Australian
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Authority

Technical Planning Parameters and Methods for Terrestrial Broadcasting

Australian Broadcasting Authority
Canberra
April 2004

Editorial note: This document is a reprint with corrections of *Technical Planning Parameters and Methods for Terrestrial Broadcasting* contained the *Interim Australian Broadcasting Planning Handbook,* Australian Broadcasting Authority, August 1995.

The corrections are limited to deletion of text in Parts 1, 2 and 3 that is not applicable under the *Broadcasting Services Act 1992*, subsequent renumbering of parts, updating of the Australian Television Channel Frequency Limits (Table 3C.6) and correction of several typographical errors in Attachment 3C.BB.

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PART 1: INTRODUCTION

The objective of the *Technical Planning Parameters and Methods for Terrestrial Broadcasting* is to set out guidelines on the methods and parameters for planning of new or modified broadcasting services. The guidelines are intended for broadcasters, planning consultants and operators of broadcasting facilities involved in detailed design of broadcasting transmitting facilities or in the preparation of planning submissions.

These guidelines are based on basis information published by:

International Radio Consultative Committee (CCIR)

Federal Communications Commission (FCC) – USA

Department of Transport and Communications – Australia

other recognised authorities

A bibliography is provided in part 5.

The planning guidelines have been arranged in parts to facilitate their use. Part 2 deals with propagation mechanisms and models for use in the MF, VHF-FM and television broadcasting bands. Parts 3 and 4 are separated into sections for each broadcasting type:

A MF AM Radio

B VHF FM Radio

C VHF/UHF Television

Part 3 consists of guideline material and part 4 consists of explanatory notes and examples to clarify use of the planning criteria.

Once familiarity with the guidelines is achieved, only part 3 need be consulted, and then only section A, B or C, depending on the type of service to be developed.

PART 2: PROPAGATION OF RADIO WAVES

2.1 Introduction

This part sets out methods appropriate for propagation calculations for broadcasting planning.

2.1.1 Alternatives

These methods have been chosen because they are simple yet generally accurate enough for the planning of broadcasting services. Other methods that are more accurate or more suitable for computer calculations may be acceptable but they should be discussed with the Department before using them to prepare planning proposals. (The Department is developing its own computer based methods of propagation prediction that will be discussed in a future edition of these guidelines.)

All propagation calculations are subject to some degree of uncertainty, because of the simplifications that are made and the limited accuracy of topographic and other data. A more accurate method, for those propagation paths whose losses are stable with time and which therefore give reproducible answers, is to perform a propagation test. Propagation tests are necessary when calculations fail to provide a conclusive result. MF groundwave propagation, and VHF/UHF propagation up to distances of about 100 km, do not show great variation with time and are suitable for propagation testing. Long VHF/UHF paths show considerable variation with time and prolonged tests under a variety of weather and seasonal conditions may be necessary to produce definite answers. MF skywave propagation shows such great variations that acceptable results cannot be obtained from propagation tests.

2.2 Propagation mechanisms and models

2.2.1 MF Broadcasting

The guidelines include two MF propagation models. They are propagation by the groundwave, affected mainly by ground conductivity and permittivity and hence essentially unvarying over a given path; and skywave propagation, caused by reflection from the ionosphere at night and highly variable. Groundwave propagation is modelled on a series of theoretical calculations, while skywave propagation is modelled on statistical analysis of propagation measurements.

2.2.2 VHF/UHF Broadcasting

The guidelines cover a number of mechanisms for the propagation of VHF/UHF signals:

- Free space attenuation (the inverse square law effect).
- Diffraction over obstacles. Diffraction may be over obstacles sharp enough to be regarded as knife edges, over rounded obstacles that may be approximated by cylinders, or around the surface of the earth.
- Reflection from the surface of the earth.
- Refraction by the earth's atmosphere. This includes refraction due to the 'normal' gradient of the refractive index of the earth's atmosphere with height, as well as super-refraction and ducting effects where unusual variations of refractive index with height cause waves to be trapped in a layer of atmosphere and propagate much further than normal.
- Tropospheric scatter (significant only on over-the-horizon paths).
- Reflections from the ionosphere, such as sporadic E and trans-equatorial propagation.

Because of the large number of mechanisms and the resulting complexities, two different approaches are taken.

In the first approach a statistical model has been produced from propagation measurements. This model predicts the field strength exceeded at 50% of locations in a particular area for various percentages of time, given three parameters (transmitter height, distance, terrain roughness) which represent the gross topographic characteristics of the path. This method is described in detail in 2.6.

The second approach is employed when the path parameters are outside the scope of the statistical model; or if point-to-point calculations are required as, for example, to an off-air relay site; or with computers when it is practicable to examine large numbers of paths and build up a more comprehensive picture of coverage. In this approach a number of models are presented, each based on only one or two of the propagation mechanisms described previously. It is necessary for the planner to examine the radio path, to decide which of the propagation mechanisms predominate, and to select and use the appropriate model. This method is described in detail in 2.7.

