SUBMISSION TO
PROPOSED MARLBOROUGH ENVIRONMENTAL PLAN

PART B: Technical Supporting Document

Joint Submission of

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PART B: Justification and Technical Supporting Documents

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Use of "ARRL" means American Radio Relay League, Inc.

Use of "NZART" means the New Zealand Association of Radio Transmitters, Inc.

What is Amateur Radio?

Amateur Radio is an internationally controlled provision for experimentation and non- commercial communication via the radio spectrum. It is internationally controlled, because Amateur Radio uses a finite international resource, The Radio Spectrum, which does not respect national boundaries. The International Telecommunications Union (ITU), an arm of the United Nations organisation, allocates spectrum to all the prospective users, and controls the use of that spectrum through tight user specifications via the International Radio Regulations. Breaches in the use of this spectrum do not just affect the users in the country where the breach occurs, but potentially users in many other nations everywhere else in the world.

Recognising that there is a need for experimentation and research, The ITU allocates the spectrum according to two main classes of criteria:

• To Broadcasters, Commercial Operators, Emergency Services, Armed Forces, and the like, it mostly allocates individual frequencies through the processes of the administrative bodies of each country. In NZ this role is undertaken by Radio Spectrum Management, a branch within the Ministry of Business, Innovation and Employment (MBIE). The equipment used is controlled through tight specifications, which control such things as the frequency to be used, the transmitted bandwidth, the output power, and the level of spurious responses that may be produced by the equipment.

• To the Radio Amateur Service and Amateur Satellite Service. These are the only legal avenues for broad spectrum experimentation. In these services, it is not the equipment or the specific frequencies that are controlled, but only the qualifications of the personnel. They are the only services in which the people are licenced, not the equipment.

Recognising the importance of the self education and of the experimentation and development benefits of Amateur radio, the ITU has made the following allocations:

Spectrum between 1.8 MegaHertz (MHz) and 30 MHz: 12.8% of the total, amounting to 3.6MHz in 9 bands. In comparison, broadcast stations are allocated 4.615 MHz in 13 bands

Spectrum between 30MHz and 1 GigaHertz (GHZ), the amateur service has 40.75 MHz, 4.2% of the total spectrum. In NZ this is reduced to 25 MHz (2.58%) by the MBIE.

Spectrum between 1GHz and 10GHz, 0.914 GHz is allocated (10.2%). In NZ this is reduced to 0.424 GHz (4.71%) by the MBIE.

Above 10GHz, over 147GHz has been allocated to Amateurs.

For a complete list of frequencies see Attachment B1 “General User Licence-Amateur Radio”.

In New Zealand amateur radio is represented by a national organisation NZART which provides a voice for individual amateurs to represent their interests to the MBIE and local government (councils) who enact regulations which govern visible aspects of amateur radio.

Radio amateurs come from all sectors of the population from lawyers to drain layers for whom it is a vocation. The current national chairman of NZART is a medical doctor. By far the greatest numbers of amateurs are the technicians and engineers who are engaged in our telecommunication infrastructure and the electronic manufacturing and service industries. Often they are technically inclined people who gain employment in technological roles because of their interest in amateur radio, and sometimes they have university or technical college training and want to extend their knowledge through personal experimentation. In normal trade or university training the basics of the technology are taught in the classroom, but by far the most significant learning experience comes from practical application to the task itself. This leads to self education and self development, and those who involve themselves invariably advance rapidly in their respective industries. As amateur radio is the only legitimate way to take part in broad-spectrum experimentation and research into radio technology, many of the leading technologists in our country are or were radio amateurs. They are the people who for example design and operate our supervisory systems (monitoring pumping stations), our traffic control systems, our emergency communication systems, not to mention our telecommunications, Internet and IT networks, and TV facilities. They are also well represented in Tertiary Institutes and the computer industry.

50 years ago nearly all amateur apparatus was home-constructed, or developed by modifying army-surplus equipment. Through such experimentation and development the electronics industry made some significant technological breakthroughs, such as equipment which could operate in electrically hostile environments. Today, an off-the-shelf amateur transceiver will typically have several hundred additional

man-hours of engineers' research and development resource in each new model behind it, but the nature of the licence allows all amateurs to design and build their own equipment if they have the expertise and inclination to do so.

What is an Amateur Radio Licence?

The licence is issued to named individuals following an examination. With the advent of the internet the conditions are available to view at the Radio Spectrum Management website http://www.rsm.govt.nz/cms/licensees/types-of-licence/general-user-licences/amateur-radio-operators

See Attachment B1 "General User Licence-Amateur Radio" downloaded in January 2014. Pages 2 and 3 of this licence lists the 36 wavebands that are allocated to amateur experimentation, and pages 3 and 4 notifies restrictions and conditions which might apply to any individual waveband.

In section 5 (Terms, conditions and restrictions) at item 7 amateur operators are encouraged to prepare for and meet communication needs in support of disaster relief in accordance with Article 25 of the International Radio Regulations.

A Licence is required to transmit radio signals. No licence is required to receive radio signals. Any member of the public can receive and that activity would not be considered an amateur radio operation.

Provisions for Radio Amateur Configurations

In considering what provisions are needed, the Environment Plan firstly needs to consider how people are being affected by its lack of satisfactory provision for amateur radio configurations. If specific provisions are not "permitted" in the plan, then a resource consent would, of course, be required for all amateur radio configurations.

If specific rules are not included in the Plan, and with a large number of the current amateurs moving into the retirement phase of their lives, few will be able to afford resource consent fees upwards of thousands of dollars per application, not to mention the time it takes to prepare an application and have it approved. The most likely outcomes of the Draft Marlborough District Plan in its present form are:

- Experimentation would be largely halted (and)
- Amateurs would continue to experiment, but without consent – by its stance, Council would have forced them to behave irresponsibly, possibly leading to sanctions and fines (and)
- Technology development and personal self-education would suffer – consequently so would the general level of technological expertise throughout Marlborough. New Zealand would suffer. Because of the prominence of NZers in world technology, so too would the world suffer (and)
- Recruitment of young people to become radio amateurs would be impeded.

For an antenna to be effective it usually needs to have a dimension which is commensurate with the wavelength at which it is operating. The condition of "Resonance" leads to efficient antennas with predictable behaviour. This mainly occurs when the primary element is a half wavelength long. It is simply not possible for one aerial to be optimum for all bands, so if an operator wants to use many bands, aerials with completely different configurations would be required.

Thus, for the 2 metre Very High Frequency (VHF) band, the primary element would usually be one metre long, but for the 80 metre High Frequency (HF) Band, the primary element would be 40 metres long. Some radio amateurs never want more than this – they operate all their lives on these two bands, so a wire aerial for 80 metres, plus a Yagi antenna for VHF is all they will ever need. Some Amateurs, though, really do want to undertake meaningful experimentation on multiple bands. The emphasis is on "some", not most. No-one would ever want to use all 36 wavebands specified in the licence, but a few, say a third of amateurs might at any time want to have several aerials of different types, and for different lengths of time.

