineering

Interference Levels

MPIS levels shall be stated in dBµV/m (within the 8 MHz necessary bandwidth) and are based on Recommendation ITU-R BT.1368-11 (DVB-T) and calculated at each protection location using the protection ratios given in Table 11 for digital (DVB-T) services using the formula MPIS = WFS – PR.

Table 11: Protection Ratios for Digital Television

Wanted	Unwanted	Lower adjacent channel	Co-channel	Upper adjacent channel
DVB-T or DVB-T2	DVB-T or DVB-T2	-30 dB	21 dB	-30 dB

These protection ratios apply for both Continuous and Tropospheric propagation.

Unwanted Emission Limits

These shall conform to the masks located in the Reference Data in the Register, and as outlined in Appendix 3: Unwanted Emission Limits for Digital Television in this document.

Coverage Planning

When engineering a digital television service. RSM uses commercially available software with the following parameters, models and settings:

- K Factor: 4/3 for wanted and 2.0 for unwanted signal strength analysis.
- ITU 525/526 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.
- Clutter loss not included.

Minimum wanted signal strength at 10 metres above ground for digital television is 48 dBµV/m for coverage, but protection locations are required to have a minimum signal strength of 57 dBµV/m.

4.5. Television White Space

The Television White Space (TVWS) interim licencing regime has been suspended indefinitely. No new applications will be accepted and the scheme is closed. The existing licences will not be cancelled at this stage, pending future decisions.

This section remains in PIB 39 for reference for the time being but will be removed in future versions.

4.5.1. Planning

Television White space devices (TVWS) are a group of developing technologies that can dynamically use the UHF television spectrum as a secondary user, working around television use and avoiding interference. TVWS devices operate on a secondary basis to the primary use, Digital Terrestrial Television (DTT[2]), whereby they must not cause interference and have no receive protection from interference.

Internationally, TVWS regulatory models typically include expectations that the white space use does not have any receive protection and must not create interference for the primary licensee. There are several approaches to TVWS developing, most of which are heading towards a database approach.

In New Zealand, television licences are relatively static over time and new television licences are often publicly known before actual transmissions commence. Radio Spectrum Management (RSM) has therefore decided to create an interim licensing scheme to allow some preliminary usage and trials in the UHF television band (510 – 606 MHz). Once international frameworks and regulatory regimes are developed and there is a clear path for New Zealand to follow, RSM will further investigate the type of long term regime that will best suit New Zealand.

The frequencies that DTT services use could change at any time, with services being either modified or established. Anyone operating under a TVWS licence must be mindful of this. TVWS must not cause harmful interference to DTT services and it is expected that TVWS licensees anticipate any potential issues and make adjustments before harmful interference occurs. Should an issue occur, licensees must immediately rectify the issue. This may involve changing frequency, reducing power, or ceasing operation. That may also require a change to the licence.

As this is an interim licensing regime to trial TVWS in New Zealand the RSM is seeking information to assist with the development of a long term regime. Licensees must complete a copy of Appendix 8: TVWS Use Survey before a licence will be registered.

Types of technology permitted

Ultimately, equipment or devices operating under any TVWS licence should be compatible with any long term regime developed. These could be devices accepted by the FCC (USA) or devices accepted by Ofcom (UK). The databases that TVWS use relies on in some other jurisdictions for the self-management of interference are not implemented in New Zealand at this stage.

Devices or equipment that operate under any TVWS licence must be a recognised TVWS technology. Non-TVWS technologies are not permitted. Equipment or devices must conform to one of the following standards:

- FCC CFR Title 47, Part 15, Subpart H - Television Band Devices 15.701 – 15.717; or
- ETSI EN 301 598 V1.1.1 *'White Space Devices (WSD); Wireless Access Systems operating in the 470 MHz to 790 MHz TV broadcast band'*

[2] Please note that specific DTT channels are referred to as "DTV XX". In New Zealand, "XX" is a number between 25 and 47.

These standards assume the use of a geo-location database. There is no mandatory geo-location database implemented in New Zealand. Therefore, equipment deployed in New Zealand will not be expected to conform to those aspects of the standard that relate to geo-location databases. However, licensees must be able to provide reasonable documented evidence that its equipment would conform to these standards if operated in either the United States or United Kingdom.

In addition, licences may be created that exceed the 250m Height Above Average Terrain (HAAT) limit required in FCC CFR Title 47, Part 15, Subpart H - Television Band Devices 15.701 – 15.717.

Examples of technologies that are not recognised TVWS technologies:

- Digital television broadcasting (DVB-T);
- Audio / Video senders; and
- Fixed links using conventional fixed equipment.

TVWS devices may only operate within the New Zealand Digital Television Channel Raster, which is based on an 8 MHz channel.[3]

Licence acquisition limit

A licensee is allowed licences for a maximum of four (4) contiguous or non-contiguous channels within any Territorial Local Authority. For clarification, in a frequency division duplex system this would mean a limit of 2x2 channels.
If a TVWS licensee is associated with another TVWS licensee within the same Territorial Local Authority then the acquisition limit applies to this associated group, i.e. the two licensees must not hold more than four TVWS licences between them. For a definition of association please refer to

[3] Bandwidths of less than 8 MHz would be permitted, as long as they are completely within one 8 MHz DTV channel.

Appendix 9: Definitions of Association for Television White Space licences.

Interim licence regime period

These licensing rules are intended as an interim solution, to:

- Promote innovative ways of providing wireless broadband;
- Allow users to take advantage of the growing body of TVWS equipment that is commercially available internationally;
- Allow industry to test TVWS technology locally;
- Give industry a licensing option under which to explore the future creation of a geo-location database;
- Gauge whether widespread TVWS deployment in New Zealand is feasible and likely.

Note that the use of geo-location databases is permitted, but not mandatory. Operators are able to use the licensing regime to test the use of databases, but database use is not linked to the licence conditions.

There is no fixed end point for the interim licence regime period, neither are there set criteria which must be met for the interim licence regime to be continued, revoked, or replaced.

Security of Tenure

There will be no security of tenure for TVWS licences under the interim licensing scheme, recognising that a balance must be struck between allowing interim use and development of TVWS systems, and protecting the rights of incumbent users. The Crown as the Manager has the right under section 57A of the Act to cancel a TVWS licence. The Crown may exercise this right with very limited notice.
It is envisaged that licences may be cancelled in the following situations:

- where the interim TVWS licensing regime is replaced by a long-term scheme such as a database approach to TVWS use;
- where changes to television licensing require subsequent changes to TVWS licensing;
- where a TVWS licensee is causing interference to television services; or
- where two or more TVWS licensees in the same area are unable to come to a coexistence agreement, noting that TVWS licences will have no receive or transmit protection.

The Crown also reserves the absolute right to cancel licences in other situations.

4.5.2. Engineering

Technical analysis

A full technical analysis by an ARE is required to ensure that any TVWS licence certified is technically compatible with DTT and no harmful interference will occur.
Any certified licence must only permit TVWS devices to operate on frequencies that are deemed to be technically compatible by the ARE.

No reliance on the TVWS device being able to self-manage interference shall be considered. When assessing technical compatibility for licensing purposes, AREs can ignore other TVWS licences as all licences are on a non-interference basis.

Interference Analysis

The '1 dB threshold degradation' method is to be used. This means that any signals from white space transmissions must not raise the noise floor of a DTT receiver by more than 1 dB. To achieve this it requires that any signals from TVWS devices arriving at a DTT receiver are at least 6 dB below the thermal noise floor.

This is a conservative approach but is appropriate for this interim licensing scheme. Although the DTT Engineering section identifies protection ratios specified for DTT and MPIS values specified on licences, these are not appropriate for interference calculations involving TVWS as they have been designed for assessing interference between two (or more) DTT services, not between other services and DTT.

For TVWS analysis, the following parameters should be used:

- Any signal(s) from any TVWS devices (fixed stations, base stations and user equipment) arriving at a DTT receiver within the 48 dBµV/m coverage[4] contour must be lower than -106 dBm. This is based on:
    - The thermal noise floor calculated based on a 7.77 MHz bandwidth; and
    - A noise figure of 6 dB5 for DTT receivers.
- Consider antenna gains and directivity. Antenna gain comes from Annex 2 of Recommendation ITU-R BT.1368-11 and is 14 dBi. AREs need to take care where there is overlapping coverage, infill sites, or a single frequency network is operating. There may be uncertainty about which direction viewers' antennas are pointing. As a worst case an ARE could assume no directivity and the maximum gain of the antenna. (Refer to Recommendation ITU-R BT.419-3 for details on directivity. This recommendation specifies either 16 dB discrimination for orthogonal polarisation or up to 16 dB for direction discrimination – depending on the angle).
- Cable and feeder losses should not be considered as there are unknown factors in this and the use of mast head amplifiers can largely overcome cable losses.

The analysis that should be conducted by the ARE is the following:

- Consider the expected coverage area of the DTT services(s). This may need to be calculated and predicted. Refer to Section 4.4 Television Broadcasting for details in calculating DTT coverage and the minimum field strengths. While the minimum field strength is defined as 48 dBµV/m, AREs should take care noting that there may be receivers operating satisfactorily in areas with a field strength of 44 dBµV/m.
- Conduct calculations to prove that any signals produced by devices operating under the proposed TVWS licences are 6 dB or more below the noise floor of a DTT receiver anywhere within the coverage of a DTT transmitter.
- It is not acceptable to conduct an interference assessment only against the protection locations on DTT licences. These protection locations are only 'survey points' and are designed for assessing DTT to DTT situations; and
- Consider adjacent channel leakage from the TVWS device and adjacent channel selectivity of DTT. Calculations for adjacent channel leakage should be conducted relative to 6 dB or more below the noise floor of the receiver (-106 dBm). Calculations for the adjacent channel selectivity should be conducted relative the minimum DTT

[4] Freeview publishes coverage maps which could give some guidance to AREs. AREs still need to conduct their own calculations in the certification process. Freeview coverage maps can be found: http://www.freeviewnz.tv/coverage/coverage-maps.aspx

[5] This noise figure is specified in Recommendation ITU-R BT.2036 *Characteristics of a reference receiving system for frequency planning of digital terrestrial television systems*.

wanted signal. Also, note that values specified are in different bandwidths and these may need to be normalised.

- Conduct calculations to ensure that the proposed TVWS licence will not cause interference through adjacent channel leakage. Details of the adjacent channel leakage of TVWS can be found in equipment specifications or the standards FCC CFR Title 47, Part 15, Subpart H – Television Band Devices 15.701-15.717 and ETSI EN 301 598 V1.1.1.
- Conduct calculations to ensure that the proposed TVWS licence will not cause interference through the adjacent channel selectivity of the DTT receiver. Details of adjacent channel figures can be found in Recommendation ITU-R BT.2033 *Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands* or ETSI EN 300 744. In the absence of more detailed information, a protection ratio of -30 dB can be applied for the first adjacent channel and -43 dB can be applied for the second adjacent channel or greater.

Table 12: Adjacent channel leakage ratios derived from Table 2 in ETSI EN 301 598

Channel (8 MHz)	Frequency (MHz)	Adjacent Channel Leakage Ratio (dB)				
		Class 1	Class 2	Class 3	Class 4	Class 5
Third adj	-28	84	74	84	74	64
Second adj	-20	79	74	74	64	53
First adjacent	-12	74	74	64	54	43
Co channel	Fc					
First adjacent	12	74	74	64	54	43
Second adj	20	79	74	74	64	53
Third adj	28	84	74	84	74	64

Table 13: Unwanted emission limits derived from 15.709 in FCC CFR 47, Part 15, Subpart H – Television Band Devices 15.701-15.717

Limits within DTV bands dBm / 100 kHz (EIRP)		
Fixed (conducted +6dBi antenna gain)	**Personal / Portable Adjacent to occupied TV channels**	**Other personal / portable**
-36.8	-56.8	-52.8

Licensing

TVWS can be licensed in the following ways:

(a) Coverage

This is a base station located at a fixed point with mobile / user equipment operated within the base station's coverage area. A licence to transmit is required for the base station and another licence is required for the mobiles to transmit within the coverage area. One mobile / user equipment licence allows an unlimited number of mobile or user equipment devices to be used.

(b) Fixed
This can be a fixed point-to-point or fixed point-to-multipoint system. Each transmitter must be licensed for a specific point location. Fixed point-to-point systems must use directional antennas. For fixed point-to-multipoint systems, the hub site may use a non-directional antenna.

Where there is a relationship between licences these must be associated with each other in the Register. For example, with a 'Coverage' system the base station licence and the mobile licence must be associated. For a 'Fixed' system the licences for the ends of the fixed links should be associated. These can be added after the licence has been certified, the licence status is 'planned' and the annual licence fee has been paid for.

Licence Types

The licence type "Other < 10 dBW (Spectrum)" is to be used.

The fee category will be D as per Schedule 6 of the Regulations 2001. To select this category in the Register, an applicant will need to select FIXED > CROWN SPECTRUM > OTHER < 10 dBW (Spectrum), as shown in Figure 2.

Figure 2: Licence type selection for creating a licence in the Register.

Management Right

TVWS is permitted in the Crown-owned management right MR 364 (510-606 MHz, i.e. channels DTV26 – DTV37).
TVWS is not permitted in the other frequencies allocated for DTT (606-686 MHz, i.e. channels DTV38 – DTV47).
DTV channels 38 and 39 (606-622 MHz) are covered by a management right owned by Te Mātāwai and any use wherein must be by agreement with Te Mātāwai as the Manager.

DTT channels 40 to 47 (622-686 MHz) do not currently contain long-term spectrum licences for television broadcasting. TVWS is not permitted in these channels for two reasons:

- The aim of the interim TVWS scheme is to allow potential licensees to trial TVWS use in real-world conditions. TVWS devices are designed to operate in the spaces between allocated television channels, not in clear spectrum.
- Pending possible future allocation, the Crown wishes to keep these channels clear.

Contents of a Licence

The licence for a TVWS must contain the following details:

(a) Basic details
The licence must be for 'licence transmit' only, i.e. under section 48(1)(b) of the Act. No reception or protection from interference shall be specified on the licence.

(b) Spectrum details
This will be frequencies or DTV channels on which the TVWS device(s) will operate. TVWS is only permitted on the New Zealand DTV raster. Up to four contiguous or non-contiguous channels, or an equivalent frequency range, that covers the usage must be specified under spectrum details. DTV channels can be used where the emission is 8 MHz or less. If the emission is greater than 8 MHz, this must be entered as part of the licensed channels/frequency range.

(c) EIRP
This must reflect the actual EIRP of the devices. In any case the maximum EIRP must not exceed 10 dBW.

(d) Emission designator
This must accurately describe the bandwidth of the transmission and type of modulation. This should preferably be taken from the manufacturer's specifications.

(e) Transmit details location
Depending on what licence is being created, this could be one of the following:

i. Fixed
This will be a specific geographic location 'point' location type describing an end of the fixed link. Equipment detail and antenna details must be specified. Unless the fixed link is uni-directional, another licence will be required for the other end of the fixed link.

ii. Base station
This will be a specific geographic 'point' location type describing the base station. Equipment detail and antenna details must be specified.

iii. Mobile
This is the mobile or the user equipment operating within the coverage of a base station. This is a 'multiple point' location type and should be a complex polygon that describes the coverage of the base station and limits the area where mobiles / user equipment are permitted to operate.

(f) Radiation pattern
This must be set to describe the directivity of the antennas being used. In the case of a mobile or user terminal this is likely to be omni.

