Wireless Institute of Australia
National Technical Advisory Committee

Guidelines for Unattended Transmitters
Section 2 - Propagation Beacons

This paper forms part of the "Guidelines for Unattended Transmitters" series, which contains detailed licensing information, technical guidelines and band planning information in a number of areas. These include the operation of beacons, repeaters, links etc.

NOTE: If you wish to apply for a beacon licence, please take careful note of Section 2.9 ("Licensing").

2. PROPAGATION BEACONS

2.1 Definition

A propagation beacon is a station which transmits continuous signals for use in the scientific study of various propagation modes over different paths, and to provide early warning of band openings. Beacons also provide stable signals of reasonably accurate frequency and constant signal strength which can be used as a reference signal source for receiver alignment.

2.2 Relevant Regulations

Unattended beacons must be licensed as such by the ACMA, and beacons which are co-sited with repeaters must be licensed separately. Beacons must comply with the conditions in Parts 2 and 8 of the LCD and operate only in bands that the licensee is authorised to use. They must identify at least once in each ten minute period, and there must be provision to terminate operation if interference is caused to other services.

2.3 Frequency Allocation: HF beacons

(a) Frequency allocation criteria

Beacon frequency allocations are made by the Technical Advisory Committee. Frequencies are determined largely in accordance with IARU band planning guidelines. Where a choice of frequencies exists, frequencies are chosen where possible to avoid clashes with existing overseas beacons. Beacon frequency spacing may be as close as 1 kHz.

(b) Time shared HF beacons

Frequencies for time shared HF beacons are determined by IARU, and Australia has one "time slot" in the IARU beacon network. The frequencies for the international beacon network are:
10.149 MHz
14.100 MHz
18.110 MHz
21.150 MHz
24.930 MHz
28.200 MHz

In addition, 29.191 MHz is reserved for future use for a time-shared beacon network within Oceania.

(c) Continuous duty beacons

To avoid overcrowding and possible interference, there is no provision for continuous duty beacons on bands below 28 MHz. On the 10 metre band, the Australian band plan reserves 28.200 - 28.300 MHz for continuous duty beacons. IARU policy is that future continuous duty beacons should operate only between 28.201 and 28.225 MHz. There are currently no plans to change the frequencies of Australian beacons operating above 28.225 MHz until and unless this policy is actually put into practice in other countries.

2.4 Frequency Allocation: 50 MHz beacons

(Note that the following does NOT apply to beacons operating on 52 MHz, which are described in section 2.5 below.)

(a) Frequency allocation criteria

As on the HF bands, beacon frequency allocations are made by the Technical Advisory Committee. The aim is to provide adequate beacon coverage while at the same time limiting the number of beacons so that distant beacons do not suffer interference from stronger local ones.

(b) Beacons below 50.100 MHz

Internationally, most beacons used to operate mainly from 50.025 - 50.080 MHz. This restricted the spectrum available for weak signal work, so beacons have migrated to new segments higher in the band (see below). The only beacon segment now remaining below 50.100 MHz is the new IARU International Synchronised Beacon Project sub-band at 50.000 - 50.030 MHz.

(c) 50.300 MHz segment

To prevent interference between Australian and overseas beacons below 50.100 MHz, a new beacon segment was adopted around 50.300 MHz as follows:
50.281 - 50.299 MHz Call areas VK1, VK2, VK3, VK4 and VK7
50.301 - 50.319 MHz Call areas VK5, VK6, VK8, VK9 and VK0

