The New Zealand Association of Radio Transmitters Incorporated
Founder Member of the International Amateur Radio Union Region 3

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Waikato District Council
15 Galileo Street
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Attention: Mr Neil Taylor

Dear Sir

Your Ref 67 02 34

Proposed Waikato District Plan: Submission 167 - Aerials

Thank you for your letter of 16 September 2005. I apologise for the delay in responding to your welcome inquiry.

You have asked whether a standard aerial design exists which might be referred to in your district plan as an "acceptable solution".

In order for you to understand the role of amateur radio in the community some explanation of the reasons for the existence of the amateur radio service is necessary.

The amateur service uses a wide range of spectrum allocations allowing it to, among other things;

1 engage in experimentation that has advanced the radio state-of-the-art,

2 provide emergency communications in times of natural or man-made disasters,

3 provide trained radio operators in times of national emergencies,

4 encourage international cooperation and goodwill by allowing direct communications between and among people on an international basis and

5 provide an important educational outlet for people interested in the more technical aspects of radio communications.

The amateur service is regulated by international convention to which all signatory countries to the International Telecommunications Union (ITU) are bound, through the auspices of the International Amateur Radio Union (IARU). The amateur radio service is regulated in New Zealand by the Radio Frequency Services section of the Ministry of Economic Development.

The spectrum allocated to amateur radio operators 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 the electromagnetic spectrum almost from DC (direct current) to daylight. There are 34 frequency bands allocated, with frequencies ranging from 165 kilohertz (Khz) to 1000 gigahertz (Ghz), corresponding to wavelengths ranging from 1800 metres to 0.3 mm. Most amateur operation and experimentation is carried out using the frequencies allocated between 3.5 Mhz and 440 Mhz, but there is strong 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. Antennas exist in many configurations, and are constructed of wires, usually horizontal or sloping, and of metallic tubes in horizontal and vertical arrays, sometimes ground mounted, and more frequently, elevated,

For low frequencies, 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 of reduced size 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.

For medium and high frequencies, 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 frequently used. For vertically polarized antennas, masts of 40 metre 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. A preferred 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. Neither of these might normally be realised on an urban lot, but both are entirely feasible in a rural environment.

The dimensions of the radiating elements are generally:

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

·for MF and LF - similar but operating at reduced efficiency.

·short for VHF - about 3 metres for 50 Mhz, and 1 metre for 144 Mhz),

·shorter for UHF -- 35 centimetres (cms) for 435 Mhz, 25 cms for 602 Mhz, and less

·even shorter for high UHF and SHF.

Antenna elements are often combined into an array to improve antenna performance. Physical size generally limits such arrays. The boom (element support) length of any beam array would seldom exceed 6 metres in length for reasons of wind loading and durability, and may often be shorter.

HF antennas can generally be reasonably accommodated on an 1000 square urban lot, although in most instances these would be compromised in performance through lack of height, or length.

The simplest 3.5 Mhz antenna, a half-wave dipole or inverted Vee, is 40 metres in length, which for long distance communications performs poorly at limited heights, (below 20 metres). At 7 Mhz, the length is 20 metres, and at 10MHz, 15 metres, but height is still necessary to obtain anything better than poor performance. Wire antennas are more common on these bands. The effectiveness of low (less than 0.5 wavelength) horizontal dipoles on these bands is compromised for effective long distance communications on these bands by lack of height, and a vertical antenna is often preferred. A full-sized 80 metre 1/4 wavelength antenna is 20 metres long, and a 40 metre 1/4 wavelength vertical is 10 metres high. The radiation pattern of an antenna is strongly influenced by the height above ground.

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 such 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 and similarly sized to a high gain terrestial TV beam antenna. In short range communication or when using repeaters, small whip antennas are common.

For the higher frequency UHF 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 4 metres or more in an urban situation; larger dishes exist in rural situations.

I suggest you obtain through the District Librarian a copy of any recent edition of the ARRL Antenna Book (the latest edition is the 20th) Many municipal libraries throughout New Zealand hold a recent edition. I appreciate that the content is technical, however even a brief perusal will indicate both the technical complexities and the wide range of antennas and supporting structure, and will illustrate, even to the layman, that any attempt to codify them into a standard is totally impracticable.

Antenna height is the most significant factor in obtaining effective antenna performance .

Heights of less than 70 feet for horizontally polarized antennas on the HF bands will compromise performance, as evidenced in the reports referenced below.

Antenna dimension is critically related to performance. Driven element dimensions cannot be reduced from the half wave-length dimensions without losses in efficiency and bandwidth, which rise rapidly with miniaturisation.

There is no single feasible or practical antenna design which covers the amateur radio spectrum. Such an antenna is a scientific impossibility. Some antenna arrays are made to operate over several bands, such arrays are widely used but are confined to the higher of the HF bands, at wavelengths from 20 metres to 10 metres.

Studies in USA have shown that for effective long-distance terrestrial communication 70 feet (21.3 metres) is the minimum necessary height for an antenna. Earlier studies on communication between Europe and South America showed that 20 metres height was required for the same reasons.