(g) Conditions
The Authorisations must be set as:

Transfer Licence: Rightholder and Manager

Modify Licence: Rightholder or Manager

Cancel Licence: Manager

The following specific conditions must be placed on the licence:

i) Transmissions pursuant to this licence must not cause interference to reception of services licensed and protected pursuant to a spectrum licence or a radio licence, the manager reserves the right cancel this licence or require that any transmission pursuant to this licence change frequency, reduce power or cease operation.

ii) This licence offers no reception protection from other services licensed pursuant to a spectrum licence or a radio licence. The manager does not accept liability under

any circumstances for any loss or damage of any kind occasioned by the unavailability of frequencies or interference to reception.

iii) Digital Terrestrial Television services may be established or modified at any time. If transmissions pursuant to this licence are likely to cause harmful interference to new or modified DTT services, this licence may be required to change frequency, reduce power or cease operation.

iv) This licence provides for the trial of TVWS devices and is an interim arrangement. It is intended that a long term regime will be developed. Once a long term regime has been developed this licence will be cancelled and transmissions pursuant to this licence must either cease operation or comply with the new regime.

v) Equipment operated under this licence must either conform with FCC CFR 47, Part 15, Subpart H – Television Band Devices 15.701-15.717 or ETSI 301 598, with the following exceptions:

- devices are not required to conform to the parts of these standards that require the use of a geo-location database; and
- licences may be created that exceed the 250 m Height Above Average Terrain (HAAT) limit required in the FCC CFR 47, Part 15, Subpart H.

(h) Unwanted emission limit
An unwanted emission limit must be set on the licence using either 'TVWS8', 'TVWS16', 'TVWS24' or 'TVWS32' spectrum masks depending on the bandwidth being licensed.

4.6. Managed Spectrum Park

4.6.1. Transitional Arrangement

All existing spectrum licences in the MSP certified prior to 1 May 2015 are still valid. The rules set in this section apply to any new or amended licences from 1 May 2015 onwards.

4.6.2. Planning

The Managed Spectrum Park (MSP) has a number of rules outside this document that must be followed, these include allocation rules, park rules and licence agreements. Applicants and AREs should familiarise themselves with these rules.

Read more about managed spectrum parks

The MSP is in the frequency range 2580 – 2620 MHz under Crown Management Right 258 until 31 December 2028. The actual and usable frequencies are outlined in table 14.

Table 14: Frequency range applicable for Managed Spectrum Park

Frequency band (MHz)	Guard band (MHz)	Net available spectrum (MHz)
2 575 – 2 620	2 575 – 2 580	2 580 – 2 620

The MSP is designed to facilitate local and regional wireless services, and seeks to encourage a flexible, cooperative, low cost, and as far as possible, a self-managed approach to allocation and use of the radio spectrum resource.

The MSP has no particular channel plan and the way the park is used must be in accordance with the MSP Allocation Rules. However, AREs are encouraged to licence the minimum bandwidth needed as the MSP is a shared resource.

Standards and technology used

The MSP is technology neutral and there are no specific requirements or restrictions on the technology used. However the band suits a number of technology standards which have wide equipment availability. The following band classes align with the MSP:

- IEEE 802.16 (WiMAX Band Class Group 3) / ETSI EN 302 326;
- 3GPP Band 41 (TDD LTE in the band 2 500-2 690 MHz); and
- 3GPP Band 38 (TDD LTE in the band 2 570-2 620 MHz).

4.6.3. Engineering

Coverage

The minimum field strength for the coverage of a service provided by systems in the MSP is 40 dBµV/m based on a nominal antenna gain of 17 dBi. This values assumes a minimum receive signal level of -89 dBm at the input of the receiver to define the edge of coverage. It sets a reasonable expectation of coverage.

Customer Premise Equipment (CPE) is not expected to be operated outside the coverage area beyond the minimum field strength of 40 dBµV/m. This minimum field strength can be used to estimate the coverage of licensed systems and therefore assess potential interference and technical compatibility.

Maximum Permitted Interfering Signal

MPIS is required for the protection area on licences in the MSP. The default minimum MPIS value is 34 dBµV/m. This value sets a reasonable level of reception protection that a licensee can expect. The MPIS value applies to the outside perimeter of the protection area.

Protection Areas

Licences in the MSP have a protection area specified to describe the expectation of receive protection location. This protection area should reflect the coverage of the base station as accurately as practicable. It is also where customer premise equipment is allowed to transmit.

It is recommended that the polygon representing the protection area be more prescriptively described using a large number of points that resemble the coverage area (noting that a simple shape like triangle or rectangle is unlikely to be an accurate representation of a coverage area). An acceptable example is shown in Figure 3.

The transmit location specified on the customer premise equipment must be within the multiple points used to define the protection area on the base station licence. The receive protection location specified on the customer premise equipment licence must be the corresponding base station location.

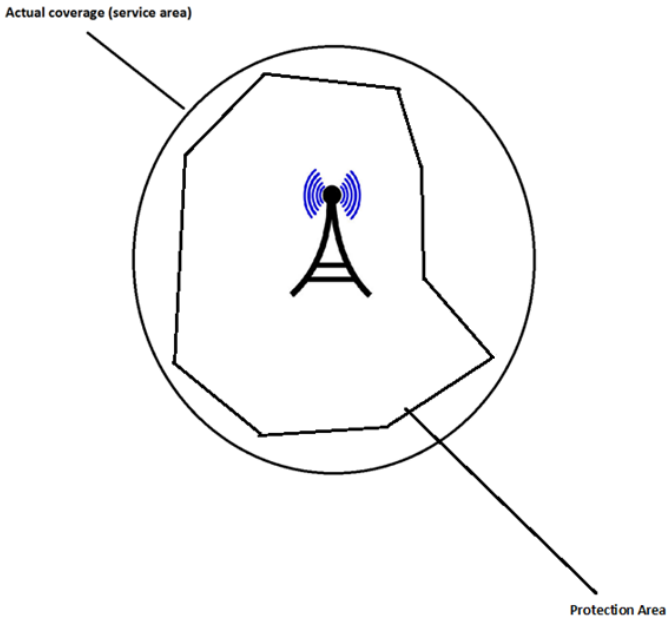


Figure 3: Example of how protection areas are to be prescribed.

Maximum Power (EIRP)

To enable better sharing of spectrum resource within the MSP, the power prescribed on licences in the MSP should be the minimum required for a satisfactory service. The maximum permitted EIRP allowed on MSP licences is 29 dBW, applicable to any necessary bandwidth within the frequency range 2580-2620 MHz.

Technical Compatibility

AREs should familiarise themselves with sections 1 and 2 of this document. In particular, their requirements for certifying licences and assessing technical compatibility. AREs should also be familiar with their requirements under the Act.

Assessing for Interference

AREs need to carefully identify the interference scenarios that they need to assess. Systems operating in the MSP based on time division duplex (TDD) technology should consider the following eight interference scenarios for systems in adjacent areas:

Outward interference

1. New base station to victim customer premise equipment
2. New base station to victim base station
3. New customer premise equipment to victim customer premise equipment
4. New customer premise equipment to victim base station

Inward interference

5. Existing base station to new customer premise equipment
6. Existing base station to new base station
7. Existing customer premise equipment to new customer premise equipment
8. Existing customer premise equipment to new base station

Where two systems are operating in the same area on different frequencies, receiver overload and desensitisation can occur. In this situation licensees may need to seek agreement with other affected licensees to implement time synchronisation systems.

Interference Thresholds

When assessing for interference and technical compatibility against licences, AREs need to carefully consider the receive protection described by the licence. The receive protection is described by a protection area and the MPIS. When assessing interference to existing licences, any new service cannot exceed the MPIS value on the perimeter of the protection area of an existing licence.

The default values on new licences are:

- Coverage area: 40 dBµV/m
- MPIS: 34 dBµV/m

Under section 25 (5) (d) of the Act, AREs must certify that a licence "is technically compatible with services authorised to be operated under existing spectrum licences and radio licences". This means that AREs should assess the actual coverage of the existing service, as only assessing to the protection area on the respective licence may not be sufficient.

Table 15 gives an example on how antenna gain can affect the effective MPIS and therefore the protection of the service. It is important to note that antenna of higher gain would usually associate with narrower beam width.

Table 15: Relative changes to effective MPIS based on different antenna gain

Antenna gain (dBi)	Effective MPIS (dBµV/m)	Conservative -3 dB beam width (degrees)	Conservative -6 dB beam width (degrees)
0	34	360	360
10	24	180	200
15	19	40	50
20	14	23	30
25	9	14	18

Methodology and Signal Strength Calculations

There is no prescribed methodology of propagation modelling for conducting interference analysis or conducting signal strength calculations. AREs may use their judgement on suitable engineering practice based on either a worst case constitutive analysis or a thorough analysis using advanced prediction software. In any case, in certifying a licence ARE must ensure technical compatibility and ensure harmful interference does not occur.

Section 3.10 Signal Strength Calculations of this document provides some guidance on signal strength calculations.

Technical Agreements between Right Holders

A new licensee may be able come to a technical agreement with an existing licensee/right holder to achieve technical compatibility. Technical agreements may allow the certification of licences which could not otherwise be certified because of interference. These technical

agreements between right holders should be in writing and recorded against the event summary of the licence in the Register.

Point-to-Multipoint Architecture

The architecture or network structure of each system within a Territorial Local Authority (TLA) and within an MSP is assumed to be point-to-multipoint configuration as shown in Figure 4. This will require one or more spectrum licences for each base station, and may have a single licence covering all of the customer premise equipment accessing all of the operator's base stations in the band. Each base station licence will identify the base station location as the transmit location, and must show the coverage area as the receive area where customer premise equipment can communicate with the base station.

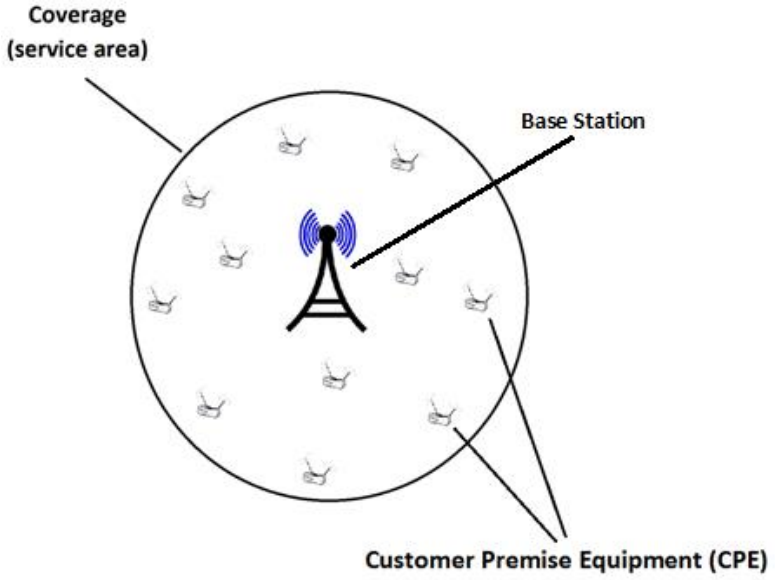


Figure 4: Typical point to multipoint architecture of licences in the MSP

Base Station Licence

Each licence for a base station has the transmitter location of the base station, and the receive protection location of the customer premise equipment. It is not necessary to identify individual customer premise equipment in the licence. The receiver location when provided as a number of points on the base station licence effectively defines the polygon describing the protection area, and allows for the protection of customer premise equipment receivers anywhere within that area.

Base stations must be licensed under one of the following categories:

- Fixed / Crown Spectrum / Other >=20 & <30 dBW (Spectrum)
- Fixed / Crown Spectrum / Other >=10 & <20 dBW (Spectrum)
- Fixed / Crown Spectrum / Other <10 dBW (Spectrum)

For base stations with multiple antennas serving individual sectors or groups of sectors where each sector or set of sectors occupying different channels within the MSP, a separate licence must be used for each set of sectors with their common channels. This is to ensure the aggregated horizontal radiation pattern (HRP) of those sectors can be shown on the licence for these channels. The nulls between those sectors can then be identified for co-ordination.

Customer Premise Equipment Licence

A single licence may be used to cover all customer premise equipment within the coverage of a base station. The transmit location specified on the customer premise equipment must be within the multiple points used to define the protection area on the base station licence.
The receive protection location specified on the customer premise equipment licence must be the corresponding base station location.

An alternative acceptable approach is to register a separate licence for each customer premise equipment being served by individual base station.
The customer premise equipment licence must be associated with the base station licence.
Customer premise equipment must be licensed under one of the following categories:

- Fixed / Crown Spectrum / Other >=20 & <30dBW (Spectrum)
- Fixed / Crown Spectrum / Other >=10 & <20dBW (Spectrum)
- Fixed / Crown Spectrum / Other <10dBW (Spectrum)

Licence Information Recorded

For efficient use of the spectrum in the MSP, AREs must provide and record technical information about the actual equipment, technical installations, and service operated as accurate as practicable. This will enable sharing with other MSP operators while preventing harmful interference.

The detailed information contained on licences should include:

- Emission designator
- EIRP
- Horizontal radiation pattern
- Unwanted emission limits (UEL) of a transmitter
- MPIS
- Transmit location
- Transmit antenna height, azimuth (if applicable), type, make and model, and configuration losses
- Transmit equipment make and model
- Receiver antenna height, azimuth (if applicable), type, make and model, and configuration losses
- Receiver equipment make and model

In principle, any licence within the MSP must not use the lower and upper frequencies of the whole MSP management right, but should show the frequency limits of the channel or sub band for each sector or set of sectors using that channel.

4.7. Regional Broadband Use in 3.3 GHz

The engineering rules set out in this section apply to spectrum licenses granted for the purpose of regional broadband use in New Zealand from the 1st of July 2023. In this context, regional broadband use implies a Fixed Wireless Access (FWA) service that uses non-national spectrum within the frequency range 3 300 – 3 340 MHz. Reference to the term "non-national spectrum" is made to differentiate radio spectrum that users can access within a particular localised geographical region and the spectrum is not available nation-wide.

4.7.1. Planning

Technical Compatibility

Assignment of licenses for Regional Broadband use within the 3 300 – 3 340 MHz frequency range has a number of other rules outside the scope of this document which must be followed. These include https://www.rsm.govt.nz/assets/Uploads/documents/auctions/licence-agreement-for-licences-within-3.30-3.34ghz.pdf. The engineering rules described in this section should be read in conjunction with the guidelines provided in sections 2 (General) and 3 (Compatibility and other technical issues) of this document. Licence applicants and AREs should familiarise themselves with these rules.

The operation of FWA services as part of regional broadband use is in the frequency range 3 300 – 3 340 MHz under Crown Management Right 514 which expires June 30, 2033. The 3 300 – 3 340 MHz frequency range (part of 3 300 – 3 400 MHz) is a subset of the overall operating band which spans from 3 300 – 3 800 MHz, also containing other MR holders. The permitted usable frequencies are outlined in Table 19.

Table 19 – Range of the Crown MR for Regional Broadband use

Operating Frequency Band (MHz)	Net Available Spectrum (MHz)
3 300 – 3 800	3 300 – 3 340

The engineering rules are designed to encourage a flexible, cooperative, low-cost, and as far as possible, self-managed approach to the use of the 3 300 -3 340 MHz radio spectrum. The allotment of 3 300 – 3 340 MHz of radio spectrum is based on 2 x 20 MHz channels or 1 x 40 MHz channel as shown in Figure 6.

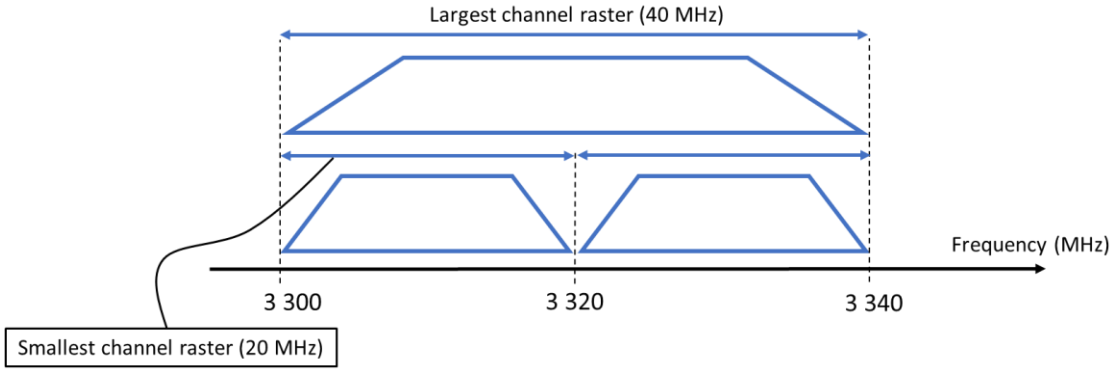


Figure 6: Allotment of 3 300 – 3 340 MHz band into 2 x 20 MHz or 1 x 40 MHz channels.