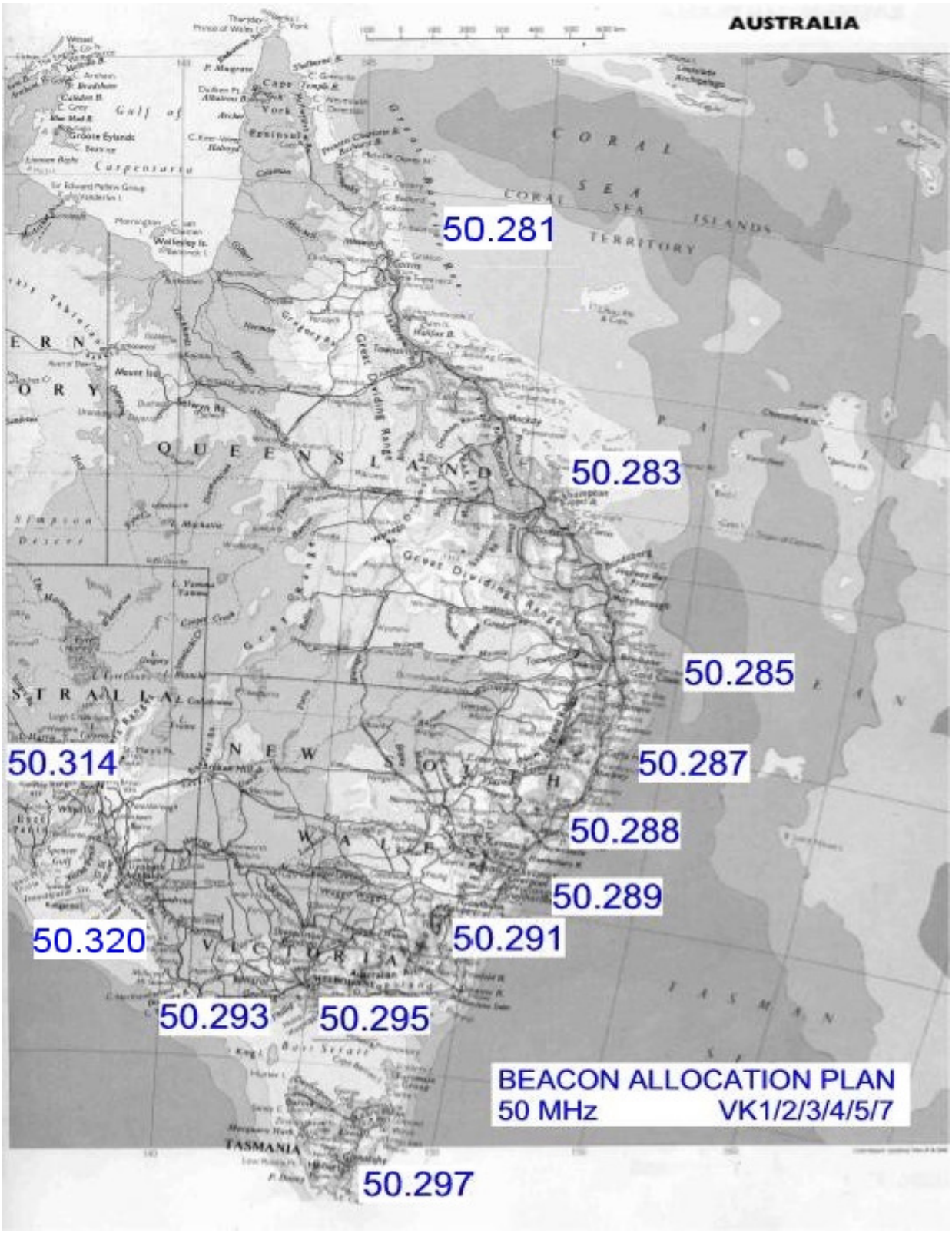
The following frequency allocation plan has bee applied:

50.281	VK4 north
50.283	VK4 central
50.285	VK4 south - Brisbane
50.287	VK2 north
50.289	VK2 Sydney area
50.291	VK1 or VK2 south-east
50.293	VK3 west
50.295	VK3 east
50.297	VK7
50.299	
50.302	VK6 north
50.304	VK6 north west
50.306	VK6 south west
50.308	VK6 south east
50.310	VK8 – Darwin
50.312	VK8 – Alice Springs
50.314	VK5
50.316	VK5
50.318	VK5
50.320	VK5 - Adelaide

However in recent years the sub-band 50.300 - 50.400 MHz has been recognised as digimode territory in all IARU regions, and some interference problems have arisen between beacons and digimode stations. Therefore our beacons need to be relocated as and when necessary to avoid any future clashes in this part of the band.