Recreational and Social Aspects of Amateur Radio

Many amateurs participate in worldwide communications from their homes as a recreational activity. International cooperation and goodwill is fostered through personal friendships, despite political tensions that arise across borders, which develop from sharing a common interest in amateur radio operation and radio technology.   Strong personal relationships develop between amateurs across geographical, political, cultural and other barriers. Amateur radio can be a lifelong activity when aging limits physical exercise.

Clubs exist for the amateurs in different regions of the country to meet and share experiences and friendship. Educational and interest programs are provided with guest speakers to extend the knowledge of the members. These clubs are affiliated to the national organisation NZART.

Amateurs frequently engage in operating contests, many of which are worldwide events, and some participate in expeditions to remote parts of the world, all of which develop and extend their communication skills, particularly in the area of weak-signal communications, which is often a feature of emergency communications. New Zealand amateurs have been involved in the rescue of yachting mishaps such as a sinking yacht 300km off the Californian coast, acting as a radio relay to the US Coastguard when the two vessels could not communicate due to the radio waves skipping over them, but both could be heard here in New Zealand.

The International Rotary movement has many “friendship groups”, one of which is Rotarians of Amateur Radio (ROAR). Every Sunday, Rotarians from all parts of the world join with each other on ROAR nets, and create very close bonds with Rotarians in other countries. They also co-operate in obtaining information on emergency situations in other countries. Early in 2013, serious flooding hit Fiji. The international Rotary organisation has a worldwide emergency response facility called “Shelter Boxes” – these are boxes pre-packed with tents, cooking utensils, first aid kits, blankets, and all the essentials of life. Because the national communications network in Fiji was completely broken Rotary called on its ROAR members to determine whether there was a need, and where that need was, which ultimately enabled hundreds of Shelter Boxes to be deployed. A very similar situation occurred again later in 2013, with the Philippines hurricanes.

Kings, presidents, leading politicians, Nobel laureates, eminent engineers and scientists, and astronauts can be counted in the ranks of radio amateurs. Today there are about three million amateur service licensees located in nearly every country of the world. Radio amateurs continue to build and maintain personal ties in a world that is in ever greater need of mutual understanding.

Amateur Radio in the Community

Amateur radio operations take place mainly at the operator’s home. Most operators reside in urban or semi-urban areas. Amateurs are normal members of the community. Many communities pride themselves on providing facilities for community and individual recreational activities, through the provision of halls, libraries, playgrounds, reserves and sports grounds, swimming pools, walking tracks, boat ramps and other facilities that enable the populace to participate in their chosen recreational activities. City and District Councils, at a cost borne by the ratepayers, provide most of these facilities. The amateur radio operators who participate in their recreational activity of amateur radio, mainly at the place where they reside are not seeking such community-funding for their facilities, just the opportunity to install effective antennas appropriate to their technological pursuit. The community as a whole benefits through and thrives on diversity. Radio amateurs create another thread to that diversity, they are responsible community members and they offer essential communication services in times of emergency.

A radio aerial, antenna or supporting structure erected for the purpose of pursuing the activities of an amateur radio operator is ancillary to the enjoyment of the dwelling on the property. It is part and parcel of the enjoyment of normal residence, and it forms part of the normal and ancillary residential appurtenances of a dwelling such as clotheslines, television antennas and swimming pools.

Technical Self-training and Development

Amateur radio provides opportunity for technical self-training, often leading to careers in technology. Among New Zealand amateurs who have achieved professional eminence was William Pickering, http://www.nzedge.com/heroes/pickering.html who led the United States space exploration programme. He developed his scientific interest through participation in amateur radio operation while at secondary school in Wellington.

Sir Angus Tait, founder of Tait Industries, Christchurch, http://www.taitworld.com/main/index.cfm/1,324,623,46,html/Sir-Angus-Tait manufacturer of high-technology radio communications systems marketed worldwide, was another prominent New Zealander whose technical interests began in amateur radio.

Many NASA scientists are radio amateurs. Not infrequently technical articles in amateur publications have been written by such scientists who in all likelihood have been experimenting with communications technologies that were being developed for the space programmes. Most astronauts have amateur licences, and amateur radio equipment is installed on the International Space Station. On two occasions this became the method of communications over periods when the main systems broke down. Many New Zealand amateurs have made contact via amateur radio with astronauts as they orbited above our country.

Emergency Communications.

Emergency communication is an infrequent activity, but one in which radio amateurs willingly engage in times of emergency. It is specifically encouraged in the wording of the Attachment B1: "General User Licence-Amateur Radio" at clause 5.7.

Infrastructure-free amateur radio communications, often overlooked in favour of more public means of communication, can maintain communications during disasters that bring more vulnerable mass technology to its knees. The simplicity and portability of amateur radio communications and expertise and wide distribution in the community means that there will always be people available when compared with the mainstream communications. This is normally advantageous in times of emergency.

There have in the past been documentaries produced on the communication links that were set up by amateurs in Hastings after the Napier/Hastings earthquake in 1931. Some amateur radio operators remained at their stations without sleep for days at a time, passing all the news and critical needs via morse code to Government in Wellington, and to the other main players throughout the country. This experience prompted radio amateurs to establish an organisation for "Emergency Communications" which has become the Amateur Radio Emergency Communications (AREC) of today.

In the last few years there have been many international emergencies which in the final anaysis depended on amateur radio communications for the supply of provisions, and in many cases, for the safety of life as well.

- There was Hurican Katrina in the States – see attachment B2
- There was the major storm in the Philipines in late 2013 which completely devastated not only outlying villages, but significant portions of major cities as well. For several weeks, amateur radio was the only viable link between communities.
- There were the major floods in Fiji in early 2013, and once again, amateurs provided the only communicatiuons link to the outlying communities.
- Just last year there was the Typhoon which hit Vanuatu, which destroyed buildings, crops and most of the vegetation – from which the Islands have still not recovered.
- Further examples are massive disasters, such as Cyclone Tracy, which hit Darwin in December 1974, and the enormous Sumatra earthquake and Andaman Islands tsunami of December 2004 in the Indian Ocean. In each of these emergencies, amateur radio provided vital links saving lives and property when normal emergency links, even military, were disrupted.
- Fortunately emergencies have not occurred in recent times in NZ, except perhaps:
    - The snowstorm throughout Canterbury in July 2008 is another example of amateur radio coming to the fore.
    - After the more recent Christchurch earthquake during the initial recovery phase amateur radio provided emergency communication links when cellphone and telephone services failed.
    - Recent events in Seddon when Radio New Zealand's AM frequency service was unable to broadcast civil defence messages after the 6.5-magnitude quake, Amateurs were already in communication, during this loss of commercial service.

Marlborough Amateur Radio Club (MARC) Community Support

Marlborough Amateurs are a diverse group with a very strong community focus and a proven track record in community support.

There are a number of organisations that rely on MARC for their communication solutions for safety and event management. The events have national and local significance, are high profile and with complex requirements.