From this, the smallest channel size which can be licensed is 20 MHz (3 300 – 3 320 MHz), while the largest channel size which can be licensed is 40 MHz (3 300 – 3 340 MHz). Within a given geographical area AREs can licence up to two regional broadband users with the 2 x 20 MHz channel allocation. AREs cannot licence a smaller channel size than 20 MHz and can also not licence a larger channel size than 40 MHz. AREs are permitted to only license 20 MHz or 40 MHz channels. The 2 x 20 MHz channel allocations are denoted as "RB1" (from 3 300 – 3 320 MHz) and "RB2" (from 3 320 – 3 340 MHz), while the 40 MHz channel is denoted by "RB12" (from 3 300 – 3 340 MHz). This terminology is aligned with that in the RSM Register for Radio Frequencies.

Permitted Technology Standards

Given that the 3 300 – 3 340 MHz frequency range is a subset of the 3 300 – 3 400 MHz, which forms part of the wider 3 300 – 3 800 MHz band, various technology choices and standards are available for use. The technology standards have a wide range of radio equipment availability. While there are no specific requirements or restrictions on the technology used to provide FWA services for regional broadband, the following standardised bands and their underlaying standards align with the frequency range of 3 300 – 3 340 MHz:

- IEEE 802.16/ETSI HiperMAN (WiMAX Band Class Group 3 in the frequency range 3 000 – 4 000 MHz) via ETSI EN 302 326, 302 217, and 302 085;
- 3GPP Band 52 (TDD 4G-LTE in the frequency range 3 300 – 3 400 MHz) via 3GPP Technical Specifications 36.104 and 36.101; and
- 3GPP Band n78 (TDD 5G-NR in the frequency band 3 300 – 3 800 MHz) via 3GPP Technical Specifications 38.104 and 38.101.

Keeping the above in mind, AREs should note that parts of the 3 400 – 3 800 MHz frequency range are widely used for 5G-NR mobile services throughout New Zealand. As a result of this, the primary/default technical conditions recommended for use are given in Annex 10 (Primary/default technical conditions in the 3 300 – 3 800 MHz frequency band). Users complying with the default/primary technical conditions will be considered as the primary users of the 3 300 – 3 800 MHz frequency band with the right to obtain protection from harmful interference. Users not complying with the primary/default technical conditions listed in Annex 10 will be treated as operating on an effective secondary basis and cannot claim interference protection from primary users.

4.7.2 Engineering

Reference Antenna Radiation Patterns at the Transmitter (FWA Base Station)

For the purpose of the discussion contained in this sub-section, the term "transmitter" implies a FWA radio base station operating within a single sector or across multiple sectors within the service area of the transmitter. For simplicity, the antenna radiation patterns are described for a single sector, however, if desired, the same pattern described can be applied to other sectors. When creating a license, AREs should include the transmitter radiation patterns in calculations to determine technical compatibility of a licence with other licenses. RSM does not stipulate, endorse or recommend any particular commercial software product for the purpose of computing the reference radiation patterns. The selection of an appropriate reference pattern for technical compatibility assessment is the responsibility of the ARE. Where possible, measured transmit antenna radiation pattern and other related characteristics/parameters are to be used. These details may be supplied by the antenna manufacturer. In the absence of measured antenna pattern, AREs should use the following set of reference antenna patterns:

- Recommendation ITU-R F.1336 "*Reference radiation patterns of omnidirectional, sectoral and other antennas for the fixed and mobile services for use in sharing studies in the frequency range from 400 MHz to about 70 GHz*".[6] Recommends 3.1 beginning Page 3 of the recommendation is to be used for the antenna pattern and associated characteristics in both the azimuth and elevation domains. Where possible, the azimuth and elevation beamwidth of actual antennas (to be deployed) are to be used. In the absence of actual values from the manufacturer, the following parameters and values are to be used in the construction of the reference radiation pattern:
    - Half-power (3 dB) azimuth beamwidth: Around 70°;
    - Half-power (3 dB) elevation beamwidth: Around 7°;
    - The parameters $k_a = k_p = k_h = 0.7$; and
    - The parameter $k_v = 0.3$.

  A maximum antenna gain (gain at the antenna boresight) of 17 dBi is to be used. For the purpose of simplification, no downtilting is to be considered while using this reference radiation pattern.
- ETSI Technical Report 25.996 "*Spatial channel model for Multiple Input Multiple Output (MIMO) simulations*". Where possible, the azimuth and elevation beamwidth and other relevant technical parameters of actual antennas (to be deployed) are to be used. In the absence of actual values from the manufacturer, the reference antenna radiation pattern described in Section 4.5.1 on Page 8 is to be used with the following parameters and values:
    - Half-power (3 dB) azimuth beamwidth: Around 70°;
    - Half-power (3 dB) elevation beamwidth: Around 7°; and
    - Front-to-back-ratio (the parameter A_m): Around 20 dB.

  A maximum antenna gain of 17 dBi is to be used. For the purpose of simplification, no downtilting is to be considered while using this reference radiation pattern.

Reference Antenna Radiation Pattern at the Receiver (FWA CPE)

For the purpose of the discussion contained in this sub-section, the term "receiver" implies a FWA CPE tuned to the appropriate frequency range for signal reception from the transmitter (FWA radio base station). When creating a license, AREs are encouraged to include the receiver radiation patterns in calculations to determine technical compatibility of a licence with other licenses. RSM does not stipulate, endorse or recommend any particular commercial software product for the purpose of computing the reference radiation patterns. Where possible, measured receive antenna radiation pattern and other related characteristics/parameters are to be used. These details may be supplied by the antenna manufacturer. In the absence of measured antenna pattern, AREs are to use the omnidirectional antenna pattern from Recommendation ITU-R F.1336 with a maximum antenna gain of 9 dBi.

Protection Areas

Licenses in the 3 300 – 3 340 MHz frequency range have a protection area specified to describe the expected service protection location. The protection area is to reflect the coverage of the transmitter (FWA base station) as accurately as possible and practicable. The protection area should be specified keeping in mind where the communicating receiver (FWA CPE) is allowed to receive to, and transmit from. Prior to defining a protection area, AREs should define the service area based on free-space propagation conditions.

[6] Accessed via https://www.itu.int/rec/R-REC-F.1336/en.

For licenses in 3 300 – 3 340 MHz frequency range, a *maximum possible* service area of 30 km is allowed. AREs must design the protection area to be *less than* 30 km. For computing the protection area, AREs should consider the use of more advanced coverage prediction tools complying with Recommendation ITU-R P.526 and P.1812. Unlike Recommendation ITU-R P.525, these models take into account the effects of propagation by diffraction (ITU-R P.526), terrain-specific variations in the point-to-multipoint links (FWA base station to multiple FWA CPEs), and detailed clutter loss modelling (ITU-R P.1812) determined as a function of the clutter clearance heights in the surrounding environment from the ITU-R Recommended database of typical values described in ITU-R P.1812. These are important mechanisms for deriving a protection area. The coverage prediction tool used by AREs should be able to map the geographical area for which a licence needs to be granted via a polygon representing the protection area. AREs should ensure that the polygon representing the protection area is prescriptively described using a large enough number of points that resemble the desired coverage area of the license. AREs should note that in most cases, a simple shape, e.g., a square, rectangle, or triangle is unlikely to be an accurate representation of a coverage area.[7] The transmit (base station) location specified on the receivers (FWA CPEs) must fall within the multiple points used to define the protection area on the transmitted license. The receive protection location specified on the receiver must be the corresponding transmitter location.

An acceptable example of the protection area relative to the service area is shown in Figure 7.

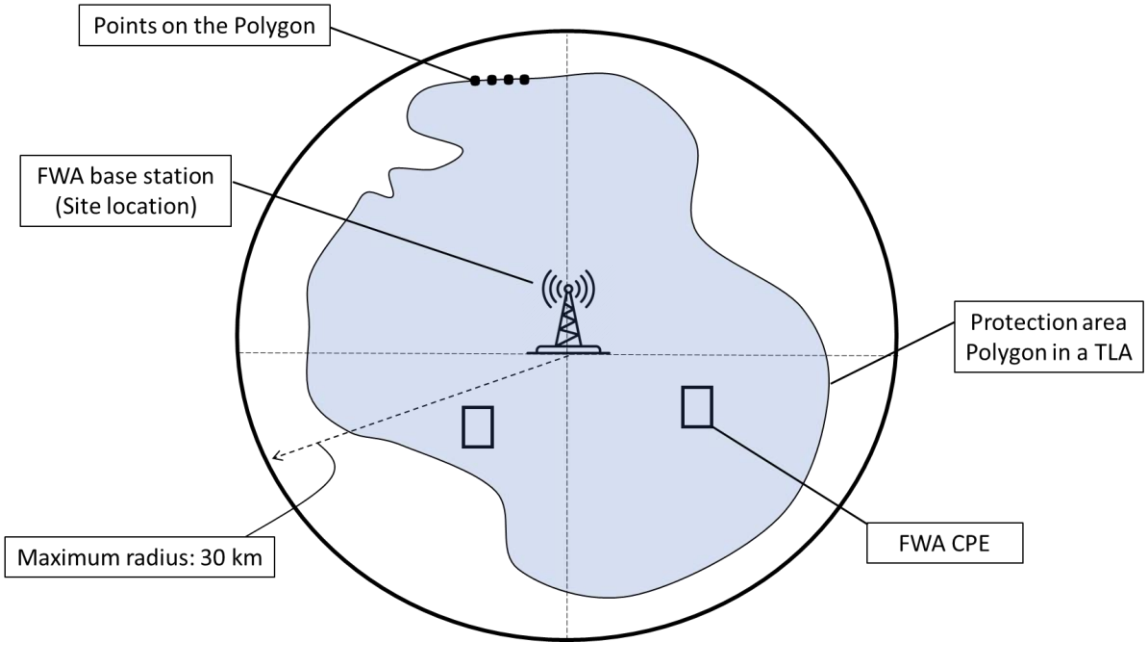


Figure 7: Service area relative to protection area for regional broadband FWA use.

[7] While it is an ARE's responsibility to use their judgement to define an area in sufficient detail to accurately represent it, there may be scenarios where RSM will request that an ARE amend an area definition if it has been defined in too little or too great detail. While it is possible to map an area in immense detail, mapping of more than a few hundred points will impact on the ability of RRF users to load licences. While it is possible there may be situations where this is appropriate, generally highly complex descriptions (of more than a couple of hundred points) are not needed.

Note that applications for new licences which result in any overlap of protection areas or interaction with other planned or current licences in the Management Right are not permitted.

Maximum Permitted Transmit EIRP

The maximum transmitted e.i.r.p. prescribed on licenses in the frequency range of 3 300 – 3 340 MHz for regional broadband use is to be calculated via the following formula

$$P_{\text{EIRP Max}} = P_{\text{TX Max}} + G_{\text{TX Max}} - L_{\text{TX}},$$

where $P_{\text{TX Max}}$ denotes the maximum transmit power at the antenna port of the transmitter (typically defined in dBm), $G_{\text{TX Max}}$ denotes the maximum antenna gain in the direction of the antenna boresight (typically defined in dBi), and L_{TX} (typically defined in dB) denotes the feeder loss from the antenna port to the input of the radiator. According to this formulation, and taking into account the guidelines on the above parameters provided on Page 12 of Recommendation ITU-R M.2292 "*Characteristics of terrestrial IMT-Advanced systems for frequency sharing/interference analyses*", the maximum permitted EIRP on licenses can be calculated as

$$P_{\text{EIRP Max}} = 46 \text{ dBm} + 17 \text{ dBi} – 3 \text{ dB} = 60 \text{ dBm} = 30 \text{ dBW}.$$

The values employed in calculating the maximum e.i.r.p. are from Recommendation ITU-R M.2292. The maximum permitted transmit e.i.r.p. remains applicable to any necessary bandwidth within the allocated channel size of either 20 MHz (3 300 – 3 320 MHz) or 40 MHz (3 300 – 3 340 MHz).

Coverage

Based on the assumptions listed in computing the maximum transmit e.i.r.p and free-space propagation loss, the received signal level (typically defined in dBm) arriving at the FWA CPE antenna located at the physical edge of the service area in (limited to a maximum of 30 km, as stated earlier) is to be calculated using the following formula:

$$P_{\text{RX}} (\text{distance} = 30 \text{ km}) = P_{\text{EIRP Max}} – L_{\text{FS}} (\text{distance} = 30 \text{ km}),$$

where L_{FS} denotes the free-space propagation path loss (typically provided in dB) at the edge of the service area (i.e., at 30 km distance from the FWA base station) computed at 3 320 MHz (mid-point frequency from 3 300 MHz to 3 340 MHz). This implies that

$$P_{\text{RX}} (\text{distance} = 30 \text{ km}) = 60 \text{ dBm} – 132 \text{ dB} = -72 \text{ dBm} = -42 \text{ dBW}.$$

This sets a reasonable expectation of coverage. Assuming a 50 Ohm load or input impedance system, using the standard procedure for converting the units of the above formula from dBm to dBµV yields

$$-42 \text{ dBm} + 107 = 35 \text{ dBµV}.$$

Adding the antenna factor of 40.6 computed at the centre frequency of 3 320 MHz with an antenna gain of 0 dBi (see https://www.everythingrf.com/rf-calculators/antenna-factor-calculator for an antenna factor calculator) yields

$$40.6 + 35 = 75.6 \text{ dBµV/m} \approx 76 \text{ dBµV/m}.$$

As such, the CPEs are not expected to operate outside the coverage area beyond the electric field strength level of 76 dBµV/m. This can be used to estimate the coverage of licensed systems and therefore assess potential interference and technical compatibility.

Signal Strength Calculations

In certifying a licence, AREs must ensure all measures are taken to not cause harmful interference. Accurate calculations of both wanted and unwanted signal strengths requires in-depth knowledge of the radio propagation environment over which both the transmitter and receiver are operating in. In the absence of field measurements, accurate radio propagation models should be used to calculate the wanted and unwanted signal strengths. The Ministry does not stipulate, endorse or recommend any particular commercial software product for this purpose.

AREs are recommended to use the following ITU-R Recommendations for a detailed assessment of both wanted and unwanted signal strengths for the purpose of creating licences in the 3 300 – 3 340 MHz frequency range:

- Recommendation ITU-R P.1812 "*A path-specific propagation prediction method for point-to-area terrestrial services in the frequency range 30 MHz to 6000 MHz".*
  This propagation prediction method should take into account the following propagation mechanisms:
  - Line-of-sight propagation;
  - Propagation via diffraction (embracing both the irregular terrain and sub-path cases);
  - Propagation via layered reflections; and
  - Location variability.

  The basic input data to the P.1812 model is described in section 3.1 of the Recommendation, while radio path profiles modelling is described in section 3.2, which includes the construction of terrain profiles using actual terrain heights as well as the modelling of clutter losses based on the clutter categories described for a variety of different environments. The overall prediction procedure to be followed is given in section 4 of the Recommendation, in particular, sections 4.2, 4.3 (including 4.3.1, 4.3.4, and 4.3.5), 4.5, 4.6, and 4.7 capture the detailed modelling of the abovementioned propagation mechanisms. The procedure outlined in section 4.10 is to be used to convert the transmission loss to an overall field strength at a defined centre frequency and reference e.i.r.p. for a given percentage of time over a given percentage of locations. The overall default model parameters useful for input to the Recommendation are given by:
  - p = 50% denoting the percentage of average year for which the calculated signal level is exceeded;
  - p_L = 50% denoting the percentage of locations for which the calculated signal level is exceeded;
  - φ_t, φ_r specific to deployment denoting the latitude of the transmitter (FWA base station) and receiver (FWA CPE) in degrees spanning -80° to 80°;
  - ψ_t, ψ_r specific to deployment denoting the longitude of the transmitter and receiver (positive = East of Greenwich) in degrees spanning -180° to 180°;
  - h_{tg}, h_{rg} specific to the deployment denoting the antenna centre height above ground level; and
  - w_s = 27 m denoting the street width in a common rural scenario.

  The above default values should be used unless specific local values better suited to a particular deployment are available.