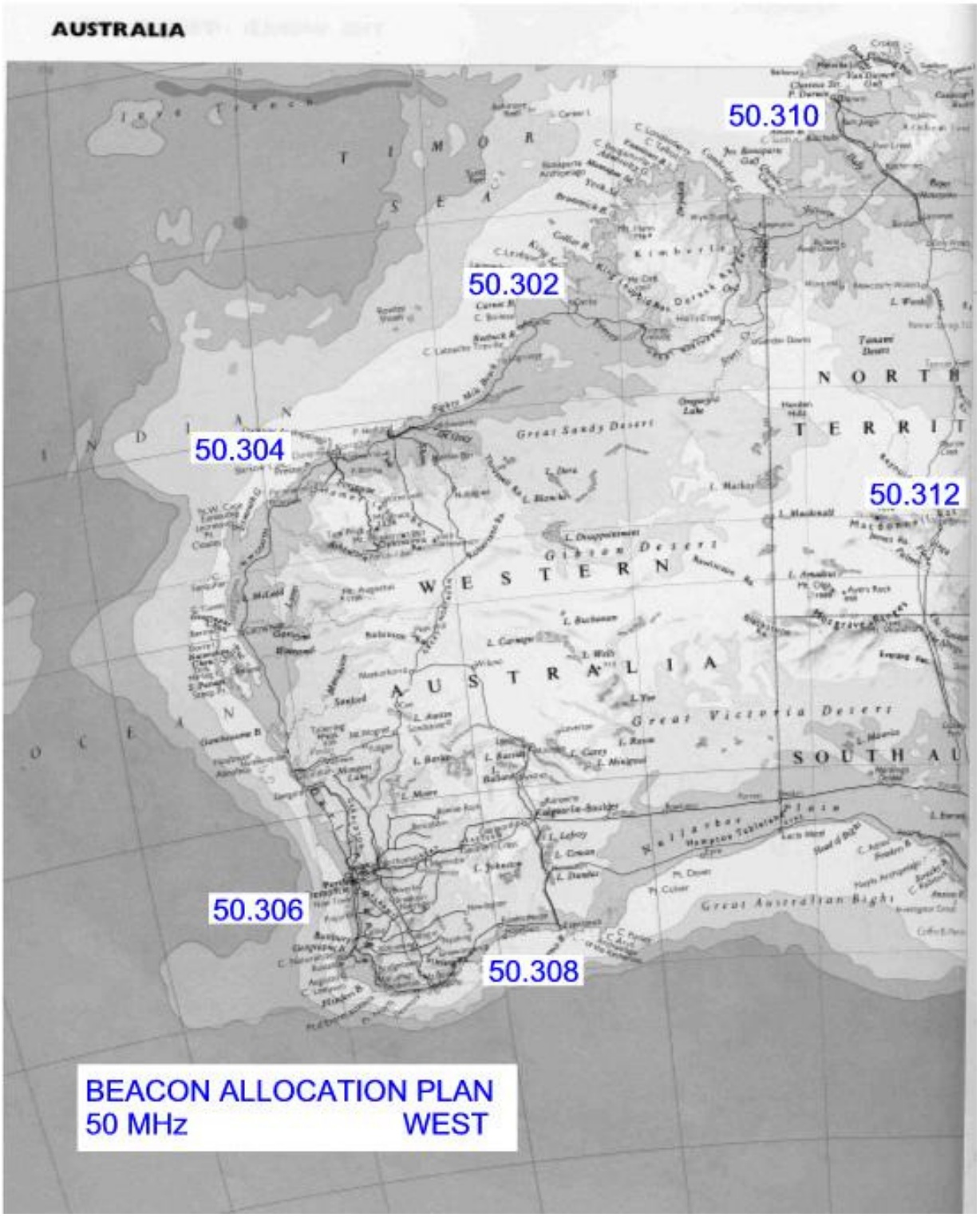
BEACON ALLOCATION PLAN – 50 MHz

VK1/2/3/4/5/7



BEACON ALLOCATION PLAN – 50 MHz

VK6/8



(d) Future beacon allocations after the closure of Channel 0 television

After the closure of analog television, the amateur service will hopefully regain the full use of the entire 50 - 54 MHz band. This will allow us to follow two relevant IARU guidelines:

- 50.300 - 50.400 MHz has been reserved internationally for future use by digital modes.
- 50.400 - 50.500 MHz has been adopted in Region I as the new recommended beacon segment. Again, it is logical for us to follow suit and bring our band plan into line with the rest of the world. Future 6 metre beacons can therefore be allocated in the 50.400 - 50.500 MHz segment, using a similar allocation plan to that used on 2 metres and higher bands.

2.5 Frequency Allocation: 144 MHz and higher bands

Note that with the closure of Channel 0 TV stations, there are no longer any beacons at 52 MHz. They are all down on 50 MHz. So the information in this section now applied only to 144 MHz and higher bands.