MARC solutions for events are not as limited as the traditional mobile network (cell phone and land mobile radio) and for this reason our group is often in demand.

Our linked repeater systems allow transmissions of VHF and higher frequencies across hundreds of kilometres. MARC operates main linking repeaters locally at:

Mt Freeth – Picton
Weld Cone – Ward
The Ned – Blenheim
Kaikoura
Wither Hills

These repeaters link into Motueka (Golden Bay) and Nelson providing continuous communication cover to the top of the South area.

In effect for 6 months of the year (November to end of March) MARC support at least two events per month, with local, national, and international significance, providing equipment, personnel, and advice for planned (and un planned) events such as:

Forrest Estate Grape Ride,
The Wine and Food Festival,
Pak n Save Marlborough Marathon,
Moa Hunt.
Queen Charlotte Challenge.
National Equine Endurance Championships,
Epay Silver Fern Car Rally,
Annual Christmas Parade
Scout and Guide organisations, (supporting Jamboree on the Air (JOTA))
Boxing Day (2000) fire on Wither hills: Provided equipment, operators, and repeater network.

Last and, most importantly, MARC participates as active AREC support and equipment for the Police Search and Rescue, and Civil Defence.

Without MARC expertise and extensive infrastructure these organisations would struggle to meet their respective safety plans and hazard reduction requirements to ensure the safety of competitors and the smooth running of these events.

The organisations, by operating their events, provide Marlborough with a diverse range of sporting, cultural and recreational pursuits, which draw a large number of visitors each year with obvious economic benefits to the area.

Attachments B9 & B10 illustrate the support and involvement that MARC has with the Community.

Disaster Management Capability

Recent events in Seddon have shown the importance of having capable individuals with linkages to disaster management capability and experience in operation of radio technology.

When Radio New Zealand's AM frequency service was unable to broadcast civil defence messages for about 20 minutes after the 6.5-magnitude quake on that Sunday morning, Amateurs were already in communication, during this loss of commercial service.

" …..Without electricity there would be no television, no computer services, and cellphone towers would not transmit", Barr said.

"In a big enough event our planning is always that we should assume that there is no power. That means that you're working on battery-operated or vehicle-operated radio systems."

At these times amateurs will come into their own being available, mobile, experienced and willing to donate time and make their equipment available.

The Christchurch earthquake was another recent local example of Amateur capability to support Civil Defence. A team from Marlborough went down to provide assistance and operators locally passed on messages both informally and formally to worried friends and family.

The Marlborough Council Decision.

Of all districts, the decision facing the Marlborough District Council on whether or not to "Permit" Amateur Radio Configurations is one of the simplest, no-brain decisions of anywhere in New Zealand. Marlborough is one of the more likely districts in NZ to be susceptible to earthquake and flooding emergency events:

The probability of a major event hitting Marlborough in the foreseeable future is high. When that happens, despite the fact that commercial communications companies will vigourously deny it, the commercial communications systems will fail. They are simply not build to cope with emergency situations. The only communications avaialable during such emergencies will be limited internet facilities from third tier ISPs and amateur radio operators.

There is 100% certainty that there will be a major Tsunami affecting the East Coast of NZ at some stage. There is a similar expectation of a major alpine 8.1+ fault for which a major Government study has just been initiated with the expected disaster recovery centre to be Marlborough. The only thing we don't know is when?

Following the February 2011 Christchurch Earthquake The simplicity and portability of amateur radio in emergency communications proved to be enormously advantageous when compared with the mainstream communications .

It behoves Marlborough District Council, therefore, to encourage radio operators to reside in the area, in order to provide emergency communications when they become necessary.

The Radio Spectrum and Antenna Dimensions

The spectrum allocated to amateur radio by the ITU ranges from low frequency (LF) through medium frequency (MF), high frequency (HF), very high frequency (VHF), ultra high frequencies (UHF) and super-high frequency (SHF), covering most of the total electromagnetic spectrum. There are 36 frequency bands allocated, with frequencies ranging from 130 kilohertz (kHz) to 1000 Gigahertz (GHz), corresponding to wavelengths ranging from 1800 metres to 0.3 mm. Most amateur operation and experimentation uses the frequencies allocated between 3.5 MHz and 440 MHz, but there is growing interest and increasing use of bands outside this range.

The physical dimensions of an antenna are very much a function of the frequency of use, the available site area, the efficiency of power radiation and the installation cost. Aerials/Antennas exist in many configurations and may be constructed of wires, usually horizontal or sloping for lower frequencies, or metallic tubes in horizontal and vertical arrays, sometimes ground mounted for medium frequencies, often elevated. As frequency rises antennas using reflectors become more effective than wires or tubes. An efficient antenna will have elements that are resonant at the frequency of operation. This requires a length of a half-wavelength at the frequency of operation. Where constraints prevent a full size element the efficiency is progressively reduced.

Antenna performance is critically related to dimension.

Low frequency (LF) antennas are characterised by height and length. A single wavelength is many hundreds of metres long, and since the land area available for an amateur installation is generally limited, LF antennas are a fraction of a wavelength and very inefficient. Cost and available real estate are the prime constraints. For that reason and for satisfactory long-distance propagation, many LF antennas are vertical.

Medium and high frequency (MF & HF) antenna lengths are usually based on multiples of a half-wavelength. At 3.5 Megahertz (MHz) a single half-wavelength is around 40 metres, and a simple horizontal single-wire antenna of this length is predominantly used. For vertically polarized antennas, masts of 40 metres or so in height are costly, and lesser heights generally up to 20 metres are more common. LF and MF antennas are generally real estate or height limited. An ideal installation could be a horizontal wire with a length of 80 metres or more, or a vertical mast element, as high as possible, say 30-40 metres minimum, but while neither of these can normally be realised on an urban lot, both are entirely feasible in a rural environment. Sometimes these antennas are elevated above ground. The radiation pattern of an antenna is strongly influenced by the height above ground.

So much for the theory – in practice the dimensions of the radiating elements are generally:

for HF - up to 40 metres long if horizontal and 20 metres if vertical at the lower HF bands,

- for MF and LF - similar, but longer where possible, otherwise operating at reduced efficiency.
- for VHF - about 3 metres long for 50 MHz, and 1 metre for 144 MHz
- for UHF - 35 centimetres (cm) for 435 MHz, 11.6 cm for 1296 MHz
- for high UHF and SHF - even smaller, but the reflector dish used is much larger than the radiating elements
- Dish antennas are larger, up to 5 metres diameter being necessary for amateur moon-bounce and space communications.

Antenna elements are often combined into an array to control the radiation pattern to desired directions – a very common example being the roof mounted TV aerial. Physical size generally limits such arrays. The boom length (the supporting element on which the radiating elements are mounted) of any beam array would seldom exceed 8 metres in length for reasons of wind loading and durability, and will often be shorter.

As stated above, HF antennas for the low HF bands are usually wire structures that can generally be reasonably accommodated on a 700 square metre urban lot, although, in most instances, these would be compromised in performance through lack of height, or length.