If AREs are unable to carry out the signal strength calculations using ITU-R P.1812, the baseline propagation models which should be used for the purpose of signal strength calculations are:

- Recommendation ITU-R P.526 "*Propagation by diffraction*"; and
- Recommendation ITU-R P.525 "*Calculation of free-space attenuation*".
  These propagation prediction methods should take into account propagation by diffraction and free-space attenuation with the following default parameters:
  - *K* Factor = 4/3 for wanted and 2 for unwanted signal strength analysis;
  - Deygout 94 Diffraction geometry for wanted and unwanted interference profiles; and
  - Fresnel zone = 0.6 with the inclusion of subpath attenuation loss of a particular time (e.g., "Standard", "Coarse", etc.). This relates to Fresnel obstruction loss and foreground loss.

The above default values should be used unless specific local values better suited to a particular deployment are available.

The Ministry does not stipulate, endorse or recommend any particular commercial software product for conducting signal strength calculations with Recommendations ITU-R P.1812, P.526, and P.525.

MPIS Level Determination

A MPIS level is required to be determined for the protection area described by the polygon on licences created for regional broadband use. Any new service cannot exceed the MPIS value on the perimeter of the protection area of an existing licence. When assessing for interference and technical compatibility against licences, AREs need to carefully consider the receive protection described by the licence. The default values on new licences can be set to:

- Coverage of a service area: 34 dBµV/m;
- MPIS level at the FWA base station and FWA CPE: 34 dBµV/m.

Under section 25(5)(d) of the Radiocommunications Act 1989 (last revised in 2001)[8], AREs must certify that a licence "*is technically compatible with services authorised to be operated under existing spectrum licences and radio licences*". This implies that AREs should assess the actual coverage of the existing service, as only assessing to the protection area or the maximum coverage area (for worst case) on the respective licence may not be sufficient. AREs should note that the MPIS level is correlated with the maximum antenna gain. This relationship has been demonstrated in section 4.6.3 ("*Engineering for the Managed Spectrum Park*") of this document.

UEL for the FWA Base Station

AREs must apply an UEL within out-of-band domain which is prescribed and derived for the FWA base station in specification ETSI EN 302 326 V2.1.0 (2020-08), "*Fixed Radio Systems; Multipoint Equipment and Antennas*". In particular, the methodology outlined in section 5.3.4 of ETSI EN 302 326 ("*Transmitter Radio Frequency spectrum mask and emissions*") is to be followed with the Primary Equipment Type (EqC-PET) = "F" which caters for radio equipment utilizing frequency-division multiple access signalling. For defining a more permissive UEL (rather than a more restrictive UEL), the lowest Equivalent Modulation Order (EqC-EMO) = "2"

[8] Accessed via https://www.legislation.govt.nz/act/public/1989/0148/latest/DLM196550.html.

is chosen. Accordingly, Table 3 on Page 25 of ETSI EN 302 326 ("*Transmitter Radio Frequency Spectrum Mask Reference Corner Points*") defines the UEL, in the general case.

Taking an *example case* of the 20 MHz channel in RB1 or RB2 as defined earlier, the UEL depicted in Figure 8 can be derived. The discrete points P_1, P_2,…,P_7 defining the UEL envelope are obtained from Table 3 of section 5.3.4 from ETSI EN 302 326. These points are described in Table 20 where the exact *x*-axis to *y*-axis relationship for each point is defined. On the power scale (*y*-axis of Figure 8), the UEL is defined in units of dBW relative to the power at the carrier centre frequency with respect to the frequency offset in units of MHz relative to the carrier centre frequency (*x*-axis of Figure 8). While Figure 8 only depicts the positive frequency offset relative to carrier centre frequencies, naturally, the corresponding negative frequency offsets need to be mirrored on the left-hand side of Figure 8 relative to its *y*-axis.

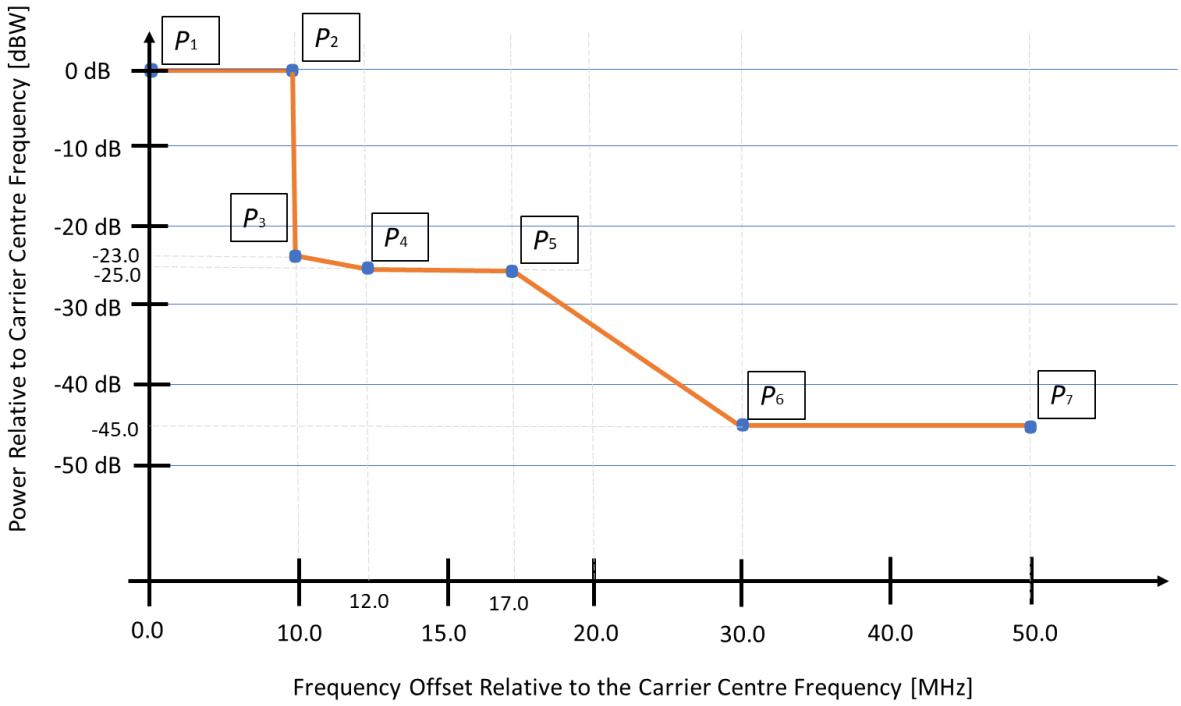


Figure 8: An example UEL for a 20 MHz channels in RB1 and RB2 derived from ETSI EN 302 326 specification for FWA base stations. The points P_1, P_2,…P_7 are as defined in Table 20.

Table 20 – UEL Corner Points for FWA Base Station for a 20 MHz Channel in RB1 or RB2

UEL Corner Point	Maximum Relative Power for a 20 MHz Reference Bandwidth [dBW]	Frequency Offset Relative to Carrier Centre Frequency [MHz]
P_1	0.0	0.0
P_2	0.0	10.0
P_3	-23.0	10.0
P_4	-25.0	12.0
P_5	-25.0	17.0
P_6	-45.0	30.0
P_7	-45.0	50.0

The UEL takes the same form for the 40 MHz channel defined earlier as RB12. The UEL for RB1 and RB2 channels are denoted as “UELRB1” and “UELRB2”, while the UEL for RB12 is denoted as “UELRB12”. When creating licenses, AREs need to appropriately select and reference the UEL from UELRB1, UELRB2 or UELRB12, as loaded in the RSM RRF. The UELs for both UELRB1 and UELRB2 are depicted in Table 21 and 22, while the UEL for UELRB12 is depicted in Table 23. The first column of Tables 21 – 23 denote the UEL corner point index with the “-“ sign denoting the points below the carrier centre frequency. The second column defines the frequency offset relative to the carrier centre frequency, while the third column lists the specific operating frequencies over which UEL is applicable. The fourth column defines the maximum relative power for a given reference bandwidth of 20 MHz (Tables 21 and 22) or 40 MHz (Table 23). Column five denotes the maximum set power level which is computed from subtracting the maximum allowed EIRP of 30 dBW from the value in column four for a given reference bandwidth of 20 MHz or 40 MHz. Columns 6 and 7 denote the maximum relative and set power levels for 1 MHz bandwidth by subtracting 10 $\log_{10}(20)$ or 10 $\log_{10}(40)$ appropriately from the counterpart value in columns 4 and 5, respectively.

Table 21 – UELRB1 for Channel RB1 (20 MHz channel size)

UEL Corner Point	Frequency Offset Relative to Carrier Centre Frequency [MHz]	Operating Frequency [MHz]	Maximum Relative Power for 20 MHz Reference Bandwidth [dBW]	Maximum Set Power Level for 20 MHz Reference Bandwidth [dBW]	Maximum Relative Power for 1 MHz Reference Bandwidth [dBW]	Maximum Set Level Power for 1 MHz Reference Bandwidth [dBW]
$-P_7$	-50.0	3 260.0	-45.0	-15.0	-58.0	-28.0
$-P_6$	-30.0	3 280.0	-45.0	-15.0	-58.0	-28.0
$-P_5$	-17.0	3 293.0	-25.0	5.0	-38.0	-8.0
$-P_4$	-12.0	3 298.0	-25.0	5.0	-38.0	-8.0
$-P_3$	-10.0	3 300.0	-23.0	7.0	-36.0	-6.0
$-P_2$	-10.0	3 300.0	0.0	30.0	-13.0	17.0
P_1	0.0	3 310.0	0.0	30.0	-13.0	17.0
P_2	10.0	3 320.0	0.0	30.0	-13.0	17.0
P_3	10.0	3 320.0	-23.0	7.0	-36.0	-6.0
P_4	12.0	3 322.0	-25.0	5.0	-38.0	-8.0
P_5	17.0	3 327.0	-25.0	5.0	-38.0	-8.0
P_6	30.0	3 340.0	-45.0	-15.0	-58.0	-28.0
P_7	50.0	3 360.0	-45.0	-15.0	-58.0	-28.0

Table 22 – UELRB2 for Channel RB2 (20 MHz channel size)

UEL Corner Point	Frequency Offset Relative to Carrier Centre Frequency [MHz]	Operating Frequency [MHz]	Maximum Relative Power for 20 MHz Reference Bandwidth [dBW]	Maximum Set Power Level for 20 MHz Reference Bandwidth [dBW]	Maximum Relative Power for 1 MHz Reference Bandwidth [dBW]	Maximum Set Level Power for 1 MHz Reference Bandwidth [dBW]
$-P_7$	-50.0	3 280.0	-45.0	-15.0	-58.0	-28.0
$-P_6$	-30.0	3 300.0	-45.0	-15.0	-58.0	-28.0
$-P_5$	-17.0	3 313.0	-25.0	5.0	-38.0	-8.0
$-P_4$	-12.0	3 318.0	-25.0	5.0	-38.0	-8.0

$-P_3$	-10.0	3 320.0	-23.0	7.0	-36.0	-6.0
$-P_2$	-10.0	3 320.0	0.0	30.0	-13.0	17.0
P_1	0.0	3 330.0	0.0	30.0	-13.0	17.0
P_2	10.0	3 340.0	0.0	30.0	-13.0	17.0
P_3	10.0	3 340.0	-23.0	7.0	-36.0	-6.0
P_4	12.0	3 342.0	-25.0	5.0	-38.0	-8.0
P_5	17.0	3 347.0	-25.0	5.0	-38.0	-8.0
P_6	30.0	3 360.0	-45.0	-15.0	-58.0	-28.0
P_7	50.0	3 380.0	-45.0	-15.0	-58.0	-28.0

Table 23 – UELRB12 for Channel RB12 (40 MHz channel size)

UEL Corner Point	Frequency Offset Relative to Carrier Centre Frequency [MHz]	Operating Frequency [MHz]	Maximum Relative Power for 40 MHz Reference Bandwidth [dBW]	Maximum Set Power Level for 40 MHz Reference Bandwidth [dBW]	Maximum Relative Power for 1 MHz Reference Bandwidth [dBW]	Maximum Set Level Power for 1 MHz Reference Bandwidth [dBW]
$-P_7$	-100.0	3 220.0	-45.0	-15.0	-61.0	-31.0
$-P_6$	-60.0	3 260.0	-45.0	-15.0	-61.0	-31.0
$-P_5$	-34.0	3 286.0	-25.0	5.0	-41.0	-11.0
$-P_4$	-24.0	3 296.0	-25.0	5.0	-41.0	-11.0
$-P_3$	-20.0	3 300.0	-23.0	7.0	-39.0	-9.0
$-P_2$	-20.0	3 300.0	0.0	30.0	-16.0	14.0
P_1	0.0	3 320.0	0.0	30.0	-16.0	14.0
P_2	20.0	3 340.0	0.0	30.0	-16.0	14.0
P_3	20.0	3 340.0	-23.0	7.0	-39.0	-9.0
P_4	24.0	3 344.0	-25.0	5.0	-41.0	-11.0
P_5	34.0	3 354.0	-25.0	5.0	-41.0	-11.0
P_6	60.0	3 380.0	-45.0	-15.0	-61.0	-31.0
P_7	100.0	3 420.0	-45.0	-15.0	-61.0	-31.0

Technical conditions on the unwanted emissions in the spurious domain are presented later in the section under *"License Conditions Recorded"*.

Interference Assessment

AREs need to carefully identify the interference scenarios that need to be assessed. Systems operating in the 3 300 – 3 340 MHz frequency range for regional broadband use based on principles of TDD should consider the following eight interference scenarios:

- *Outward interference:*
  - New FWA base station to victim FWA CPE;
  - New FWA base station to victim FWA base station;
  - New FWA CPE to victim FWA CPE; and
  - New FWA CPE to victim FWA base station.
- *Inward interference:*
  - Existing FWA base station to new FWA CPE;
  - Existing FWA base station to new FWA base station;

- Existing FWA CPE to new FWA CPE; and
- Existing FWA CPE to new FWA base station.

Where two systems are operating in the same or neighbouring areas on different carrier centre frequencies, receiver overload (at either the base station or CPE ends) and desensitisation can occur. In these situations, time and frequency synchronisation methods may need to be implemented between the affected licensees and licensees may need to seek agreement with other affected licensees to implement mutually agreeable protocols to reduce harmful interference to the maximum extent possible. Technical agreements may allow the certification of licences which could not otherwise be certified because of interference. These technical agreements between right holders should be in writing and recorded against the file note of the licence in the RSM RRF.

If a service operating on a licence is subjected to interference from another party who has been granted a licence that is second-in-time, without limitation RSM may carry out an interference investigation and audit the Approved Person(s) which may also result in the Manager of the Management Right for 3.3 GHz regional wireless broadband cancelling the interfering licence.

Typical Point-to-Multipoint Architecture for Regional Broadband Use

The architecture or network structure of each system for regional broadband use is assumed to be point-to-multipoint configuration as shown in Figure 9. This will require one or more spectrum licences for each base station, and may have a single licence covering all of the FWA CPEs accessing all of a given user's FWA base stations in a particular channel within 3 300 – 3 340 MHz. Each FWA base station licence will identify the base station location as the transmit location, and must show the coverage area as the receive area where CPEs can communicate with the FWA base station.

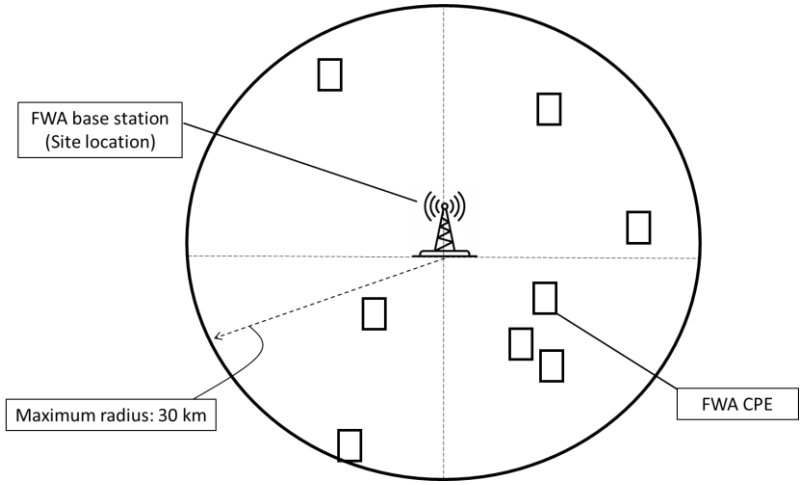


Figure 9: Typical point-to-multipoint architecture of licences for regional broadband use in 3 300 – 3 340 MHz.