2.3 Medium frequency Groundwave calculations

The theoretical groundwave propagation curves at figures 1 to 19 (or equivalent) shall be used for predicting medium frequency field strengths. These curves, published by the ITU[2], predict field strength as a function of distance, with ground conductivity as a parameter, and are normalised for a CMF of 100 volts.

2.3.1 Ground conductivity

Acceptable methods of estimating a value of ground conductivity for use with the curves are, in order of preference:

- propagation test results;
- derivation from field strength measurements of existing services in the region; and
- observation of terrain characteristics.

Physical measurement of earth constants does not yield information useful for propagation purposes.

2.3.2 Homogenous earth (uniform conductivity)

The procedure for estimating field strength at a given distance is:

- select the propagation curves for the frequency of interest;
- identify the specific curve appropriate for the assumed average effective ground conductivity (drawing an intermediate curve by interpolation if necessary);
- note the field strength corresponding to the required distance; and
- determine the estimated field strength for the particular value of CMF on the basis of direct proportionality between field strength and CMF.

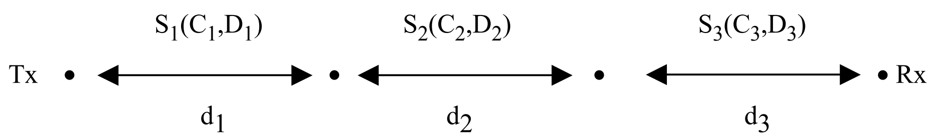
In a similar manner, an estimated distance for a given field strength can be derived.

2.3.3 Inhomogenous earth (non uniform conductivity)

In some circumstances, the propagation path may traverse generally clear and discrete regions of differing average effective ground conductivity. In this case the method of Recommendation 368-5[19] may be used to derive a better estimate as follows.

The path is considered to be made up of sections S_1, S_2, S_3, etc., of length d_1, d_2, d_3, etc., having conductivity and dielectric constant (C_1, D_1), (C_2, D_2), (C_3, D_3); and so on.

A three section path is considered below:



The propagation curve appropriate to section S_1 is chosen and the field strength $E_1(d_1)$ at the distance d_1 is then noted. The curve for the section S_2 is then used to find the field strengths $E_2(d_1)$ and $E_2(d_1 + d_2)$. Similarly for section S_3 etc.

A received field strength (E_R) is given by:

$$E_R = E_1(d_1) - E_2(d_1) + E_2(d_1 + d_2) - E_3(d_1 + d_2) + E_3(d_1 + d_2 + d_3) \quad (1)$$

The procedure is then reversed and by calling R the transmitter and T the receiver, a field strength (E_T) is given by:

$$E_T = E_3(d_3) - E_2(d_3) + E_2(d_3 + d_2) - E_1(d_3 + d_2) + E_1(d_3 + d_2 + d_1) \quad (1a)$$

The required field strength is then given by the expression:

$$E = \tfrac{1}{2}(E_R + E_T) \quad (1b)$$

All field strengths used in these calculations are expressed in dB with respect to 1 µV/m (dBµV/m).

2.4 Medium frequency skywave propagation

2.4.1 Median skywave calculations

For planning purposes within Australia assessment of skywave interference shall be based upon the median skywave field strength determined as follows:

Definitions:

V is the relative cymomotive force of the transmitter in the azimuth and elevation of propagation, in dB with respect to a cymomotive force of 100 V.

F_o is the median skywave field strength for a cymomotive force of 100 V, in dBµV/m.

F is the median skywave field strength for the actual cymomotive force of the transmitter, in dBµV/m.

d is the great circle distance between the transmitter and the reception point, in km.

p is the slant propagation distance, in km.

h_r is the assumed effective height of the ionospheric E-layer, in km (h_r = 100 km)

Method:

$$p = \sqrt{d^2 + 4h_r^2} \quad (2)$$

$$F_o = 95.6 - 20 \log p - 0.0051\, p \quad (3)$$

$F = F_o + V$ between the hours of local sunset and local sunrise at the transmitter site of the service being interfered with. (4)

$F = 0$ otherwise.

F_o is represented graphically at figure 20.

This method is based upon that of CCIR Report 575-3[17] but is simplified by replacing terms dependent upon hour of day, frequency, geomagnetic latitude and sunspot number by median constants. The constants have been determined by substituting the following values: reference time 2 hours after sunset, frequency 1000 kHz, geomagnetic latitude 42 degrees south and a 12 month smoothed Zurich sunspot number of 0. The terms relating to sea gain and excess polarisation coupling loss have been omitted.