(a) Frequency allocation criteria

Beacon frequency allocations are made by the Technical Advisory Committee. The effectiveness of the beacon network can be maximised by allocating beacon frequencies according to a consistent plan. A plan has been developed which is based on the following considerations:

- Beacon frequencies should be unique, and beacons should occupy clear channels.
- The spectrum available for beacons is limited, so it is necessary to make a compromise that will allow a reasonable number of beacons while retaining a reasonable frequency spacing between them. The band plans provide for a frequency spacing of 2 kHz (except in Western Australia, where the WA VHF Group has advised that they wish to use a 4 kHz frequency spacing wherever possible).
- The frequency spacing between beacons should where possible be in proportion to the geographical distance between them. Beacons in adjacent areas may use adjacent channels, but more distant beacons should not suffer interference from strong local beacons on nearby frequencies.
- For most efficient use of spectrum space, and to facilitate beacon planning, each call area should be subdivided into zones, each of which is allocated a unique set of beacon frequencies. If a beacon comes into operation in any area, it should be allocated the frequencies which have been reserved for use in its area.
- All beacon frequencies allocated to a specific location on different bands should correspond, e.g. for Brisbane, 144.440, 432.440, 1296.440 etc. Beacon licences should include the allocated frequencies for all bands up to 10 GHz, even if there are no immediate plans to activate beacons on all of these bands.
- To provide enough clear channel beacon frequencies for larger call areas, frequencies for larger call areas may be "borrowed" from smaller call areas (e.g. VK1, VK7).

In practice some of the criteria listed above may conflict, so compromises must be made. In addition any revised allocation plan must take into account the frequencies of existing beacons and not require wholesale frequency changes. The allocation plan is therefore a compromise between what would be ideal and what already exists.

(b) Band plan beacon segments

The band plan beacon segments for bands above 52 MHz are as follows:

52.300 -	52.500	Note 1
144.400 -	144.600	
432.400 -	432.600	
1270.400 -	1270.600	Note 2
1296.400 -	1296.600	
2403.400 -	2403.600	
3400.400 -	3400.600	
5670.400 -	5670.600	Note 2
5760.400 -	5760.600	
10368.400 -	10368.600	
10448.400 -	10448.600	Note 2
24048.400 -	24048.600	
24192.400 -	24192.600	Note 3

NOTE 1: From 2014, all 52 MHz beacons have been closed or migrated to 50 MHz. No new beacon frequency allocations are to be made in this segment. It is retained in the band plan pending the final ACMA reallocation of the old 45 - 52 MHz broadcast allocation. All new beacons will be allocated frequencies in accordance with section 2.4 (d) above.

NOTE 2: The beacon segments at 1270, 5670, and 10448 MHz are reserved in accordance with IARU policy to provide for future narrow band segments adjacent to each satellite band.

NOTE 3: Alternative segment. The recommended segment is 24048 MHz.

(c) Call area frequency allocations

The band plans include a geographic allocation plan by which in most cases the 10 kHz digit of the beacon frequency indicates the call area.

.400 - .409	VK0	.500 - .509	Reserved *
.410 - .419	VK1	.510 - .519	Reserved *
.420 - .429	VK2	.520 - .529	VK2
.430 - .439	VK3	.530 - .539	VK3
.440 - .449	VK4	.540 - .549	VK4
.450 - .459	VK5	.550 - .559	VK5
.460 - .469	VK6	.560 - .569	VK6
.470 - .479	VK7	.570 - .579	VK6
.480 - .489	VK8	.580 - .589	VK6
.490 - .499	Reserved *	.590 - .599	VK9

Note that on 52 MHz only, the segment above 52.500 MHz is allocated to FM. Therefore on this band only, the beacon segment is 52.300 - 52.500 MHz. The 52.300 - 52.399 block follows the same pattern as that shown above for .400 - .499. While the 52 MHz beacon segment remains for existing beacons, it is recommended that future beacons should use frequencies in the segments described above in 2.4.

* The “Reserved” segments are available for use in areas where the normal band plan frequency is unsuitable (e.g. because of site compatibility problems), or for special purpose use such as beacons or transponders using narrow band digital modes such as PSK.

(d) Geographic allocation plan

The following plan reserves specific frequencies for use in specific areas. This avoids frequency clashes and ensures that where possible the frequency separation between beacons is in proportion to their geographic distance from each other. The plan also allows all beacons in a given area to be on corresponding frequencies on all bands.