Transmitter (FWA Base Station) Licence

Each licence for a base station has the transmitter location of the base station, and the receive protection location of the CPE. It is not necessary to identify individual CPE in the licence. The receiver location when provided as a number of points on the base station licence effectively

defines the polygon describing the protection area, and allows for the protection of CPE receivers anywhere within that area.
Base stations must be licensed under one of the following categories:

- Fixed / Crown Spectrum / Other >=20 & <=30 dBW (Spectrum);
- Fixed / Crown Spectrum / Other >=10 & <20 dBW (Spectrum); and
- Fixed / Crown Spectrum / Other <10 dBW (Spectrum).

For FWA base stations with multiple antennas serving individual sectors or groups of sectors where each sector or set of sectors occupying different channel, a separate licence must be used for each set of sectors with their common channels. All other recommendations remain identical for each sector. This is to ensure the aggregated azimuth antenna radiation pattern of those sectors can be shown on the licence for these channels. The nulls between those sectors can then be identified for co-ordination purposes.

Receiver (FWA CPE) Licence

A single licence may be used to cover all CPE within the coverage of a base station. The transmit location specified on the CPE must be within the multiple points used to define the protection area on the base station licence. The receive protection location specified on the CPE licence must be the corresponding base station location. An alternative acceptable approach is to register a separate licence for each CPE being served by individual base station. Depending on their respective type, the CPE licence must be associated with the base station licence. CPEs must be licensed under one of the following categories:

- Fixed / Crown Spectrum / Other >=20 & <=30dBW (Spectrum);
- Fixed / Crown Spectrum / Other >=10 & <20dBW (Spectrum); and
- Fixed / Crown Spectrum / Other <10dBW (Spectrum).

Licence Information Recorded

For maximising the efficient use of radio spectrum between 3 300 – 3 340 MHz, AREs must provide and record technical information about the actual equipment, technical installations, and service operated as accurate as practicable. This will enable sharing with other users using the spectrum for regional broadband use while preventing harmful interference.

The detailed information contained on licences must include:

- Channel type for either a 20 MHz or 40 MHz channel in accordance with RB1, RB2 or RB12;
- Emission designator;
- e.i.r.p.;
- Antenna radiation patterns of the transmitter (FWA base station) in both azimuth and elevation domains (if/when applicable) and receiver (FWA CPE);
- UEL of a transmitter (FWA base station) for a 20 MHz (RB1 or RB2) or a 40 MHz channel (RB12) in accordance with: UELRB1, UELRB2 or UELRB12;
- MPIS;
- Service area size (maximum limit of 30 km);
- Protection area size;
- Coverage of the service area;
- Transmitter (FWA base station) location;

- Transmitter (FWA base station) antenna height, azimuth (if applicable), type, make and model, and configuration losses;
- Transmitter (FWA base station) equipment make and model;
- Receiver (FWA CPE) antenna height, azimuth (if applicable), type, make and model, and configuration losses;
- Receiver (FWA CPE) equipment make and model;

Licence Conditions Recorded

Each Licence for a Regional Broadband must contain the following conditions:

- UELs in the out-of-band emissions domain and the spurious emissions domain must be defined as e.i.r.p. in units of dBW with a reference bandwidth of 1 MHz.
- UELs in the Spurious Domain must meet or be lower than Recommendation ITU-R SM.1539-1 or Category B of 3GPP TS 38.104 for base stations (transmitters) or meet the limits prescribed in Category B of Recommendation ITU-R SM.329.
- License holders can use TDD LTE or LTE-like Configuration Type 2 as a secondary frame structure in accordance with the appropriate TDD LTE or LTE-like standard such as 3GPP TS 36.211 ("*Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and Modulation*").
- The conditions on Management Right 514 apply to this licence which is created in relation to the Management Right. Use that does not conform to the default synchronisation and frame structure, in accordance with the primary technical conditions in the 3 300 – 3 800 MHz band, must not cause interference to and cannot claim protection from licences in other management rights using the default synchronisation and frame structure.

Licence Authorisations

The Authorisations on each licence must be set as:

Transfer Licence: Rightholder and Manager

Modify Licence: Rightholder and Manager

Cancel Licence: Rightholder or Manager

Appendices

Appendix 1: Terminology for Management Right Spectrum Parameters

The terminology used for defining management right spectrum parameters in the Act and the associated Regulations is illustrated in the three diagrams following the glossary of terms.

Glossary of abbreviations and terms:

SL Spectrum Licence (must lie within the range of frequencies of the management right within which it is first registered).

PL Protection Limit (management right parameter defining the e.i.r.p power spectral density limit within the frequency range of the management right and which must not be exceeded by the AFELs of other management rights registered later).

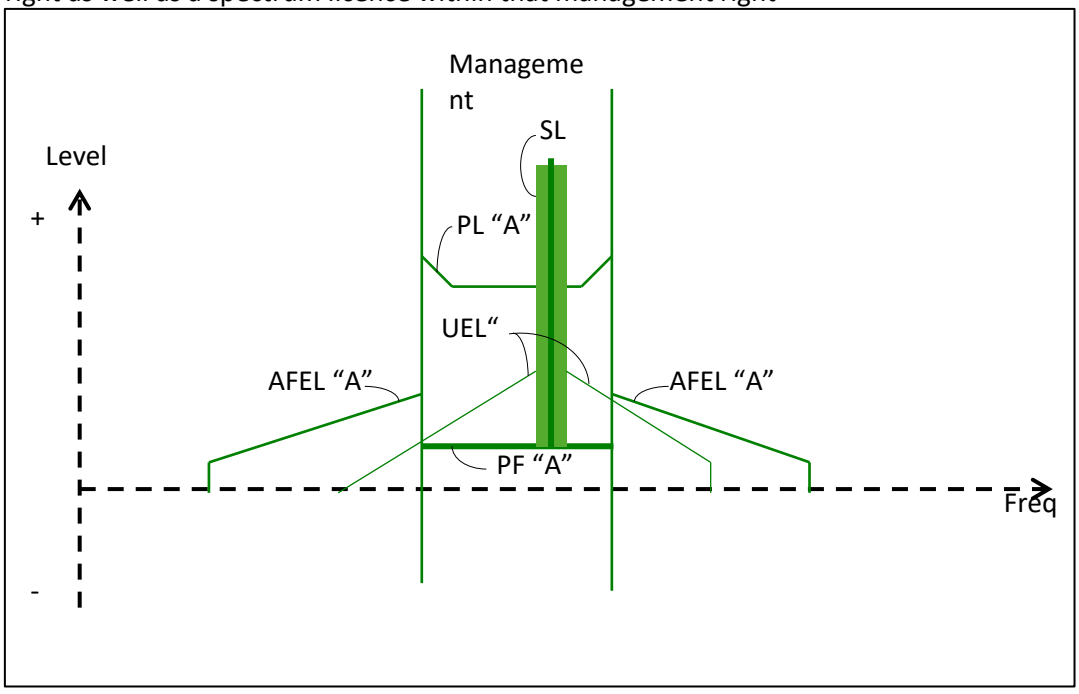
PF Power Floor (management right parameter, defining the lower boundary of the management rights, in terms of e.i.r.p power spectral density).

RL Radio Licence (can exist below the PF of a management right).

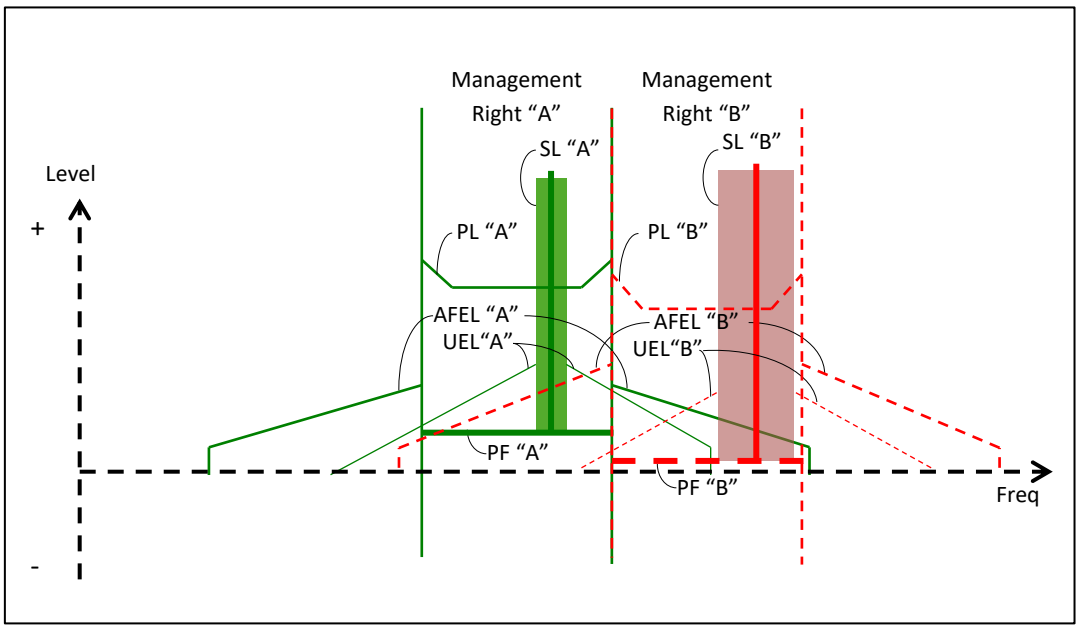
AFEL Adjacent Frequency Emission Limit (management right parameter defining the power spectral density profile below and above the frequency range of the management right and which must not be exceeded by the UELs of spectrum licences registered under the management right).

UEL Unwanted Emission Limit (spectrum licence parameter defining the permissible e.i.r.p power spectral density profile of unwanted emissions below and above the frequency range of the spectrum licence).

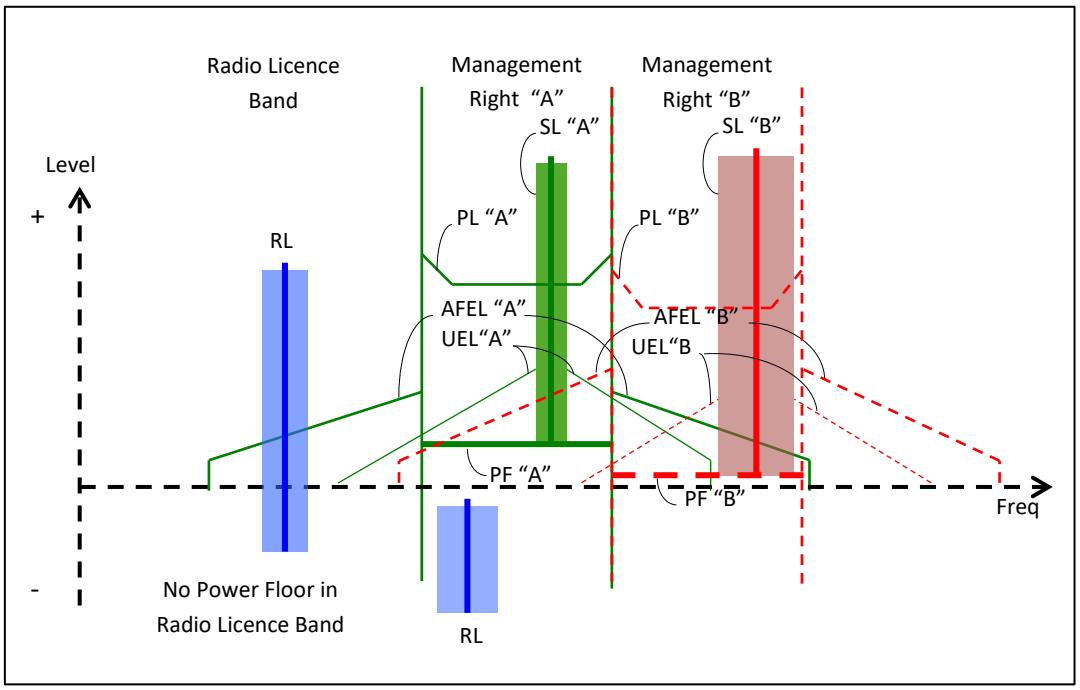
The figure below illustrates spectrum boundaries and parameters relating to a management right as well as a spectrum licence within that management right



The figure below illustrates spectrum boundaries and parameters relating to management right “A” and neighbouring management right “B” with a spectrum licence (SL “B”)



The figure below illustrates spectrum boundaries and parameters relating to management rights “A” and “B” and two radio licences, one in adjacent spectrum under the Radio Licence Regime, and one in management right “A” spectrum, but below the power floor.



Appendix 2: Sample Approved Engineer's Certificate

CERTIFICATE ISSUED PURSUANT TO SECTION 25(4) or 57D(4)
OF THE RADIOCOMMUNICATIONS ACT 1989

I, ……., approved radio engineer, having regard to:-

(i) the nature and characteristics of the rights described the spectrum licence; and

(ii) the International Radio Regulations; and

(iii) the ITU-R Reports and Recommendations; and

(iv) Annex 10 to the Convention on International Civil Aviation; and

(v) the International Convention for the Safety of Life at Sea; and

(vi) the nature of the service proposed to be operated under the spectrum licence; and

(vii) any relevant reference standards 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 exercise of the rights conferred by the spectrum licence to which this certificate relates, being the spectrum licence identified by:

Licence ID: [000000]

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 and 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 radio licences, and

e) will sufficiently define the protection area and the nature and characteristics of the proposed transmissions to enable subsequent licences and radio licences to be co-ordinated with the exercise of rights to which this spectrum licence relates, for the purpose of avoiding harmful interference.

…….
Approved Radio Engineer Number [000]
Dated [DD-MMM-YYYY]

Appendix 3: Unwanted Emission Limits

Spectrum licences are required to include Unwanted Emission Limits (UELs) which define the profile of the maximum power spectral density of unwanted emissions that must not be exceeded by any transmission operating in accordance with the licence. UELs are expressed as the maximum e.i.r.p. (in dBW) within a reference bandwidth. AREs are responsible for ensuring the UEL values do not exceed Adjacent Frequency Emission Limits (AFELs) identified within management rights.

The current AFEL and UEL values for management rights and spectrum licences used for MF AM, FM, Land Mobile and digital television broadcasting are outlined below.

MF AM Unwanted Emission Limits and Associated AFELs

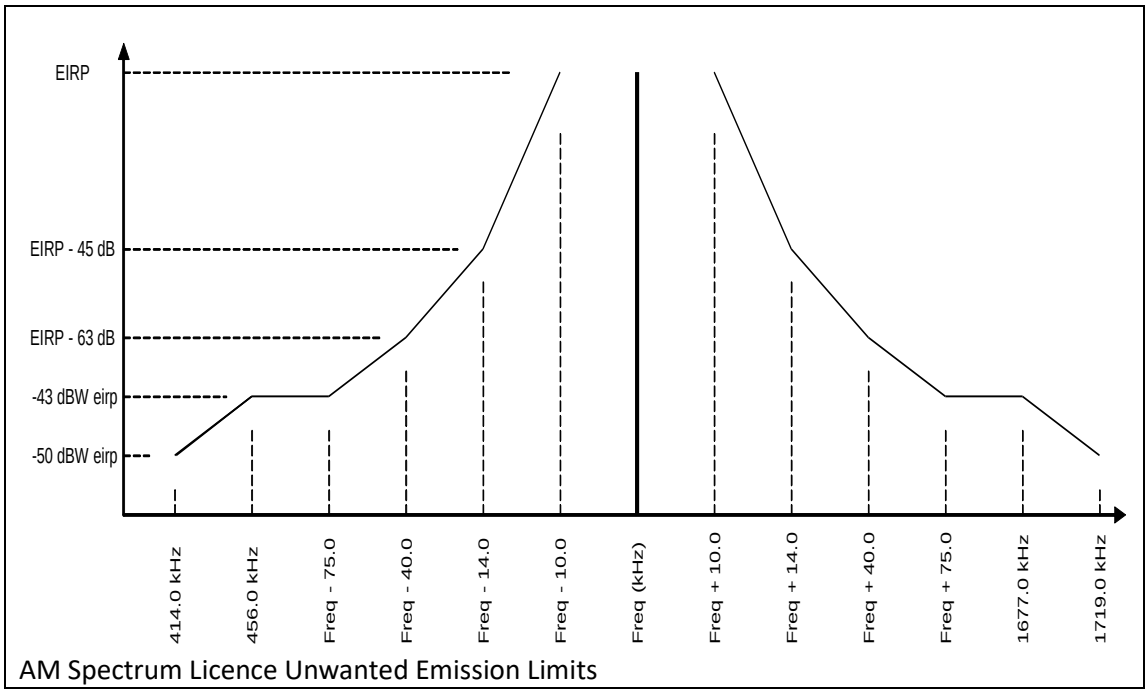
The UELs for MF AM spectrum licences and associated AFELs are identified in Table 24 and graphical representations below. The levels in the table below for MF-AM have a reference bandwidth of 10 kHz.