2.4.2 Great circle distance and bearings

The standard methods for calculating great circle distances, azimuths and elevations that are required in the estimation of groundwave field strengths, median skywave field strengths and radiation levels, are detailed below. Other methods are also suitable.[2]

The great circle distance and bearing of point B from point A may be determined as follows:

Definitions:

d is the great circle distance, in kilometres (km).

b is the great circle bearing of point B from point A, in degrees with respect to true north (degrees true).

r is the average radius of the earth, in km (r = 6371.2 km).

a is the arc subtended by the great circle joining points A and B, in radians.

P_A, P_B are the parallels of latitude of points A, B (in radians); south negative.

M_A, M_B are the meridians of longitude of points A, B (in radians); east positive.

Method:

$$a = \cos^{-1} [\sin P_B \sin P_A + \cos P_A \cos P_B \cos(M_B - M_A)] \quad (5)$$

$$d = r\,a \quad (6)$$

$$b = \cos^{-1}\left(\frac{\sin P_B - \sin P_A \cos a}{\cos P_A \sin a}\right) \quad (7)$$

where b has the sign of $\sin(M_B - M_A)$

2.4.3 Take-off angle

The angle of elevation (take-off angle) for a skywave signal propagating in the plane of the great circle and ‘reflecting’ off the ionospheric E-layer at a height of 100 km may be determined as follows:

Definitions:

d is the great circle distance between the transmitter and the reception point, in km.

d_h is the path length of each ionospheric hop, in km.

h_r is the assumed effective height of the ionospheric E-layer, in km (h_r = 100 km).

C is the arc subtended by the take-off point and the reflection point, in degrees.

T is the take-off angle, in degrees up from the horizontal.

Method:

d as calculated in equation (2)

d_h is the largest integral submultiple of d less than or equal to 1500 km.

$$C = \frac{180\, d_h}{2\pi r} \quad (8)$$

$$T = \tan^{-1}\left(\frac{\cos C - \frac{r}{r + h_r}}{\sin C}\right) \quad (9)$$

2.5 Propagation of VHF and UHF radio waves

VHF FM radio and VHF/UHF television propagation calculations are needed to determine:

. median field strength levels at various locations throughout a service area;

. the level of potentially interfering signals; and

. input signal levels available at off-air relay sites.

Section 2.6 covers point-to-area calculations. The method makes use of a series of empirically derived propagation curves together with a correction factor for terrain irregularities.

Section 2.7 covers more complex cases, involving point-to-point calculations that take into account such factors as the curvature of the earth and the influence of specific obstructions along the propagation path.

All calculations and measurements associated with domestic receiving locations are based on a receiving antenna height of 10 metres above local ground level.

2.6 Point-to-area calculations

The empirically derived propagation curves of Recommendation 370-5[19] at figures 21 to 27 shall be used to estimate coverage and potential interfering signal levels. The curves for field strengths exceeded at 50% of locations for 50% of the time are for use in coverage and continuous interference calculations, while those for 50% of locations for 10% of the time are for tropospheric interference calculations.

2.6.1 Effective radiated power (ERP)

The actual ERP in the direction of, and at the angle of depression to, the area under consideration shall be used when making field strength estimates. All propagation curves are for 1 kW ERP (reference dipole).

2.6.2 Effective transmitting antenna height

The parameter ‘effective transmitting antenna height’ used in the curves is defined as antenna height above the average level of the ground in the range 3 to 15 kilometres from the transmitter in the direction under consideration.

It is expected that the effective transmitting antenna height will be established for all directions of significance, either by manually drawing a profile or by computer analysis of the profile.

2.6.3 Terrain irregularity

The parameter ‘terrain irregularity’ (Δh) used in the curves is defined as the difference in heights exceeded by 10% and 90% of the terrain in the range 10 kilometres to 50 kilometres from the transmitter (see figure 28) in the direction of interest. If the lowest field strength value of interest is initially predicted to occur over a particular propagation path at a distance that is less than 50 kilometres from the transmitter, the terrain profile segment used in determining terrain irregularity over the path should be that included between points 10 kilometres from the transmitter and such lesser distance.

Figures 21, 22, 24 and 26 (those propagation curves associated with land paths) were developed assuming a terrain irregularity of 50 metres. An attenuation correction factor should be applied to field strength values estimated to occur along a path where the terrain irregularity is found to depart appreciably from 50 metres. The attenuation correction factor, as a function of distance and terrain irregularity, may be determined by reference to figures 29 and 30.

2.6.4 Statistical nature of the propagation curves

The propagation curves are intended for estimation of both coverage and potential interference over a wide area. (The more accurate methods of section 2.7 and the actual terrain profile data shall be used for point-to-point calculations.)