For the remaining HF bands, horizontal multi-element beam arrays are more common, with element lengths spanning 10 metres at 14 MHz, reducing to 5 metres at 29 MHz. These beam arrays may have up to 6 - 8 elements on boom lengths up to 8 or more metres. Survivability under high wind loads generally limits the dimension of beams. These beams are similar in appearance to a typical low VHF band television (TV) antenna, but of larger dimensions, in inverse proportion to the frequency.

The VHF and low UHF bands often use multiple element beam arrays, not unlike a high gain terrestrial TV beam antenna. For short-range communication or when using local repeaters small vertical whip antennas are common.

For the higher frequency UHF bands and the SHF bands the actual radiating elements are quite small but to achieve antenna performance gain reflector dishes may be used for experimental purposes up to 5 or so metres in diameter in an urban situation. Larger dishes exist in rural situations.

Antenna development is a continuing experimental science. There is no single feasible or practical antenna design which covers all the amateur radio spectrum. Some antenna arrays are made to operate over several bands and these arrays are widely used but are confined to the higher of the HF bands, at wavelengths from 20 metres to 10 metres.

See Attachment B3: “Photos of Amateur Radio Configurations”.

Many municipal libraries throughout New Zealand hold a recent edition of the ARRL Hand Book for Radio Communications (the 2013 printing is the 90th edition). A sister publication the ARRL Antenna Book is now in its 22nd edition (2011) has 936 pages in 30 chapters. It is appreciated that the content is very technical, however even a brief perusal will show both the technical complexities and the diverse range of antennas and supporting structures, and this should illustrate that any attempt to codify them into a standard is totally impracticable.

For an antenna to be effective it usually needs to have a dimension which is commensurate with the wavelength at which it is operating. The condition of “Resonance” leads to efficient antennas with predictable behaviour. This mainly occurs when the primary element is a half wavelength long. It is simply not possible for one aerial to be optimum for all bands, so if an operator wants to use many bands, aerials with completely different configurations would be required.

Thus, for the 2 metre Very High Frequency (VHF) band, the primary element would usually be one metre long, but for the 80 metre High Frequency (HF) Band, the primary element would be 40 metres long. Some radio amateurs never want more than this – they operate all their lives on these two bands, so a wire aerial for 80 metres, plus a Yagi antenna for VHF is all they will ever need. Some Amateurs, though, really do want to undertake meaningful experimentation on multiple bands. The emphasis is on “some”, not most. No-one would ever want to use all 36 wavebands specified in the licence, but a few, say a third of amateurs might at any time want to have several aerials of different types, and for different lengths of time.

Antenna Height and Radio Wave Propagation

Amateurs have for many years erected their antennas as high as possible, knowing how important the appropriate height is in achieving effective performance.

Radio waves emanating from an antenna travel in straight lines into space. Different layers of the ionosphere absorb and/or refract radio waves. In daytime, waves below about 7 MHz are absorbed by the D Layer. At higher frequencies those that travel upwards above about 45° generally penetrate all the ionised layers and continue out into space. Lower angled waves and those below a frequency which depends on the sun’s activity at that particular time are refracted back to the earth by the E and F Layers at a considerable distance, say 1,000 to 4,000km from the transmitter.

The propagation of radio waves around the world is strongly affected by the height of the ~~transmitting~~ antenna. The reception performance of an antenna is the same as the transmission performance. These effects are due to the angle of the outgoing or incoming wave. This wave-angle is almost entirely determined by the height of the antenna above the local ground area.

A low horizontal antenna radiates mainly upwards and the energy is lost into space. Only a small amount of the radiated energy from such an antenna is radiated at a low angle. The low angled wave reaches the ionosphere at a shallower angle than the upward wave, and it can be refracted by the ionosphere to return to earth. The wave will be reflected by the earth to the ionosphere in a second hop, and up to four or more hops may be required for a wave to reach its destination. At each reflection, both in the ionosphere and at the earth’s surface much of the remaining energy of the wave is lost through being absorbed. So for long distance communication the minimum number of hops is required to maintain an adequate signal level (the more hops, the more absorption). The wave take-off angle should be as low as possible, directing the radiated energy towards the horizon.

Placing an amateur radio antenna system higher has other secondary advantages. A higher antenna reduces the chances of electromagnetic interference with neighbours’ equipment, reduces the chances of picking up spurious radio noise from neighbourhood computers and electronic appliances, and lowers exposure to radio frequency fields.

There have been several studies in different parts of the world to determine the best antenna height for effective long-distance terrestrial communication although earlier studies may not have had scientific rigour. In USA, a figure of 70 feet (or 21.3 metres) was considered necessary for such an antenna and that figure is now set in Federal Rules. Earlier studies on communication between Europe and South America showed that 20 metres height was required for the same reasons.

A report was prepared by the ARRL on amateur antenna performance in relation to height “Antenna Height and Communications Effectiveness; a Guide for City Planners and Amateur Radio Operators”. See Attachment B4: “A Guide for Planners and Amateur Radio Operators”.

Quoting from that report:

> *" ...In terms of safety and aesthetic considerations it might seem intuitively reasonable for a planning board to want to restrict antenna installations to low heights. However, such height restrictions often prove to be very counter-productive and frustrating to all parties involved. If an amateur is restricted to low antenna heights, say 35 feet, he will suffer from poor transmission of distant signals. In an attempt to compensate on the transmitting side (he can't do anything about the poor reception problem), he might boost his transmitted power from say 150 watts to 1,500 watts, the maximum legal limit. This ten-fold increase in power will very significantly increase the potential for interference to telephones, televisions, VCRs and audio equipment in his neighbourhood.*
>
> *Instead, if the antenna can be moved further away from neighbouring electronic devices -- putting it higher in other words -- this will greatly reduce the likelihood of interference, which decreases at the inverse square of the distance. For example, doubling the distance reduces the potential for interference by 75%. As a further benefit, a large antenna doesn't look anywhere near as large at 120 feet as it does close-up at 35 feet.*
>
> *As a not-so-inconsequential side benefit, moving an antenna higher will also greatly reduce the potential for exposure to radio-frequency fields for neighbouring human and animals...."*

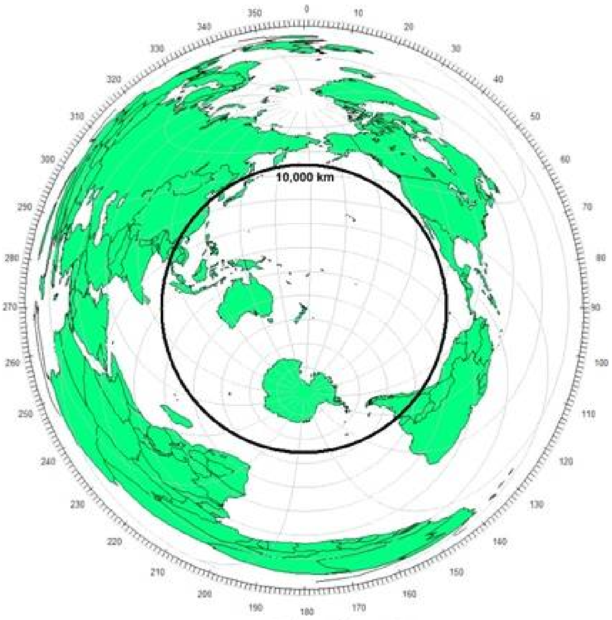
The same considerations apply in New Zealand, except that the maximum power limit here has only recently been increased to 1000 watts peak envelope power (PEP). Amateur antenna installations on towers exceeding 120 feet in height are not uncommon in the US, although mainly in rural communities.