Table 24: Unwanted Emission Limits for MF-AM Services

Frequency	Maximum Level
414 kHz	-50 dBW e.i.r.p
456 kHz	-43 dBW e.i.r.p
fc - 75.0 kHz (if > 456 kHz)	-43 dBW e.i.r.p
fc - 40.0 kHz	e.i.r.p – 63 dB (if level > -43 dBW)
fc - 14.0 kHz	e.i.r.p – 45 dB (if level > -43 dBW)
fc - 10.0 kHz	e.i.r.p
fc + 10.0 kHz	e.i.r.p
fc + 14.0 kHz	e.i.r.p – 45 dB (if level > -43 dBW)
fc + 40.0 kHz	e.i.r.p – 63 dB (if level > -43 dBW)
fc + 75.0 kHz (if < 1677 kHz)	-43 dBW e.i.r.p
1,677 kHz	-43 dBW e.i.r.p
1,719 kHz	-50 dBW e.i.r.p

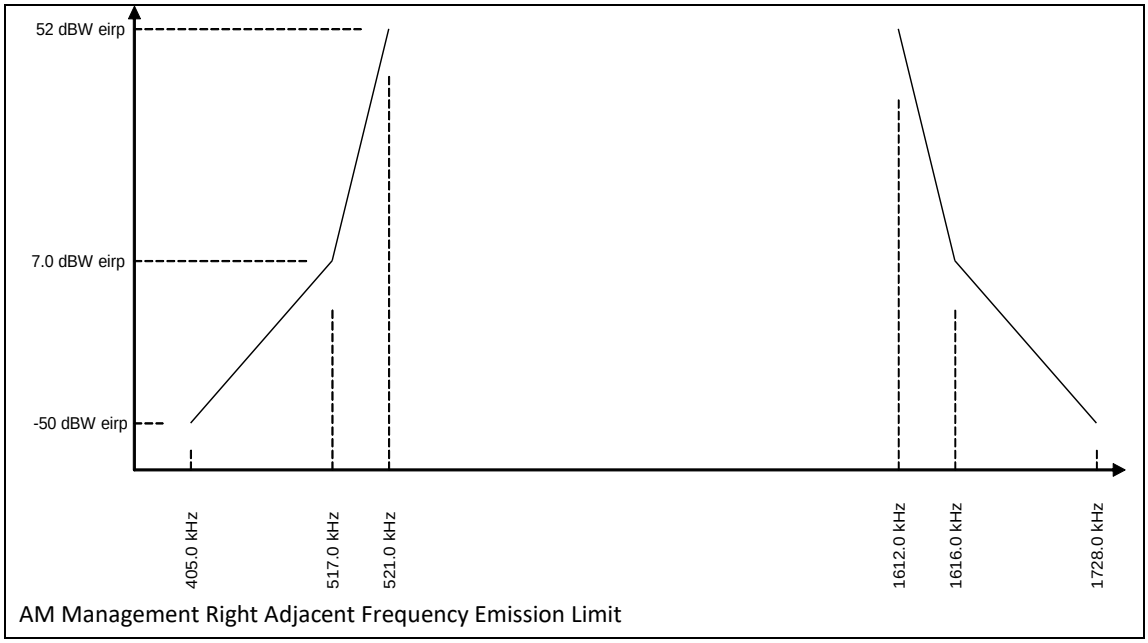
This spectrum mask is contained in the UEL template AM MR206 in the Register.

The figure below illustrates the UELs for MF-AM conforming to template AM MR206 in the Register.



AM Spectrum Licence Unwanted Emission Limits

The figure below shows the band limits and AFELs for MF-AM management right MR206.



AM Management Right Adjacent Frequency Emission Limit

FMBC Unwanted Emission Limits and Associated AFELs

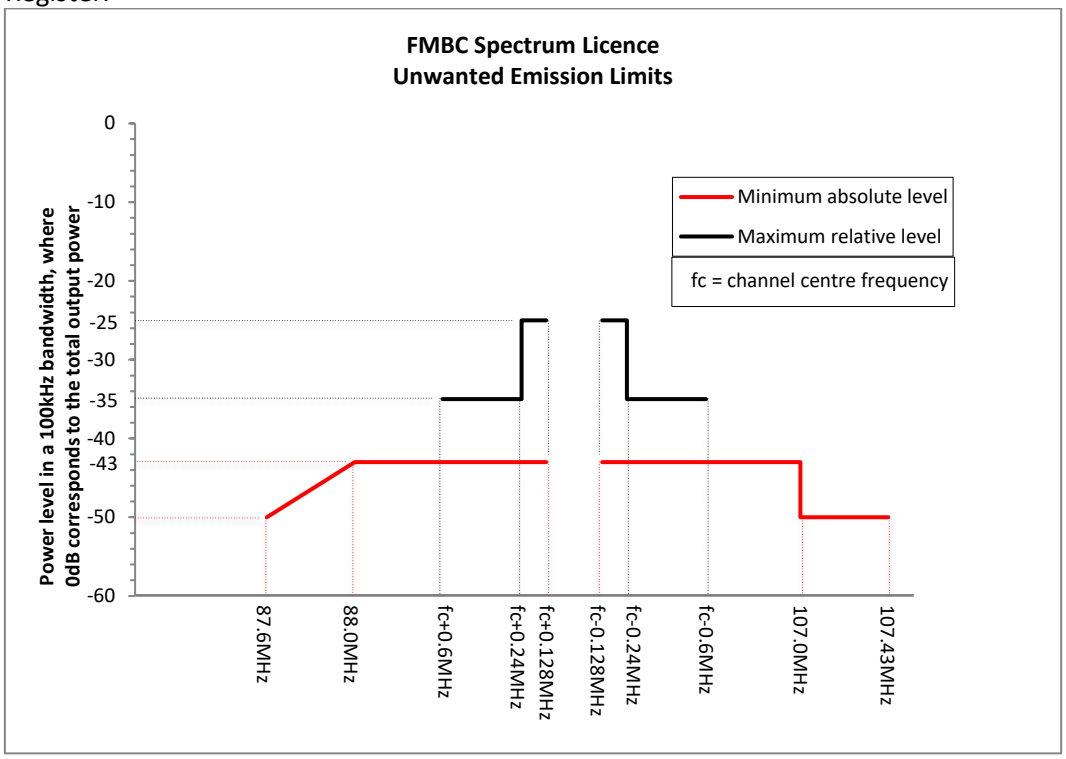
The UELs for FMBC spectrum licences and associated AFELs are identified in the table and graphical representations below. The levels in Table 25 below for FMBC have a reference bandwidth of 100 kHz.

Table 25: Unwanted Emission Limits for FMBC Services

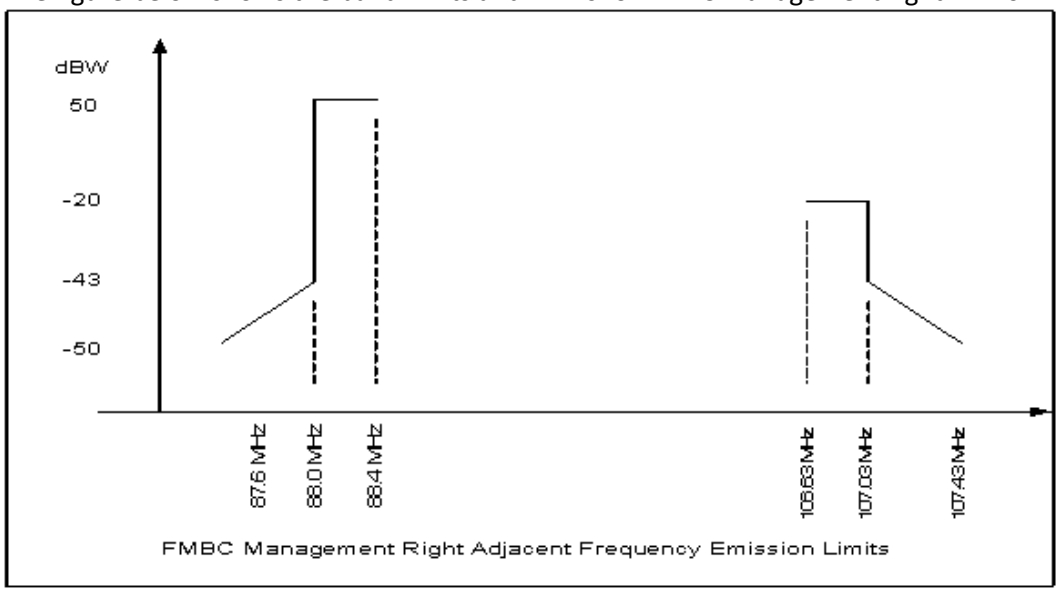
Frequency	Level
87.60 MHz	-50 dBW e.i.r.p
88.00 MHz	-43 dBW e.i.r.p
fc - 600.0 kHz (if > 88.00 MHz)	-43 dBW e.i.r.p
fc - 600.0 kHz (if > 88.00 MHz)	e.i.r.p – 35 dB (if level > -43 dBW)
fc - 240.0 kHz	e.i.r.p – 35 dB (if level > -43 dBW)
fc - 240.0 kHz	e.i.r.p – 25 dB (if level > -43 dBW)
fc - 128.0 kHz	e.i.r.p – 25 dB (if level > -43 dBW)
fc + 128.0 kHz	e.i.r.p – 25 dB (if level > -43 dBW)
fc + 240.0 kHz	e.i.r.p – 25 dB (if level > -43 dBW)
fc + 240.0 kHz	e.i.r.p – 35 dB (if level > -43 dBW)
fc + 600.0 kHz (if < 107.03 MHz)	e.i.r.p – 35 dB (if level > -43 dBW)
fc + 600.0 kHz (if < 107.03 MHz)	-43 dBW e.i.r.p
107.03 MHz	-43 dBW e.i.r.p
107.03 MHz	-50 dBW e.i.r.p
107.43 MHz	-50 dBW e.i.r.p

This spectrum mask is contained in the UEL template FM MR207 in the Register.

The figure below illustrates the UELs for FMBC conforming to template FM MR207 in the Register.



The figure below shows the band limits and AFELs for FMBC management right MR207



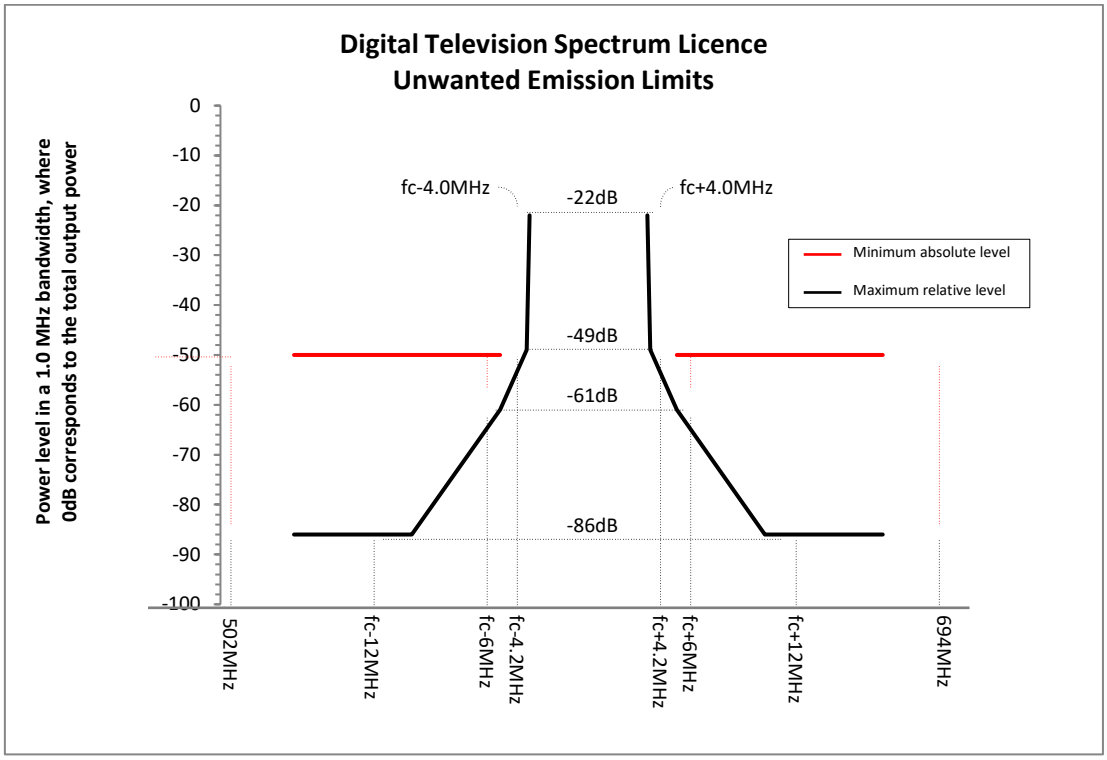
UHF Digital Television Spectrum Licence Unwanted Emission Limits and Management Right Adjacent Frequency Emission Limits

The unwanted emission limits (UEL) for digital television spectrum licences in non-critical cases and in critical cases are given in the table and graphical representations below. The critical case levels are required to be used for licences in channel DTV26. The UELs for digital television in Table 30 and figures below have a reference bandwidth of 1.0 MHz.