Around 1983 an appeal was taken to the Town and Country Planning Tribunal relating to the Napier City Council Planning Scheme Review, and the decision of that appeal was to allow antenna support heights of 17 metres. You may wish to refer to the Tribunal decision.

I have enclosed for your information an electronic copy of a report, prepared by the American Radio Relay League, on amateur antenna performance in relation to height entitled "Antenna Height and Communications Effectiveness -- a Guide for City Planners and Amateur Radio Operators". A study of this paper, based on antenna modelling studies, would be of value to you, since it validates the need for antenna height to achieve adequate antenna performance.

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 antenna 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, although the maximum power limit is 400 watts.

120 feet high towers for amateur antenna installations are not uncommon in the US, although mainly in rural communities.

The matter of antenna heights has been of much concern to the amateur radio service in the USA, where, due to undue restrictions imposed by planning authorities, a federal preemption was issued by the US government overriding local planning laws. This federal preemption generally prevents planning authorities limiting antenna heights to below 70 feet,. but does not apply to restrictions arising from land use covenants or private contracts.

The federal preemption was the topic of a recent paper published in the Connecticut Law Review Vol.37:321, entitled "Reasonable Accommodation of Amateur Radio Communication by Zoning Authorities: The FCC's PRB-1 Preemption."

I have enclosed for your information an electronic copy of this paper in PDF format. A study of this paper would be of value to you, as it discusses the application of PRB-1 and recent developments. PRB-1 is the result of the strong concerns of the US government in response to overly restrictive planning laws. I realise that no such preemption exists in this country. However, if conditions such as those in your proposed plan are not revised to reasonably accommodate the amateur service, then this Association will actively lobby for similar preemption of local planning rules, to eliminate the frustration of a legitimate activity, the amateur radio service, by discriminatory rules.

One further reason for ensuring reasonable antenna requirements is the increasing pollution of the electromagnetic spectrum. This pollution, which is the subject of intense scientific investigation can be likened to an electronic smog. It has dramatically increased over recent years with the proliferation of electronic devices, which when 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 the 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 effect of the increase in the noise floor on weak signal radio communication is analogous to the difficulty astronomical telescopes have in to detecting distant celestial bodies, arising from urban city lighting).

Some amateur antenna communications require more substantial installations than others if they are to provide the amateur operator with the communications he/she desires to engage in. The height of 15 metres sought in our submission, for permitted uses, is seen as the height to which any operator *must* be able to erect an antenna supporting structure. Heights above 15 metres are seen to be attainable in circumstances set by the Council following submission of an application. For instance, heights exceeding 15 metres should be permitted in most circumstances except, perhaps, in areas of intensive urban development. The 15 metre height should not become the de facto maximum or norm for all installations.

I have attached several photographs of a typical urban amateur antenna installation, The mast height is 17 metres and the installation provides for operation on HF (80 metres, 20 metres, 15 metres and 10 metres), and VHF - 2 metres. These bands represent the interests of the station operator. The antennas shown are not necessarily representative of the requirements of any or all operators, since they may need to use other bands, depending on the personal interests of the station operator, and the existing HF propagation conditions (which are affected by the 11-year sunspot cycle).

I respect the view you may have in regard to so-called "amenity", however I am puzzled by your concept of a "minimalist" style and I request further clarification of this concept.

Our members are very concerned about the erosion of property rights - in particular through imposition of antenna restrictions - and the consequences to the amateur services of inappropriate and excessive restrictions. Such erosion will have significant effects on entry to the amateur radio service, and will reduce the availability of emergency communications assistance in times of emergency.

From your considerations you should be aware that there are many territorial authorities in New Zealand which allow antennas to be erected at greater heights than allowed for in your proposed plan. This Association will strongly defend the rights of the amateur service to erect effective antennas, and considers that your Council must effect a more reasonable accommodation in the matter of amateur radio antennas and their supporting structures, based on technical considerations, and the role of amateur radio in the community. Planning rules which involve placement, screening, or height of antennas based on health, safety or aesthetic grounds must be crafted to accommodate reasonably practicable regulation to accomplish the Council's legitimate purpose, without frustrating the legitimate purpose of the amateur radio service.

Any planning rules must give reasonable consideration to the needs of the amateur radio service. The proposed rules do not show such consideration has, so far, been given, and in short, will act as an severe impediment to amateur radio operations and future recruitment.

In conclusion I reiterate four statements made earlier in this letter; -

* Antenna height is the most significant factor in obtaining effective antenna performance
* Antenna dimension is critically related to performance
* Efficient antennas demand height and appropriate dimensions. They cannot be miniaturised
* There is no single practical antenna design which traverses the amateur radio spectrum

I apologise for the length of this reply, however I feel that to provide you with less information would be to belie the importance of an appropriate functioning antenna installation. I have tried to cover the salient points in a layman's terms.

I welcome any further opportunity to provide any advice or assistance you may seek to advance this matter, by way of correspondence or pre-hearing discussions, in the interests of this Association, the International Amateur Radio Service, and the Waikato District Council.

Yours sincerely

Mike Newman ZL1BNB

Local Government Liaison Officer