Long Distance Communications

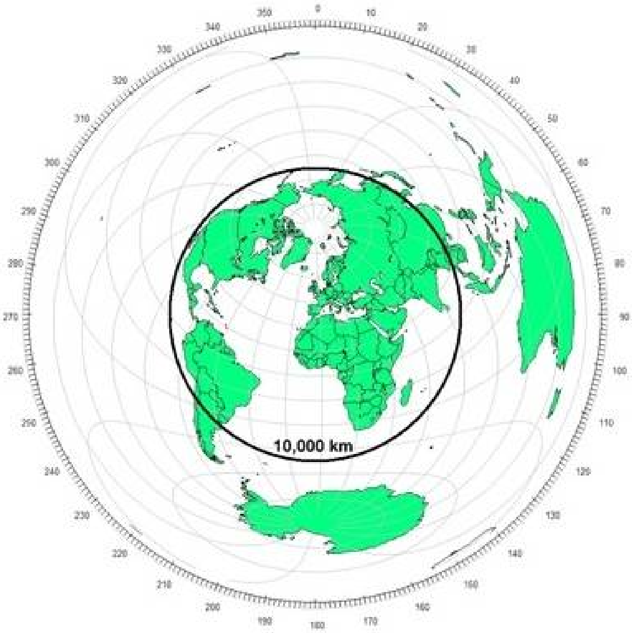
New Zealand is at a very great disadvantage for long distance short-wave communications compared with many other countries, especially European and North American countries. The geographic isolation of New Zealand places most countries of the world at far greater distance. Refer to the great circle maps below.

> Map 1 shows that there are very few countries in the hemisphere centred on New Zealand. Most of the world lies more than 10,000 km away.
>
> Map 2 is centred in Spain, at the antipodes to New Zealand. Most of the world's countries are within 10,000km.

As a result, NZ amateurs have to pay far more attention to the efficiency of their radiated signals, which can only be achieved by effective antenna installations.



Map 1
Great Circle centred on
New Zealand

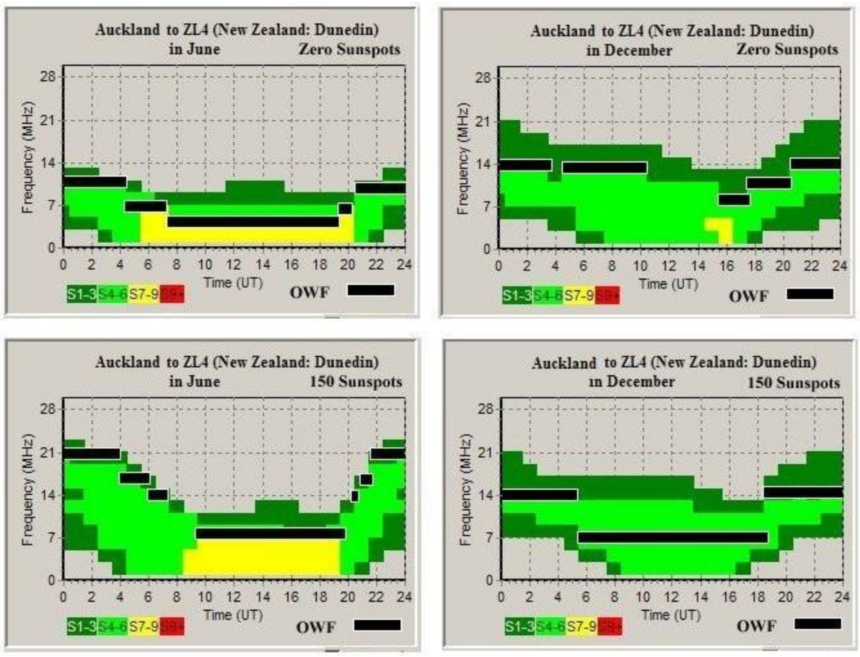


Map 2
Great Circle centred on the
Antipodes of New Zealand

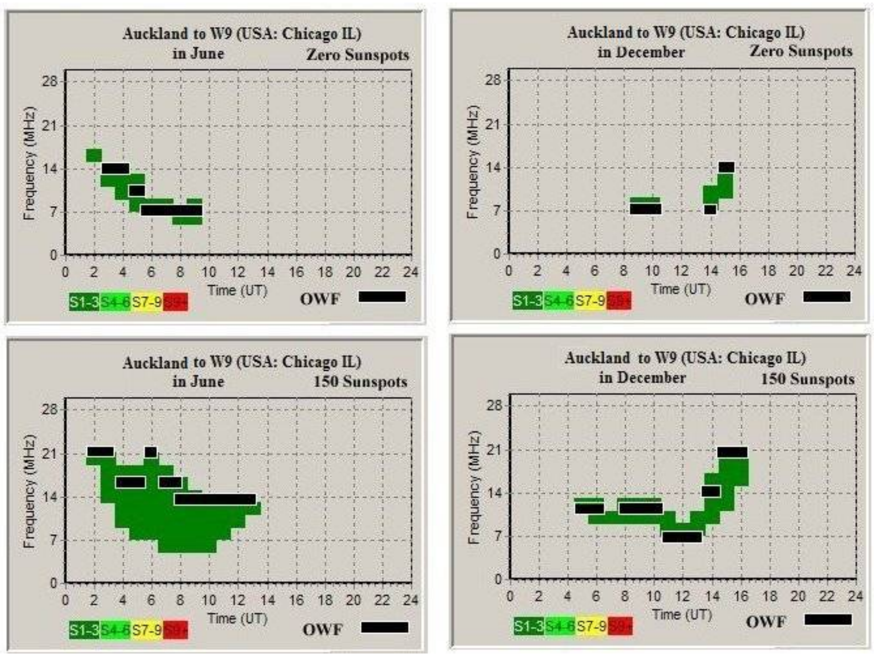
It is clear from these two maps that worldwide communications from New Zealand is much more difficult than it is from USA, Europe, North America, most of Asia, South America, and Africa.

The following set of four graphs shows the Optimum Working Frequency (OWF) in black. The OWF is the best frequency for two stations to use over a given path. The first example is between Auckland and Dunedin. There are two columns of graphs, the first is for the month of June and the second for December, showing the seasonal effect of the Sun.

The two rows below show the effects of ionisation in the atmosphere. The first row is during periods of very low sunspot activity, and the second row for periods of relatively high sunspot activity. The graphs show that stations will have to change frequency a number of times throughout the day over 3 or 4 bands, thus the need to have a number of available antennas.