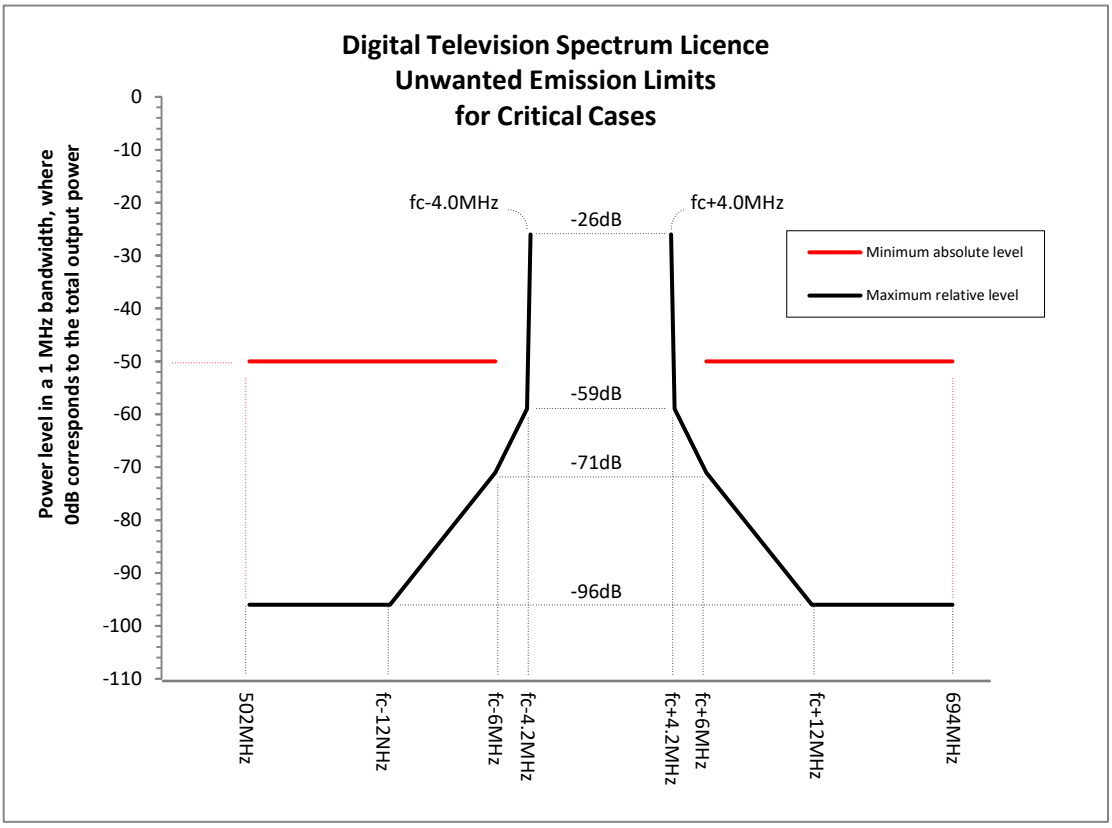
Table 30: Unwanted Emission Limits for non-critical and for critical cases for Digital Television Services

Frequency (MHz)	Absolute level (dBW e.i.r.p per reference bandwidth)	Non-critical cases Level relative to total output power (dBW e.i.r.p per reference bandwidth)	Critical cases Level relative to total output power (dBW e.i.r.p per reference bandwidth)
502	-50	-86	-96
fc-12	-50	-86	-96
fc-6	-50	-61	-71
fc-4.2		-49	-59
fc-4.0		-22	-26
fc-4.0		-22	-26
fc-4.2		-49	-59
fc-6	-50	-61	-71
fc-12	-50	-86	-96
694	-50	-86	-96

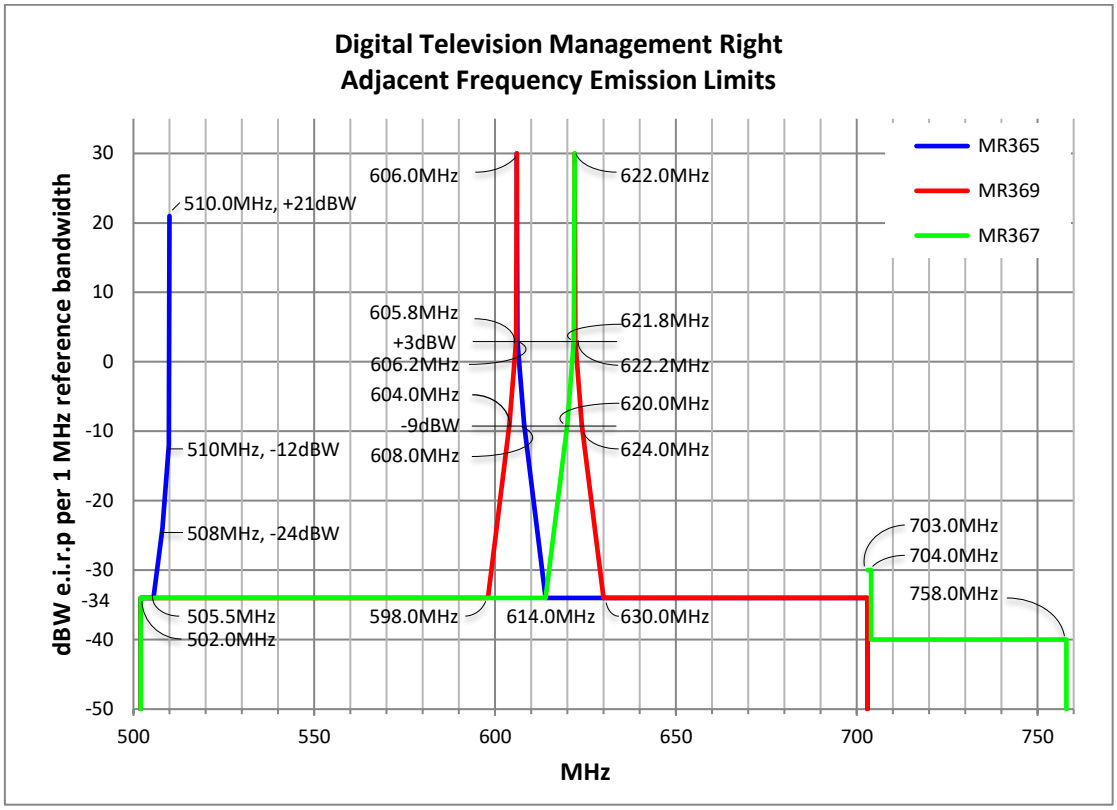
The spectrum masks in the above table are contained in the UEL template DTV2013 in the Register for non-critical cases and to template DTV26 for critical cases. Where both the absolute and relative levels are shown, the lower of the two applies.
The figure below illustrates the UELs for DTV according to the template DTV 2013 in the Register.



The figure below illustrates the UELs for DTV spectrum licences for critical cases according to template DTV26 in the Register.



The band limits and AFELs for digital television management rights are shown in the figure below. The AFELs have a reference bandwidth of 1 MHz.


Digital Television Management Right
Adjacent Frequency Emission Limits
dBW e.i.r.p per 1 MHz reference bandwidth
MHz
MR365
MR369
MR367
510.0MHz, +21dBW
606.0MHz
622.0MHz
605.8MHz
+3dBW
606.2MHz
621.8MHz
622.2MHz
604.0MHz
-9dBW
608.0MHz
620.0MHz
624.0MHz
510MHz, -12dBW
508MHz, -24dBW
505.5MHz
502.0MHz
598.0MHz
614.0MHz
630.0MHz
703.0MHz
704.0MHz
758.0MHz
30
20
10
0
-10
-20
-30
-34
-40
-50
500
550
600
650
700
750

Appendix 4: Standard Spectrum Licence Conditions

Spectrum Licences – General Conditions

The following licence conditions apply to all spectrum licences in Crown management rights and are included in the General Conditions attached to each and every spectrum licence:

- The Rightholder shall not transfer the Rightholder's interest in this licence to any foreign government, or to any party on behalf of any foreign government, without first obtaining the written approval of the Chief Executive of the Ministry of Business, Innovation & Employment.
- The chief executive or any inspector duly authorised by him shall be granted by the Rightholder at all reasonable times entry to any place, premises or building for the purposes of ensuring compliance with this licence.

Spectrum Licences – Mortgage Conditions

The licence conditions relating to the application, variation, cancellation of caveats and mortgages may apply to spectrum licences in Crown management right and should be included when required. An example of such a condition is;

- No transfer or mortgage of this licence shall be registered by the Registrar of Radio Frequencies unless the Minister has consented to that transfer or mortgage. (See section 170 subsection 4 of the Act).

AM Licences – Required Conditions

The following paragraphs are required for the licensing conditions of the AM licences:

- This spectrum licence is constrained by and subject to international agreements on medium frequency (MF) broadcasting, in particular the Final Acts of the Regional Agreement on LF/MF Broadcasting, Geneva 1975, including any revision, amendment or agreement in substitution for such Final Acts.
- Maximum permitted interfering signals shall be measured at a height of 2 metres above ground level.
- The maximum permitted interfering signal or signals that apply to the protection location or locations or protection area are conditions on the exercise of the right to have no harmful interference from co-channel emissions on the frequencies that apply to this licence in accordance with section 49(1)(j) of the Act.
- A protection location that is identified as having the same grid reference as the transmit location is to be used solely for assessing the likelihood of harmful interference resulting from skywave propagation. The levels are calculated in accordance with the Final Acts of the Regional Administrative Conference (Regions 1 and 3), Geneva, 1975 and Recommendation ITU-R BS.560-4 which specifies a ratio of 30 dB and 9 dB for frequency differences of 0 kHz and 9 kHz respectively.
- Measurements to determine whether harmful interference is being created as a result of skywave propagation may be taken at any location within a 2 kilometre radius of the transmit location. Identification of a suitable measurement location will depend upon the proximity of antenna structures, earth mat radials, buildings, trees or any other thing that may unduly affect the measurement results. Additionally, identification of a suitable measurement site should take into account other issues that may affect measurement results such as proximity to sea water.
- A protection location, that is identified as having a grid reference that is not that same as the transmit location, is to be used solely for assessing the likelihood of harmful

interference resulting from ground wave (day time) propagation. The levels are calculated using the wanted signal level and Recommendation ITU-R BS.560-4 which specifies a ratio of 30 dB and 9 dB for frequency differences of 0 kHz and 9 kHz respectively between wanted and unwanted signals.

AM Licences – Typical Conditions

The following paragraphs are typical licensing conditions of the AM licences and should be included when required:

- The time periods during which broadcasting may occur are 0600-2400 hours daily.
- This licence is for daytime hours of operation only. The hours defining daytime/night-time will be in accordance with figure 20, Chapter 3 (Annex 2) of the Final Acts of the Regional Administrative LF/MF Broadcasting Conference (Regions 1 and 3), Geneva 1975.
- During night-time hours, the maximum e.i.r.p will be restricted to [39.0] dBW. The hours defining daytime/night-time operation will be in accordance with Chapter 3 (Annex 2) of the Final Acts of the Regional Administrative LF/MF Broadcasting Conference (Regions 1 and 3), Geneva 1975.
- This licence is provided for service evaluation and shall cease operation when required by the Ministry.

FM Licences – Required Conditions

The following paragraphs are required for the licensing conditions of the FM licences:

- Maximum permitted interfering signals shall be measured at a height of 10 metres above ground level.
- The maximum permitted interfering signal or signals that apply to the protection location or locations or protection area are conditions on the exercise of the right to have no harmful interference from co-channel emissions on the frequencies that apply to this licence in accordance with section 49(1)(j) of the Act). The levels are calculated using the wanted signal level and Recommendation ITU-R BS.412-9 which specifies a ratio of 45 dB, 33 dB and 7 dB for frequency differences of 0 kHz, 100 kHz, and 200 kHz respectively between wanted and unwanted signals.
- The designation of emissions on this licence provides for the transmission of supplementary information for station and programme identification in FM broadcasting and other applications, using the radio-data system (RDS) as specified in Recommendation ITU-R BS. 643-2. Other digital emissions are not permitted.

FM Licences – Typical Conditions

The following paragraphs are typical of licensing conditions of the FM licences in particular circumstances.

- The use of this licence is governed by a contract between the Rightholder and the Chief Executive of the Ministry reference [XXXX])
- This licence is to be used exclusively for transmission of the National Programme.
- This licence is provided for service evaluation and shall cease operation when required by the Ministry.
- This licence is intended to operate as part of a synchronous broadcast system comprising licences on the same frequency at the following transmitter locations: [include as required: TRANSMIT LOCATION 1 (grid reference LAT/LONG (NZGD2000) xxx.xxxxxxx –xxx.xxxxxxx), and TRANSMIT LOCATION 2 (grid reference LAT/LONG

(NZGD2000) yyy.yyyyyyy –yyy.yyyyyyy). Maximum permitted interfering signal levels are not applicable to other transmissions from the same synchronous broadcast system.

TV Licences – Required Conditions

Maximum permitted interfering signals shall be measured at a height of 10 metres above ground level.
The Unwanted Emission Limits specified on this licence are a power spectral density in a reference bandwidth of 1 MHz.
Where this licence is used to transmit a DVB-T, DVB-T2 or other terrestrial DVB standards based service on a free-to-air basis the Rightholder must also transmit Service Information with values of Original Network ID, Cell ID, Network ID, and Logical Channel Numbers which are supplied by, or otherwise compatible with those managed by, Freeview Ltd (or its successor) and must ensure that its service is compatible with the Original Network ID, Network ID, Cell IDs and Logical Channel Numbers used by other licensed DTT services. Alternatively, Service Information should be transmitted with parameters as advised from time to time by the Chief Executive of the Ministry.

TV Licences – Typical Conditions

The licence shall operate on the basis of a single frequency network whenever necessary to ensure compatibility with any other licences on the same frequency which provide coverage infill of services broadcast from the Rightholders transmissions at Waiatarua. Maximum permitted interfering signal levels are not applicable to signals from other transmissions within the same single frequency network.

General and Further Licence Conditions

The following General and Further conditions are applied automatically to all spectrum licences registered through the Register. When examining an existing licence in the Register, having selected "Conditions" from the left hand menu, you will see the above required conditions, along with any additional conditions entered by the licensing ARE. To see the following Spectrum Licence General Conditions which apply to all spectrum licences, click on the button at the top right of the screen. Note that these Spectrum Licence General Conditions may not appear in a printed out copy of the licence.

Regional Broadband in 3.3 GHz Licence Conditions

- UELs in the out-of-band emissions domain and the spurious emissions domain must be defined as e.i.r.p. in units of dBW with a reference bandwidth of 1 MHz.
- UELs in the Spurious Domain must meet or be lower than Recommendation ITU-R SM.1539-1 or Category B of 3GPP TS 38.104 for base stations (transmitters) or meet the limits prescribed in Category B of Recommendation ITU-R SM.329.
- License holders can use TDD LTE or LTE-like Configuration Type 2 as a secondary frame structure in accordance with the appropriate TDD LTE or LTE-like standard such as 3GPP TS 36.211 ("*Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and Modulation*").
- The conditions on Management Right 514 apply to this licence which is created in relation to the Management Right. Use that does not conform to the default synchronisation and frame structure, in accordance with the primary technical conditions in the 3 300 – 3 800 MHz band, must not cause interference to and cannot claim protection from licences in other management rights using the default synchronisation and frame structure.

SPECTRUM LICENCE GENERAL CONDITIONS

TERMS, CONDITIONS, AND RESTRICTIONS APPLYING TO EVERY SPECTRUM LICENCE UNDER THE FIRST SCHEDULE TO THE RADIOCOMMUNICATIONS ACT 1989 ('the Act')

1. Compliance with International Radio Regulations
   Every person transmitting radio waves must comply with the International Radio Regulations.

2. False or misleading communication
   No person may—

   (a) cause or permit the transmission, under any spectrum licence, of any radiocommunications of a false, fictitious, or misleading character; or
   (b) cause or permit to be transmitted any false or deceptive distress signal or distress call.

3. Breach of other enactment
   No person may transmit radio waves under a spectrum licence in breach of any other enactment.

FURTHER CONDITIONS
GENERAL TERMS, CONDITIONS, AND RESTRICTIONS APPLYING TO THIS SPECTRUM LICENCE

1. The Rightholder shall not transfer the Rightholder's interest in this licence, to any foreign government, or to any party on behalf of any foreign government, without first obtaining the written approval of the chief executive of the Ministry of Business, Innovation and Employment.

2. Any radio transmitter operating under a spectrum licence must comply with the requirements of the International Radio Regulations (to the extent that they reasonably apply to the category of service specified on the spectrum licence), and with any technical specifications or standards that may be notified from time to time by the chief executive by notice in the Gazette.

3. Observance of all terms, conditions, and restrictions relating to a spectrum licence by any person authorised to operate a radio transmitter under a spectrum licence remains the personal responsibility of the right-holder of the spectrum licence, as the case may be.

4. The holder of a spectrum licence must comply with any directions given by the chief executive, or any person authorised by the chief executive to give directions on the chief executive's behalf, for the use of the radio transmitter operating under the spectrum licence.

5. If an authorised officer is of the opinion that a contravention of the Act or the Regulations has taken place and requires that a radio transmitter cease operating, the licensee under the relevant spectrum licence must comply with the requirement.

6. Radio transmitters to which this spectrum licence relates must operate only on or at the frequency(ies), emission(s), power(s) and location(s) prescribed on this licence, or on any schedule annexed to this licence.

7. Nothing in this spectrum licence, the Act, the Regulations, or the International Radio Regulations prohibits any person in distress from using any means at the person's disposal to attract attention, indicate the person's position, and obtain assistance.

8. While all reasonable care has been taken in the engineering of this spectrum licence, the nature of radio propagation is such that no guarantee can be given that harmful

interference will not occur. In the event that harmful interference does occur, the licensee must comply with any direction given by the chief executive, including cessation of transmissions, until the cause of the harmful interference is identified and remedied.