This plan was devised with the aim of providing the best possible “fit” for future beacons while leaving existing beacon frequencies unchanged. The plan may be revised from time to time, especially in response to changes in available beacon sites. If a beacon ceases operation, its frequency could be reshuffled with other currently unused frequencies in order to provide a better “fit”.

Some existing and long-established beacons do not comply with this plan, but any new beacon should use the frequency that has been reserved for its area.

On 2.4 GHz and higher bands, difficulties may occur with close geographic spacing between neighbouring beacons leading to very narrow frequency spacings between them. In such cases, the geographic allocation plan can be varied to make use of frequencies outside the normal range for the location in question.

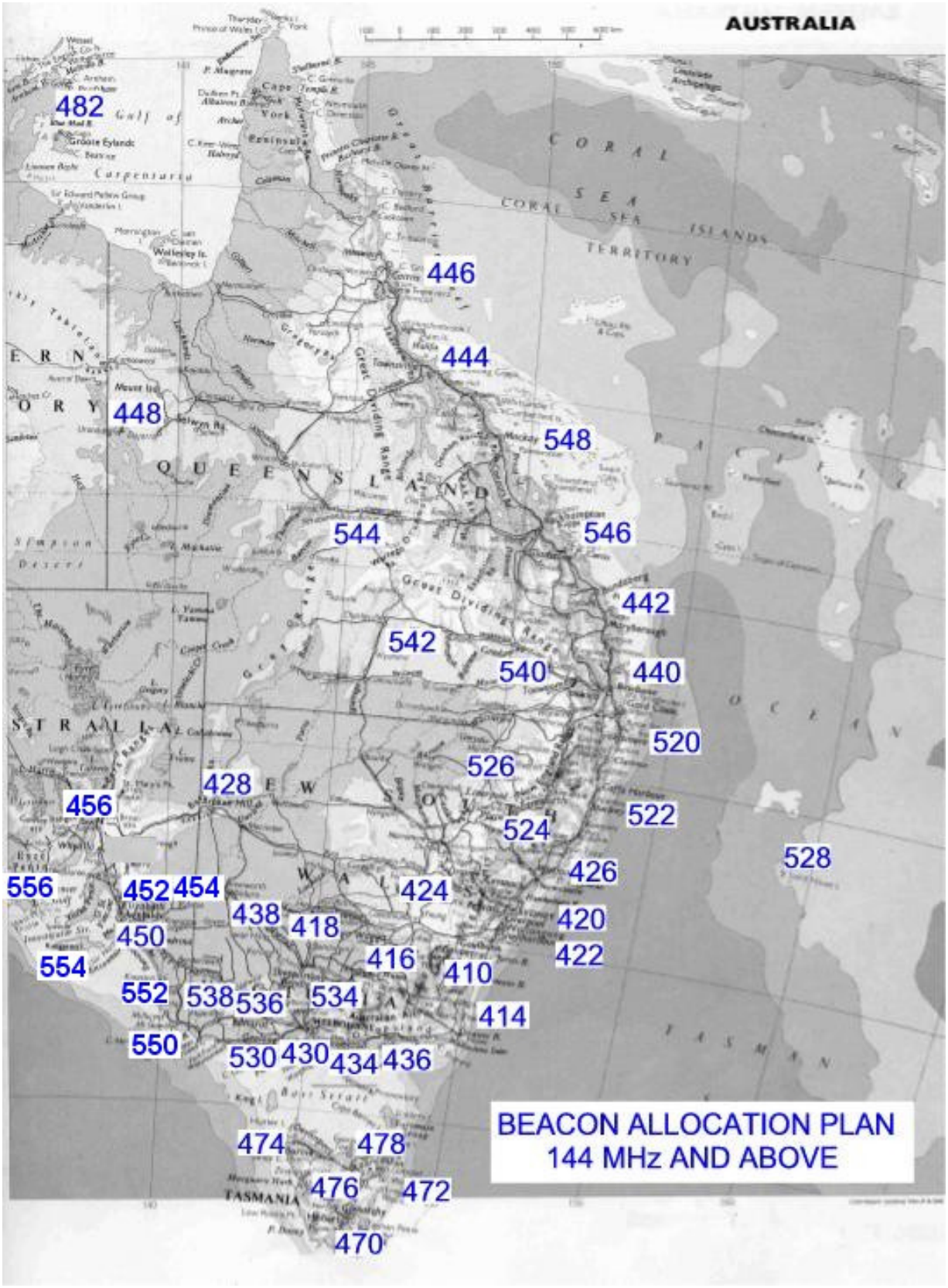
The frequencies reserved for each area are as follows:

.400	VK0	Heard Island	.500	Reserved - see 2.5 (c)
.402	VK0		.502	Reserved - see 2.5 (c)
.404	VK0		.504	Reserved - see 2.5 (c)
.406	VK0	Macquarie Island	.506	Reserved - see 2.5 (c)
.408	VK0		.508	Reserved - see 2.5 (c)

.410	VK1	Canberra	.510		Reserved - see 2.5 (c)
.412	VK1	Areas near Canberra	.512		Reserved - see 2.5 (c)
.414	VK2	NSW South Coast	.514		Reserved - see 2.5 (c)
.416	VK2	Wagga area	.516		Reserved - see 2.5 (c)
.418	VK2	Western Riverina	.518		Reserved - see 2.5 (c)
.420	VK2	Sydney	.520	VK2	Lismore - Murwillumbah
.422	VK2	Wollongong area	.522	VK2	Grafton - Coffs Harbour
.424	VK2	Blue Mountains - Orange	.524	VK2	Tamworth - Muswellbrook
.426	VK2	Newcastle Area	.526	VK2	Moree - Inverell
.428	VK2	NSW West - Broken Hill	.528	VK9	Lord Howe Island
.430	VK3	Melbourne primary	.530	VK3	Geelong
.432	VK3	Melbourne area secondary	.532	VK3	Central south coast
.434	VK3	Latrobe Valley	.534	VK3	Northern or NE Victoria
.436	VK3	East Gippsland	.536	VK3	Ballarat
.438	VK3	Mallee - Wimmera	.538	VK3	South West - Hamilton
.440	VK4	Brisbane	.540	VK4	Toowoomba
.442	VK4	Maryborough - Bundaberg	.542	VK4	Charleville - Roma area
.444	VK4	Townsville area	.544	VK4	Longreach
.446	VK4	Cairns	.546	VK4	Rockhampton
.448	VK4	Mt Isa	.548	VK4	Mackay
.450	VK5	Adelaide	.550	VK5	Mount Gambier
.452	VK5	Adelaide NE - Elizabeth	.552	VK5	South East Coast
.454	VK5	Spencer Gulf North	.554	VK5	Kangaroo Island
.456	VK5	Riverland	.556	VK5	Eyre Peninsula
.458	VK5		.558	VK5	Streaky Bay - Ceduna
.460	VK6	Perth	.560	VK6	Busselton
.462	VK6		.562	VK6	Augusta area
.464	VK6	Northampton - Geraldton	.564	VK6	Albany
.466	VK6		.566	VK6	
.468	VK6	Carnarvon	.568	VK6	Esperance
.470	VK7	Hobart	.570	VK6	
.472	VK7	East Coast	.572	VK6	Kalgoorlie
.474	VK7	NW Coast	.574	VK6	
.476	VK7	Central highlands	.576	VK6	Exmouth - Onslow
.478	VK7	Launceston	.578	VK6	
.480	VK8	Darwin	.580	VK6	Karratha - Port Hedland
.482	VK8		.582	VK6	
.484	VK8	Alice Springs	.584	VK6	Broome - Derby
.486	VK8		.586	VK6	
.488	VK8		.588	VK6	Wyndham - Kununurra
.490	Reserved - see 2.5 (c)		.590	VK9	
.492	Reserved - see 2.5 (c)		.592	VK9	
.494	Reserved - see 2.5 (c)		.594	VK9	
.496	Reserved - see 2.5 (c)		.596	VK9	
.498	Reserved - see 2.5 (c)		.598	VK9	