The second set of graphs shows the same information, but this time for a relatively long path from Auckland to Chicago.



The colour bands on these graphs represent received signal strength. Dark green is a strength of 1 – 3 (very weak signals), Light Green is Strengths 4 – 7 (good signal levels) and Yellow represents strengths 7 – 9 (strong signals)

The History of Experimentation

Experimentation is an activity in which amateurs engage in pursuit of technical knowledge, understanding and the development of equipment. Amateurs are permitted to construct their own equipment, a privilege not available to any other spectrum users, who are required to have their equipment pass rigorous type approval processes. In New Zealand individual amateurs may contribute articles to the “Break In” magazine based on the results of their experiments.

Experimentation with antennas is probably the most frequent form of experimentation radio amateurs engage in. Antennas are frequently built, modified and replaced with alternative designs. The range of possible design configurations is virtually unlimited.

Examples of experimentation over time

(i) In the mid-1920's, exploration of the “short waves” was just beginning. Through experimentation radio amateurs were well ahead of their commercial counterparts in exploiting the long-distance capabilities of this unique part of the radio spectrum. The technical contributions of the amateurs were very important to subsequent telecommunication development, and remain so today.

With Amateurs situated all over the world they have studied propagation of radio waves since the beginning of radio with networks of beacons and remote listening stations so that they can listen to their own signals received in distant parts of the world.

ii) Amateurs were one of the fore-runners of data radio. Many years before internet was in general use, amateurs were using Packet Radio to transmit news and technical information to post on “Bulletin Boards” for others to download at a later stage. The technology was built on existing wired computer protocols between 1978 and 1983 when X.25 was adapted to AX.25 and became the standard for amateur messaging, data downloads and satellite use in 1984.

(iii) At a “Radio Conference” in Auckland in the early 1990s, there was a presentation by the Police plaintively wishing for technology which would enable Police Head Quarters to know the location of each of their vehicles all the time. Within a very short period after GPS became available, amateurs had linked GPS to VHF radios, which constantly transmitted the vehicle’s location. This was called Automatic Position Reporting System (APRS) and has since become used widely not only in Police vehicles, but in most major transport and fleet companies. It is not known whether amateurs were the first to develop the commercial application – but they were certainly there at the ground floor.

(iv) One of the more interesting recent amateur developments is not actually in Communications, but in satellite research. Radio Amateurs are about the only group outside governments, large communications companies, and the armed forces, that have their own satellites orbiting the earth. Beginning in 1961 they were launched “free of charge” on rocket launch vehicles that had spare payload capacity. The only significant launch cost that amateurs had to stand in the early days was insurance – there had to be an insurance policy which covered any loss of the Rocket and/or all its client payloads, should the volatile fuel used in manoeuvring engines explode. Unfortunately, the insurance premium for billions of dollars of cover was not cheap, so the commercial answer was the “Ion Thrust” engine where an inert fuel can be decomposed into ions which are accelerated by RF fields. What Amateurs are really good at is producing fields and waves. By experimenting with “micro ion thrust” and producing miniaturised technology, small amateur satellites can have safe technology to position themselves in orbit which has not previously been possibleThe development of the Ion Engine makes it today the predominant engine used by all commercial satellite developers for deep space exploration. These have become bigger and stronger over time.

Satellites are not things that are only developed by others somewhere else in the world. A group of Auckland amateurs have completed construction of our own “Kiwisat”. It is currently mounted on a promontory near Papakura, and is undergoing post production testing. The Launch is currently re-scheduled to 2016, but even that could fall back.

(v) As recently as October 2013, NASA requested amateurs throughout the world to contact the Juno spacecraft on its way to Jupiter. The "Say Hi to Juno" project was made possible by the fact that Juno passed within 350 miles of the Earth's surface on 9th October in a slingshot manoeuvre to gain momentum for its July 2016 encounter with Jupiter. Over 2,500 amateurs responded from widely dispersed locations around the world. NASA would simply not have been able to set up such a dispersed test facility without the aid of amateurs. Juno did not return the greeting or even directly decode the messages but the Juno team evaluated the Waves instrument data containing the messages when the spacecraft was still over 37,000 kilometres from the Earth, and subsequently acknowledged all those amateurs who had taken part in the exercise.

Planning Rules in other places

The matter of antenna heights has been of much concern to the amateur radio service world wide. In particular, in the USA where, due to undue restrictions imposed by planning authorities, the US government over-rode local planning laws by issuing a federal pre-emption. (This is similar in many respects to National Environmental Standards (NES) that are sometimes used in NZ). This federal pre-emption, called PRB-1, generally prevents planning authorities limiting antenna heights to below 70 feet (21 metres), but does not apply to restrictions arising from land use covenants or private contracts. PRB-1 is the result of the strong concerns of the US government in response to overly restrictive planning. Regrettably no such pre-emption exists in this country.

One further reason for requiring reasonable antenna requirements is the increasing pollution of the electromagnetic spectrum. This pollution, and its consequences, which are the subject of intense scientific investigation can be likened to electronic smog. It has dramatically increased over recent years with the proliferation of electronic devices, which taken singly are of no great consequence, but which now number many millions. The cumulative effect of these devices is to raise the noise floor (the background noise) of the electromagnetic spectrum. Efficient antennas are required to discern the wanted signals over prolific background noise, and efficient antennas demand height and appropriate dimensions. They cannot be miniaturised. Amateur communications are only as effective as the antennas they employ.

Note - the way urban city lighting has affected the ability of astronomical telescopes to see distant celestial bodies is analogous to the way prolific electronic background noise has reduced the ability of radio users to detect weak signals.

Heights of less than 21 metres (a soft conversion from the 70 feet referred to in ARRL reports) for horizontal antennas on the HF bands will compromise performance.

An Academic Analysis of Optimum Antenna Heights

Attached is a very recent treatise by Dr Siwiak "An Optimum Height for an Elevated HF Antenna" published on page 32 of the May/June 2011 issue of QEX by the ARRL. (See attachment B8). While this article is rather academic and uses several specialist terms and concepts, it does complement several previous studies which were based both on simulated modelling and on experimental measurements.

The Summary and Conclusions on page 7 of the article says:

> "*Constructive and destructive wave interference from a direct path and an earth reflected path causes a vertical standing wave at the antenna location. The standing wave pattern details depend on the wave angle of arrival, polarisation, on whether the reflection point was ground or sea water, and on the terrain profile (not considered here). Optimum antenna heights are largely governed by the lowest arrival angle deemed important at the highest desired frequency. Antennae that are placed too high can suffer from significant wave destructive interference at desired higher arrival angles. The earth reflection point is typically several kilometres away for low arrival angles, but can be tens of metres for very high arrival angles, so the condition of the ground immediately below the elevated antenna is of little importance. Because height gain can be significantly greater for higher arrival angles, the lowest arrival angle path (fewest hops) does not always result in the best link margin for paths that can be closed with different numbers of earth-ionosphere hops. <u>Optimum height is 1.5 to 1.6 wavelengths for any one band, or a compromise height can be found for a multiband antenna operating over several bands by using the optimum for the highest frequency</u>.*

<u>Most amateurs who are interested in international HF communications are interested in these very frequencies because of the limitations of the Ionosphere.</u>

To cater for the periods of low sun spot numbers where lower frequencies must be used, the optimum height increases. (see "Long Distance Communications charts for Optimum Working Frequency" earlier in this paper.)