9. The chief executive does not accept liability under any circumstances for any loss or damage of any kind as a consequence of action taken by the chief executive pursuant to these conditions.
10. The chief executive or any inspector duly authorised by him shall be granted by the licence holder at all reasonable times entry to any place, premises or building for the purposes of ensuring compliance with this licence.
11. For the period for which a licence is valid, a fee is payable in proportion to that period, rounded up to the nearest month.
12. Fees are prescribed in Schedule 6 to the Radiocommunications Regulations 2001 and are inclusive of Goods and Services Tax.
13. Any fees payable that are not paid constitute a debt to the Crown until paid in full, and may be recovered from the person liable at the suit of the chief executive or the Registrar in any court of competent jurisdiction.

Appendix 5: Minimum Usable Field Strengths for Broadcast Service Protection Areas and Minimum Field Strengths for Protection Locations

The minimum usable field strengths (MUFS) defining the contiguous boundary of protection areas, and the minimum field strengths (MFS) to be used for Protection Locations for broadcasting services are as follows:

Table 31: Minimum Usable Field Strengths for Broadcast Service Protection Areas and Minimum Field Strengths for Protection Locations

Band	Service	Source	Protection Area MUFS (dBµV/m)	Protection Location MFS (dBµV/m)
512 – 1,612 kHz	MF-AM	Engineering Daytime	66	66
		Engineering Night-time	74	74
88.4 – 106.63 MHz	FM	Engineering	66	66
510 – 606 MHz	Digital TV	Engineering	48	57
622 – 703 MHz	Digital TV	Engineering	48	57

Field Strength Reference height

MUFS and MFS values in the table above for MF-AM are at a reference height of 2 metres above ground level, and for FM and Digital TV are at a reference height of 10 metres above ground level.

Interference investigation

An investigation of reported interference to a broadcast service should take into account the MUFS value from the above table when deciding whether the wanted service field strength (WFS) at the particular location qualifies that location as being within the coverage area of the service.

The WFS relative to the MUFS should be used as a guide, and should not be seen as a mandatory requirement to resolve the interference. Locations such as coverage holes, not meeting the MFS due to local geographical and other factors may not have a right to freedom from harmful interference, despite being within the prime coverage area. Fortuitous locations that are above the MUFS but lie outside the continuous MUFS contour may also not be entitled to receive interference-free coverage. In the case of Digital TV the effective coverage area may be affected by anomalous propagation causing occasional co-channel interference from transmitters in neighbouring areas. Such low duration propagation cannot be effectively modelled and should not be considered in licence certification.

Appendix 6: List of Agencies for Band Usage Approval

Table 32: List of Agencies for Band usage Approval

General Frequency Range	Comments	Agency
AM and FM radio broadcasting bands	All applications for "community" broadcasting	MCH
AM and FM radio broadcasting bands	All applications for promotion of Māori language and culture via sound broadcasting	TPK

MCH Ministry for Culture and Heritage

TPK Te Puni Kokiri, Ministry of Māori Development

Appendix 7: Identification of Sound Broadcasting Spectrum Licences

In New Zealand the allocation of Broadcasting Spectrum Licences is controlled by various agencies.
The Crown Spectrum Asset Manager (CSAM) in RSM at the Ministry is responsible for issuing commercial licences.
Licences which fall under the Crown Reserved Broadcasting (CRB) umbrella are allocated by the following agencies:

(a) Te Puni Kokiri (TPK) is responsible for issuing licences for Maori use.

(b) The Ministry for Culture and Heritage (MCH) is responsible for issuing various other types of licences.

Management Rights for AM (MR206) and FM (MR207) sound broadcasting licences commenced on 3 April 2011 and expire on 2 April 2031.
Licences granted under these management rights have been "tagged" so that the agency and service identification are searchable in the Register.
This initiative uses the "System Identifier" function within the Register to identify the licence type, the agency involved, and the service type, for each broadcasting licence.
The System Identifier consists of the following format:

XXX_YYY_ZZZ

The first group of up to 3 letters denotes	**Licence Type**
The second group of 3 letters denotes	**Agency**
The third group of 3 letters denotes	**Service**

Table 33: Code Table

LICENCE TYPE	
AM	Amplitude Modulated Broadcasting
FM	Frequency Modulated Broadcasting
AGENCY	
CSAM	Crown Spectrum Asset Manager (the Ministry)
CRB	Crown Reserved Broadcasting (Reservation)
MCH	Ministry for Culture and Heritage
TPK	Te Puni Kokiri
SERVICE	
COM	Community Radio
COP	Concert Programme
LOC	Local Commercial
LOV	Low Value
LTC	Long Term Commercial
MAO	Maori
NAT	National Radio
PAU	Pending Auction
PIR	Pacific Island Radio
PLM	Parliament Radio
RES	Reservation
STC	Short Term Commercial

Examples of System Identifiers are:

FM SAM PAU FM pending auction licence.
AM CRB MAO AM Crown planned status reservation for Māori.
FM MCH NAT FM licence issued for National Radio Programme.
FM SAM LTC FM long term licence issued for commercial use.
FM TPK MAO FM licence issued for Māori use.
FM CRB PIR FM Crown planned status reservation for Pacific Island Radio
AM MCH COM AM licence issued for Community Radio.

The following should be noted:

(a) System Identifiers can only be assigned by The Crown Spectrum Asset Manager.

(b) MCH and TPK agency licences are assigned, or can be reassigned under cover of an overarching planned status Crown Reservation in the Register.

Appendix 8: TVWS Use Survey

Radio Spectrum Management (RSM) has developed an interim licensing scheme for television white space (TVWS) to allow some preliminary usage, trials, and to gain a better understanding of benefits for New Zealand. RSM is watching international developments and is investigating what sort of long term regime would best to accommodate TVWS in New Zealand.
RSM is gathering information on TVWS use in New Zealand and requests that licence applicants complete the following form. The form should be submitted to RSM at the same time as the licence application. Licences will not be registered if they do not have an accompanying form.

RSM will not be making this information public. However, applicants should be aware that any information you provide is subject to the Official Information Act 1982 ("the OIA"). The OIA allows members of the public to request information that public agencies hold.

There are grounds for public agencies to withhold information that has been requested, and this can include commercial information such as trade secrets, etc. Section 9 of the OIA contains the common grounds for withholding information. There are several subsections of section 9 under which commercially sensitive information can be withheld, depending on the situation.

If your information is requested from RSM by a third party, usual practice is to consult you regarding its potential release.

Name of Licensee:_____
Full name of person completing this form:_____
Position/job title:_____
Date:_____
Signature:_____

What type of service do you intend to deliver? For example, broadband or utilities monitoring and control.

Please give a general description of the services you intend to deliver : What do you envisage the service being used for (e.g. general IP connectivity, broadband provision, SCADA, voice, etc.)? What type of connection are you intending for your service (e.g. always on, ad hoc, report at specific times, or polled at specific time)?

Who is this service for? Who are the customers? Are you charging them for the service?

If this service will be used to provide services to an end customer, how is it networked and backhauled? How many devices are intended to be deployed? Please attach any technical information which may provide a better understanding of the system.

Which standard does your equipment comply with? FCC CFR 47, Part 15, Subpart H - Television Band Devices 15.701 – 15.717, or ETSI 301 598?

Will you be using a TVWS database? If so which database are you using and who is the provider?

Appendix 9: Definitions of Association for Television White Space licences

For the purposes of the Television White Space Licensing rules, person A is an Associate of person B (and vice versa) if:

(a) person A is a body corporate, and person B is:

  i. a director of that body corporate; or

  ii. a Related Body Corporate of that body corporate; or

  iii. a director of a Related Body Corporate of that body corporate; or

(b) person A is in the same immediate family as person B (including a spouse, civil union partner, de facto partner, child (including step-child), parent (including step-parent) or sibling (including step-siblings and half-siblings) of person B); or

(c) person A is a nominee or trustee for person B; or

(d) person A is a director of a body corporate, or person A holds any voting power in the body corporate, and person A and person B are parties to an agreement relating to:

  i. the control of that body corporate; or

  ii. any of the voting power in that body corporate; or

(e) person A holds or controls directly or indirectly any of the voting power, or any of the issued shares, in person B; or

(f) person B (or a director, employee or other Associate of person B) is the trustee of a trust acting in that capacity and person A is a settlor, beneficiary, or trustee, of that trust; or

(g) person A is a person who, in making a decision or exercising a power materially affecting a Business, is accustomed, or under an obligation, or proposes or is likely (in the Chief Executive of the Ministry of Business, Innovation and Employment's sole opinion, which is final), to act in accordance with the directions or instructions or wishes of person B; or

(h) person A and person B are acting, or propose or are likely to act (in the Chief Executive of the Ministry of Business, Innovation and Employment's sole opinion, which is final), jointly or in concert in relation to a Business; or

(i) person A (being a person other than the Chief Executive of the Ministry of Business, Innovation and Employment) and person B are parties to an Agreement that entitles one of the persons to a substantial degree of influence, or the right to obtain a substantial degree of influence, over radio frequency spectrum covered by the Television White Space Licence and in respect of which the other person is or will be a rightholder under the Act; or

(j) person A is an Associate of another person that is an Associate of person B under these Terms and Conditions, including an Associate in a chain of Associates.

An Associated Group means the holder of a Television White Space Licence together with any Associate of that person that is also the holder of a Television White Space Licence.

Appendix 10: Primary/Default Technical Conditions in the 3 300 – 3 800 MHz Frequency Band

The technical requirements in this Appendix apply to a transmission under a spectrum licence in a MR within the 3 300 – 3 800 MHz frequency band. MRs in this band should primarily utilize TDD systems. The MR holders must synchronize their transmissions to a specified frame structure and the start point of their frames must be aligned with Universal Time Coordinated (UTC) primary reference time clock (PRTC). The AFELs and Protection Limits for the MRs within the frequency band 3 300 MHz – 3 800 MHz have been based on the unwanted emissions limits specified in 3GPP Technical Specification 38.104, the core base station specification for 5G-NR systems . The unwanted emissions limits set the absolute maximum allowable emission level on adjacent frequencies relative to the band of operation, which is 3 300 – 3 800 MHz.

1. Synchronisation Requirements:

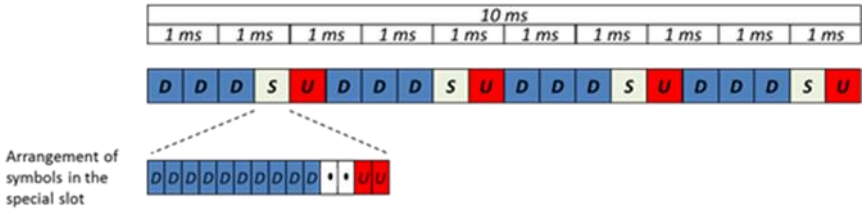
(a) *Primary/Default Synchronisation Frame Structure:*

The prescribed primary/default frame structure uses terminologies specific to the 3GPP specification for defining the frame structure. TDD frame is constructed as in the following pattern: DDDSUDDDSUDDDSUDDDSU. Where S is a special frame with the arrangement of DDDDDDDDDDGGUU, where “D” denotes the Downlink, “U” denotes the Uplink and “G” denotes the Guard Period. Specifications for the frame structure are defined in Table 29 and the figure after Table 34.

Table 34: Specified Parameters for the Primary/Default Frame Structure

Specified Parameter	Corresponding Value
Frame duration	10 ms
Reference orthogonal frequency-division multiplexing (OFDM) subcarrier spacing	30 kHz (20 slots in one frame)
OFDM symbols in each slot	14
Periodicity of the downlink-uplink pattern	2.5 ms
Number of consecutive full downlink slots at the beginning of each pattern	3
Number of consecutive downlink symbols in the beginning of the slot following the last full downlink slot	10
Number of consecutive full uplink slots at the end of each pattern	1
Number of consecutive uplink symbols in the end of the slot preceding the first full uplink slot	2
Number of guard period symbols	2

Based on the parameters in Table 29, one TDD frame is shown as follows:



(b) *Common Phase Clock Reference and Accuracy Requirement:*
Right holders must synchronise their frame structure on a UTC primary reference time clock. The start point of the first timeslot in the frame must align with the UTC second with a time offset T_{offset} = 0 and an accuracy of ≤ ±1.5 µs. The frequency accuracy must be within ±50ppb. It is recommended that deployed base stations should maintain a holdover period in the absence of UTC primary reference time clock of 4 – 12 hours with Oven Controlled Crystal Oscillator (OCXO). Licenses in MRs in the 3 300 – 3 800 MHz band that do not conform to the synchronisation requirement:

Licenses in Management Rights that do not conform to the synchronisation requirement must not interfere with Licenses in other Management Rights that are conforming with the described synchronisation requirements in this section, and therefore cannot claim protection from interference from such licenses.

2. AFEL, Unwanted Emission Limits, Protection Limits and Power Floors:

The AFEL, Protection Limits and Power Floor are specified in e.i.r.p, as required by the Radiocommunications Act 1989 (last revised in 2001). Limits relating to the AFEL and Protection Limits are based on the UEL specified in 3GPP TS 38.104 and have been normalized to a bandwidth of 1 MHz, specified in the units of dBW/MHz (discussed in the text under 2(a)).

(a) **AFEL:**

The unwanted emissions limits consist of limits in the out-of-band domain and spurious domain (see also 2(b)). Unwanted emissions in the out-of-band domain limits for the base station (BS) transmitter is specified in terms of the 3GPP Operating Band.

i. *Operating band class/Category*: 3GPP band n78 (3 300 – 3 800 MHz)/Category B;
ii. *The unit of power:* dBW/MHz EIRP.

The AFEL has been calculated assuming a 64 transmit 64 receive Active Antenna Systems (AAS) (assumed at the point in time when developing this schedule to be the largest applicable deployment configuration of a base station with AAS capability in 3GPP band n78) and the base station unwanted emission requirements are defined in accordance with the basic limits specified in the core base station specification, 3GPP TS 38.104, with an additional value of 35 dBi (for a single polarisation). The 35 dBi constant added to the 3GPP TS 38.104 Category B base station basic limits is comprised of three values in $10\log_{10}(8) + 10\log_{10}(32) +$ 11 dBi, which denote the factors needed for translating the AFELs from total radiated power (TRP) to EIRP (in accordance with the 3GPP TS 38.104), the number of physical ports on the AAS base station used for forming the traffic beams from each polarisation, and the assumed antenna gain per-antenna element.

The AFEL limits for the applicable MR from 3 300 – 3 400 MHz are given by:
Below the lower boundary of the operating band frequency:
-10.0 dBW at 3 260.0 MHz to -10.0 dBW at 3 290.0 MHz.
-10.0 dBW at 3 290.0 MHz to 1.0 dBW at 3 290.0 MHz.
1.0 dBW at 3 290.0 MHz to 1.0 dBW at 3 295.0 MHz.
1.0 dBW at 3 295.0 MHz to 1.0 dBW at 3 300.0 MHz.
8.0 dBW at 3 300.0 MHz to 8.0 dBW at 3 400.0 MHz.

Above the upper boundary of the operating band frequency:

8.0 dBW at 3 400.0 MHz to 8.0 dBW at 3 800.0 MHz.
8.0 dBW at 3 800.0 MHz to 1.0 dBW at 3 805.0 MHz.
1.0 dBW at 3 805.0 MHz to 1.0 dBW at 3 810.0 MHz.
1.0 dBW at 3 810.0 MHz to -10.0 dBW at 3 810.0 MHz.
-10.0 dBW at 3 810.0 MHz to -10.0 dBW at 3 840.0 MHz.

(b) **Unwanted Emissions Limits in the Spurious Domain:**
Unwanted Emissions limits in the Spurious Domain must meet or be lower than Category B of 3GPP TS 38.104 for base stations (transmitters) and 3GPP TS 38.101 for user equipment (receivers) ***or*** meet the limits prescribed in Category B of Recommendation ITU-R SM.329.

(c) **Protection Limit:**
The protection limit for a MR is equal to the AFEL of adjacent MRs. Where multiple AFEL values exist at the same frequency, the highest value will be used to set the protection limit.

(d) **Power Floor:**
The Power Floor limit is -50 dBW EIRP across the MR and is normalised to a bandwidth of 1 MHz.