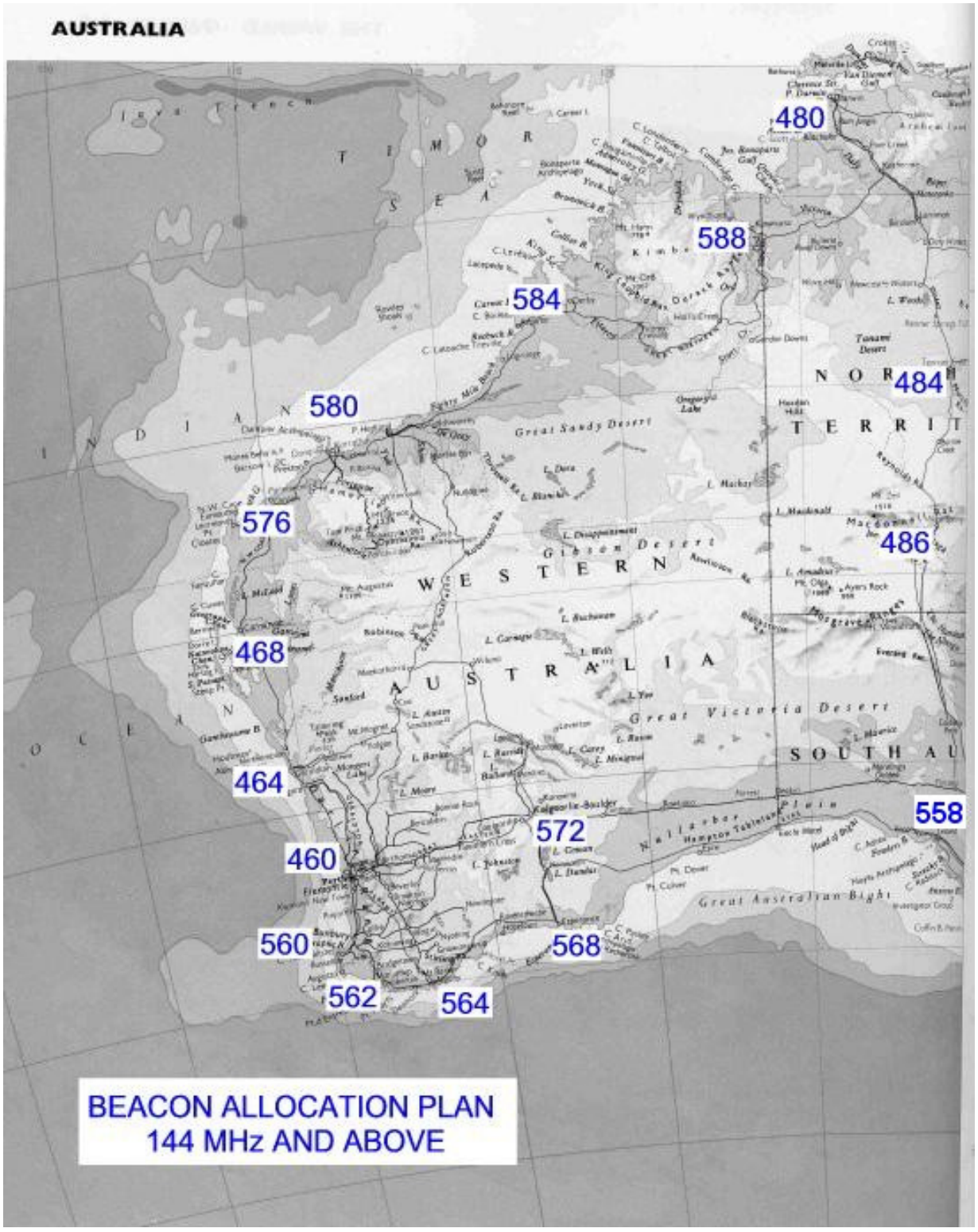
BEACON ALLOCATION PLAN – 144 MHz AND ABOVE

EASTERN CALL AREAS



BEACON ALLOCATION PLAN – 144 MHz AND ABOVE

WESTERN CALL AREAS



2.6 Technical Standards

(a) Horizontal antenna polarisation is standard for all beacons, although vertical polarisation may be used on bands below 30 MHz. Circular polarisation may also be used.

(b) Beacon antenna radiation patterns are dictated by the purpose of the beacon. In many cases omnidirectional antennas will be used but directional antennas are often preferable on higher bands or if the main purpose is to study propagation over a specific path. If directional antennas are used, advance notice should be given of any changes in beam headings.

(c) Beacon power output should be consistent with average amateur power levels on the band in question.

(d) Beacon frequency accuracy and stability should be +/- 1 part per million or better.

(e) In order to provide the most benefit and reliability, beacons should transmit 24 hours per day throughout the year.