Some other Councils on becoming aware of the impediment their rules create to efficient amateur antenna installations, have provided relief for the amateur stations by using the less restrictive antenna height limitations applying to their utility network operators, rather than the lesser heights in building rules which have not considered amateur antenna needs. The pragmatic approach of these Councils is applauded. US States are progressively implementing the Federal PRB-1 into their own laws.

The types of communication systems used by the network utility operators such as Spark are radically different from those for the amateur service. Spark must carry very large volumes of data requiring very high frequency of operation. At these frequencies transmission travels in line-of-sight paths. The curvature of the earth limits the distance to the horizon so antennas must be mounted at sufficient height to obtain the required range. Spark and the other utility operators operate of necessity at an extremely high rate of service, pursuant to the reliability of the essential services they supply. The propagation paths they use must be unobstructed and are usually much shorter than amateur operators use. Spark and the other utility operators frequently have their major installations in the industrial zones where by virtue of higher permitted building heights the required unobstructed path can be obtained.

Amateur radio operators operate mainly in the residential zones where the building heights are less, so are considerably disadvantaged in comparison with utility operators such as Spark and others unless similar antenna heights are permitted.

Court Precedence

The Environment Court Decision [2012] NZEnvC-193 created rules to be added to the Tauranga City Plan, removing any ambiguity and clearly defining the permitted installations. Attachment "[2012]-NZEnvC-193" pages 4 – 11 (See attachment B5).

The reasoning behind NZEnvC-193 is contained in attachment Tauranga-City-Council [2012]-EnvC-107 pages 6 – 14. (See Attachment B6) clauses 25, 29, 39, 42, 49, 50, 54 are particularly relevant. From clause 25

> *In our view the importance of the amateur radio community to the infrastructure of New Zealand is often underestimated. The Court recognises that they have a particular role both in times of emergency and in maintaining, in a general sense, international communications. Accordingly, that duty needs to be recognised by the Council and balanced with the needs of its community for amenity.*

From clause 50

> *Nevertheless we also consider that it would be unfair if the outcome turned upon whether a particular neighbour decided, for whatever reason, to oppose an application. In the end, given our conclusions as to effects, we consider that there is no need to justify the application by getting the consent of neighbours, either next door, or within a 50m radius.*

The effect of these two clauses is to recognise that international and NZ Government regulation have permitted amateur radio and Local Government is required to follow their direction.

To balance the potential adverse effects on the environment of an amateur radio configuration, the Environment Court in Tauranga clearly articulated the standards that any plan should meet.

> *In my opinion Amateur Radio operation can be suitably provided for and addressed as a Permitted activity within Chapter 25.7 Network Utilities and Electricity Transmission Corridors subject to meeting specific standards. To ensure this is suitably provided for I recommend additional standards within 25.7.6.2 are incorporated to provide for Amateur Radio operations.*

The preferable solution for the Marlborough District Council Proposed Plan is to regard the amateur radio service as a special case of Network Utilities, just as the District Plans of many other Local Authorities already do, and apply the Draft Rule outlined in Part A of this submission or one based on the Rangitikei Consent Order, to provide reasonable accommodation for the amateur radio service.

Existing Amateur Radio Configurations to be Deemed Complying

While not an existing practice in New Zealand planning law, there are known cases from around New Zealand where Councils have tacitly not questioned long established existing configurations. Some practices are explicitly provided for in some places overseas; see Attachment B7: "House of Commons Library, Standard Note:

SN/SC/1579 Enforcement of Planning Law", which on page 2 states:

We consider it appropriate that for an existing non-complying amateur radio configurations which have not been the subject of complaint or enforcement for a significant time period, Councils should deem them complying. The time period of two years is considered appropriate for an amateur radio configuration.

Attachments

Attachment B1: General User Licence – Amateur Radio.pdf
(issued by NZ Radio Spectrum Management)

Attachment B2: Katrina Summary, ARRL QST November 2005.docx
(ARRL President Jim Haynie testimony to a Congressional Committee)

Attachment B3: Photos of Amateur Configurations.pdf

Attachment B4: A Guide for Planners and Amateur Radio Operators.pdf
(Second Edition 1999 published by ARRL – Antenna Height and Communication Effectiveness)

Attachment B5: [2012]-NZEnvC-193
ENV-2011-AKL-000074 is the Case Number that resulted in decision 193.
(Environment Court Decision re Tauranga plan change for Amateur Radio)

Attachment B6: [2012]-NZEnvC-107
(Environment Court reasoning behind the decision re Tauranga City and Amateur Radio)

Attachment B7: House of Commons Library: Enforcement of Planning Law, Standard Note: SN/SC/1579, Last updated: 16 July 2013, Author: Louise Smith, Section: Science and Environment.

Attachment B8: Optimum Height for an HF Antenna.pdf
(Dr Siwiak, ARRL, QEX May/June 2011 magazine

Attachment B9: AREC Activity Report

Attachment B10: MARC ‘ Interface’ Magazine Community Activities Extract

Radio Spectrum Management

Amateur radio operators

Pursuant to section 111 of the Radiocommunications Act 1989 and Regulation 9 of the Radiocommunications Regulations 2001, and acting under delegated authority from the chief executive, I give the following notice.

Notice

1. Short title and commencement

1. This notice is the Radiocommunications Regulations (General User Radio Licence for Amateur Radio Operators) Notice 2013.
2. This notice comes into force on 1 August 2013.

2. General user radio licence

A general user radio licence is granted for the transmission of radio waves by amateur radio operators in New Zealand, for the purpose of communications in the amateur radio service in accordance with the terms, conditions and restrictions of this notice.

3. Terms, conditions and restrictions applying to New Zealand amateur operators

1. Persons who hold a General Amateur Operator’s Certificate of Competency and a callsign issued pursuant to the Regulations may operate an amateur radio station in New Zealand.
2. The callsign prefix of “ZL” may be substituted with the prefix “ZM” by the callsign holder for the period of, and participation in, a recognised contest, or as the control station for special event communications.
3. Operation on amateur bands between 5 MHz and 25 MHz is not permitted unless a person has held a General Amateur Operators Certificate of Competency for three months and logged 50 contacts during this period. The person must keep the logbook record for at least one year and, during this period, produce it at the request of the chief executive.

4. Terms, conditions and restrictions applying to visiting amateur operators

1. Persons visiting New Zealand who hold a current amateur certificate of competency, authorisation or licence issued by another administration, may operate an amateur station in New Zealand for a period not exceeding 90 days, provided the certificate, authorisation or licence meets the requirements of Recommendation ITU-R M.1544 or CEPT T/R 61-01 or CEPT T/R 61-02 and is produced at the request of the chief executive.
2. The visiting overseas operator must use the national callsign allocated by the other administration to the operator, in conjunction with the prefix or suffix “ZL”,

except where subsection (3) applies, which is to be separated from the national callsign by the character "/" (telegraphy), or the word "stroke" (telephony).

3. The visiting overseas operator may use the prefix or suffix:
   a. ZL7 when visiting the Chatham Islands
   b. ZL8 when visiting the Kermadec Islands
   c. ZL9 when visiting the Sub-Antarctic Islands

5. Terms, conditions and restrictions applying to all amateur operators

1. The use of callsigns, including temporary and club callsigns, must be in accordance with publication PIB 46 "Radio Operator Certificate and Callsign Rules" published at www.rsm.govt.nz
2. Callsigns must be transmitted at least once every 15 minutes during communications.
3. National and international communication is permitted only between amateur stations, and is limited to matters of a personal nature, or for the purpose of self-training, intercommunication and radio technology investigation, solely with a personal aim and without pecuniary interest. The passing of brief messages of a personal nature on behalf of other persons is also permitted, provided no fees or other consideration is requested or accepted.
4. Communications must not be encoded for the purpose of obscuring their meaning, except for control signals by the operators of remotely controlled amateur stations.
5. Except as provided to the contrary in this notice, transmitter power output must not exceed 1000 watts peak envelope power (pX), as defined in ITU Radio Regulation 1.157.
6. Amateur stations must, as far as is compatible with practical considerations, comply with the latest ITU-R recommendations to the extent applicable to the amateur service.
7. In accordance with Article 25 of the International Radio Regulations, amateur operators are encouraged to prepare for, and meet, communication needs in support of disaster relief.
8. Amateur beacons, repeaters and fixed links may not be established pursuant to this licence.
9. Unwanted emissions outside the frequency bands specified in this Schedule must comply with the requirements of technical standard ETSI ETS 300 684 published by the European Telecommunications Standards Institute (ETSI).
10. This general user radio licence applies only to transmissions within the frequency ranges set out in the Schedule to this licence. All such transmissions must be made in accordance with the notes for the frequency range in which that transmission take place and in accordance with the other conditions set out in this licence.

6. Consequential revocation of licences

The Radiocommunication Regulations (General User Radio Licence for Amateur Radio Operators) Notice 2012 dated the 29th day of November 2012 and published in the *New Zealand Gazette*, 6 December 2012, No. 147, page 4287, is revoked.

Schedule

Frequency Range	Notes
130 to 190 kHz	2, 4, 6
472 to 479 kHz	2, 7
505 to 515 kHz	2, 4, 7, 8, 9
1.80 to 1.95 MHz	2
3.50 to 3.90 MHz	2
7.00 to 7.10 MHz	1
7.10 to 7.20 MHz	
7.20 to 7.30 MHz	2
10.10 to 10.15 MHz	2
14.00 to 14.35 MHz	1
18.068 to 18.168 MHz	1
21.00 to 21.45 MHz	1
24.89 to 24.99 MHz	1
26.95 to 27.30 MHz	2, 3, 5, 6
28.00 to 29.70 MHz	1
51.00 to 53.00 MHz	2
144.00 to 146.00 MHz	1
146.00 to 148.00 MHz	2
430.00 to 440.00 MHz	1, 2, 3
921.00 to 928.00 MHz	3, 7
1.24 to 1.30 GHz	1, 2
2.396 to 2.45 GHz	1, 3
3.30 to 3.41 GHz	1, 2
5.65 to 5.85 GHz	1, 3
10.00 to 10.50 GHz	1, 2
24.00 to 24.05 GHz	1, 3
24.05 to 24.25 GHZ	3
47.00 to 47.20 GHz	1
75.50 to 76.00 GHz	1, 2
76.00 to 81.00 GHz	1, 2
122.25 to 123.00 GHz	2, 3
134.00 to 136.00 GHz	1
136.00 to 141.00 GHz	1, 2
241.00 to 248.00 GHz	1, 2, 3
248.00 to 250.00 GHz	1

275.00 to 1000 GHz	2, 4

Notes to Schedule

1. The following ranges of frequencies may also be used for amateur satellite communications:

7.00 to 7.10 MHz	3.40 to 3.41 GHz
14.00 to 14.25 MHz	5.65 to 5.67 GHz (a)
18.068 to 18.168 MHz	5.83 to 5.85 GHz (b)
21.00 to 21.45 MHz	10.45 to 10.50 GHz
24.89 to 24.99 MHz	24.00 to 24.05 GHz
28.00 to 29.70 MHz	47.00 to 47.20 GHz
144.00 to 146.00 MHz	75.50 to 81.00 GHz
435.00 to 438.00 MHz	134.00 to 141.00 GHz
1.26 to 1.27 GHz (a)	241.00 to 250.00 GHz
2.40 to 2.45 GHz	

   a. Limited to the earth-to-space direction.

   b. Limited to the space-to-earth direction.

2. These frequencies are, or may be, allocated for use by other services. Amateur operators must accept interference from, and must not cause interference to, such other services.
3. The frequencies:

27.12 MHz	(26.957 - 27.283 MHz),
433.92 MHz	(433.05 - 434.79 MHz),
921.5 MHz	(915 - 928 MHz),
2.45 GHz	(2.4 - 2.5 GHz),
5.8 GHz	(5.725 - 5.875 GHz),
24.125 GHz	(24.00 - 24.25 GHz),
122.5 GHz	(122 - 123 GHz), and
245 GHz	(244 - 246 GHz)

4. are designated for industrial, scientific and medical (ISM) purposes. These frequencies may also be allocated to Short Range Device (SRD) services. Amateur operators must accept interference from ISM and SRD services within these frequency ranges.
5. Allocated to the amateur service on a temporary basis until further notice.
6. Telecommand and telemetry operation only.
7. Radiated power must not exceed 5 watts e.i.r.p.
8. Radiated power must not exceed 25 watts e.i.r.p.
9. The bandwidth of emissions must not exceed 200 Hz
10. Use of this band is not permitted after 31 December 2013.

Dated at Wellington this 30th day of July 2013.
JEFFREY DENNIS HICKS, Manager, Radio Spectrum Management Licensing, Ministry of Business, Innovation and Employment.

Explanatory Note

This note is not part of the notice, but is intended to indicate its general effect.

This notice:

1. Prescribes that, pursuant to Regulations made under the Radiocommunications Act 1989, a general user radio licence is granted for the transmission of radio waves by amateur radio operators in New Zealand, for the purpose of communications in the amateur radio service, in accordance with the terms, conditions, and restrictions of this notice. This notice comes into force on 1 August 2013.
2. This notice replaces the Radiocommunications Regulations (General User Radio Licence for Amateur Radio Operators) Notice 2012. The principal change from that notice is the changes to visiting amateur callsign requirements.