2.7 Identification

(a) Beacons should identify at regular and accurately timed intervals, preferably at each 30 or 60 seconds.

(b) Identification content should be minimal: either callsign only or callsign plus locator.

(c) Beacon identification mode is dictated by standard practice on the band in question, but the occupied bandwidth of the beacon should be as narrow as possible. The following modes are recommended:
On frequencies below 52 MHz: Keyed CW (200HA1A/A1B).
On frequencies above 52 MHz: FSK (1K12F1A/F1B).

(d) Recommended frequency shift for FSK is between 500 and 700 Hz, and no greater than 850 Hz. The space frequency should correspond to the nominal beacon carrier frequency, and the mark frequency should be higher than the space frequency.

(e) If keyed CW identification is used, the period between identifications should if possible be key down. If FSK is used, it is suggested that the carrier should be on the mark frequency during non-ID periods. This provides a more continuous audible signal if the beacon is being monitored with a USB receiver set to zero beat on the space frequency.

(f) In cases where it is necessary to conserve power or rotate the beacon between a sequence of different bands or directional antennas, the period between identifications can be key up (or, in the case of FSK, carrier off).

(g) Keying speed should be within the range 8 - 12 words per minute.

(h) For IBP time-shared beacons only, the keying cycle is ten seconds per band in each three minutes in the beacon's IBP allocated time slot. The transmission should consist of the callsign sent at 100 watts, then a series of dashes at 100, 10, 1 and 0.1 watts, then a final ID at 100 watts.

2.8 General

(a) Beacon locations should be superior to those of the average amateur station, otherwise the ability of the beacon to provide early warning of band openings will be lost.

(b) Beacon siting requires a compromise between proximity to the intended service area and protection of local operators from receiver overload. Beacons should not be located in areas where they could cause any significant interference to weak signal reception, including the reception of more distant beacons on nearby frequencies. Beacon sites should be within 100 km of the area they are intended to serve, but no closer than 20 km from any significant centres of amateur population.

(c) To conserve spectrum space, numbers of beacons must be limited. Current policy is for a limit of two beacons nationally on each band below 28 MHz, no more than one beacon per call area on 28 MHz, and no more than two beacons per call area on 50 MHz.

(d) To make best use of available spectrum space, beacons that do not meet the technical standards detailed above - especially with regard to ERP, frequency stability and reliability of service - should be either upgraded or their licences surrendered so that their frequencies can be reallocated.

(e) The purpose of propagation beacons is defeated unless they can be monitored at all times without interference. The beacon segment of each band, including its band edges, should be regarded as "no transmit" zones and kept clear of all other transmissions.

2.9 Licensing

The licence application should specify modes such as 200HA1A, 1K12F1D, 4K00J2A, 4K00J2D or 4K00J3E. Output power should also be specified, and the legal maximum for CW or FSK is 120 watts. The location of the proposed site must be given in degrees, minutes and seconds or in the form of Australian Map Grid co-ordinates.

When a licensing enquiry is received, the WIA can provide information, answer queries and make recommendations concerning the licence proposal. Enquiries re new licences or for frequency changes may be referred to the Technical Advisory Committee. If applications are forwarded direct to the National Repeater Co-ordinator, he consults the TAC before approving the application.

The details of the application are checked to ensure that the proposal complies with the national band plan and the criteria given in this paper, and that the proposed frequency is clear and has not been applied for by any other licensee. If there are problems in any of these areas, these will be discussed and resolved with the applicant.

When these details of the application have been finalised, the application will be referred to the WIA National Repeater Co-ordinator, who is responsible for approving the licence application and supplying a "Letter of Co-ordination" which is required by ACMA to confirm that the requested frequency complies with the band plan.

When ACMA receives the licence application, it performs a site compatibility check to ensure that the proposed frequency will not cause any interference to other services in the area. If there are no problems, they will then issue the licence. If there is a compatibility problem, the proposed frequency or location of the station may have to be changed. For this reason it is important to leave the purchase of crystals until the licence has been issued.

When the licence has been granted by ACMA, the applicant should advise the TAC so that the details can be added to the WIA data base. Licensees are requested to keep the TAC informed of any changes to the status of their beacons so that the information circulated to the amateur community can be kept up to date. In the event that a beacon licensee is unable to establish or maintain his beacon, it is requested that the licensee should relinquish the licence.