Although the curves can be usefully employed both to approximate the extent of the nominal coverage of a service and to calculate the likely effect of potential sources of interference, they have limitations:

- The propagation curves have been developed from a statistical analysis of a considerable amount of experimental data. Significant variations between predicted and actual field strengths can be expected to arise from time to time and from location to location, particularly in rough terrain or beyond the radio horizon.
- The propagation curves associated with land paths are intended to be representative of propagation over 'average terrain' with a terrain irregularity parameter Δh of 50 metres. Corrections are given for Δh other than 50 m, but as Δh has been calculated for the 50 km radial distance from the transmitter the correction will be inaccurate where terrain irregularity varies markedly with distance.
- The experimental data on which the curves are based includes the effects of the clutter losses of the areas concerned. Particularly at UHF, the curves will tend to underestimate the field strength in flat open uncluttered areas and overestimate the field strength in areas of high clutter.

Diurnal or seasonal variations between actual and predicted values of field strength may be caused by variations in atmospheric conditions. Such variations can result in marked increases (or decreases) in field strength over a period of several hours or even several days.

More permanent variations can arise when the gradient of the radio refractive index of the atmosphere varies markedly from the normal gradient of the radio refractive index to which the propagation curve relates. Specific terrain features (both man-made and natural) and vegetation can also have a marked influence.

The extent to which statistical variations may occur from location to location increases with radio frequency and the extent of terrain irregularity. Within the range of frequencies currently used for broadcasting purposes in Australia and under all but the most rugged terrain conditions, the empirical formula of Report 239-6[19] may be used to determine the standard deviation of these variations.

The standard deviation (SD) of the path-to-path variability, for paths approximately equal length, may be estimated by normalising the terrain irregularity parameter (Δh) with respect to wave length (λ) and using the expression:

$$SD = 6 + 0.69\sqrt{\frac{\Delta h}{\lambda}} - 0.0063\frac{\Delta h}{\lambda} \qquad (10)$$

Consequently, the standard deviation expected for, say, bands I, III and V would be approximately 8, 10 and 12 dB respectively when applied to the propagation curves (where $\Delta h = 50$ metres) and would increase as Δh increases.

The more accurate point-to-point methods (see 2.7), or propagation tests, shall be used if coverage or interference estimates using these curves have only a small safety margin, or if it is proposed to take account of the additional losses of mountain ranges.

Further information concerning the statistical nature of the curves is available from the bibliography[19, 28, 30, 31].

2.7 Point-to-point calculations

Some radio paths are unsuitable for use with the empirically derived propagation curves of part 2.6. Examples are:

- paths with low effective transmitting antenna heights (less than 37.5 metres);
- short paths (less than 10 km);
- paths obstructed by rugged terrain; and
- paths for off-air relay sites.

For these paths, field strength calculations shall be carried out on a point-to-point basis with appropriate consideration being given to factors such as 'clutter' loss and signal fading. Point-to-point calculations provide a means of estimating the median field strength available at a specific receiving location.

All propagation nomograms and mathematical expressions in this section relate to propagation between half wave dipoles, unless otherwise specified.

Note: The nomograms are for 1 kilowatt radiated.

2.7.1 Propagation path profile

To estimate the effect of the terrain along a given path on the field strength, it is necessary to define the terrain shape, and its relationship to the first Fresnel zone of the ray line. This may be done graphically by plotting the profile of the terrain along the path on special graph paper (see figure 31). The paper takes into account the curvature of the earth and atmospheric refraction, with an exaggerated vertical scale to allow accurate plotting of physical features, while still permitting lines of propagation (ray lines) to be drawn as straight lines.

Atmospheric refraction is due to variation in the radio refractive index of the atmosphere with height. It normally decreases with height so that rays are refracted so as to follow the curvature of the earth to some extent. These rays are 'straightened' on the graph paper by increasing the earth radius by a factor k. The value of k for figure 31 is 1.33, which is the value considered representative of normal atmospheres. Other values may be chosen to examine propagation under conditions with a specified (low) probability of occurrence[46]. For the examination of the effects of ducting and super-refraction on co-channel interference at off-air relay sites, a value of k of 4.5 may be assumed for both VHF and UHF paths over land and VHF over the sea for 1% of the time, and a value of k of 25 may be assumed for UHF over the sea for 1% of the time.

Method:

. a propagation path profile for the path between the transmitting and receiving sites* is drawn on suitably scaled graph paper;

. receiving and transmitting antenna heights are then marked at the appropriate locations on the graph sheet;

. the locus of the ‘lower edge’ of the first Fresnel zone is then plotted between the transmitting and receiving antennas. For practical purposes, the radius (H_1) of this zone (which is centred on the ray line) at a particular point along the ray line, is given by the expression:

$$H_1 = 550\sqrt{\frac{d_1\, d_2}{d\, f}} \quad \text{metres} \qquad (11)$$

where:

d_1, d_2 are the distances from the point in question to the transmitting and receiving antennas, in km;

d is the total distance between antennas, in km;

f is the frequency, in MHz; and

. the points of intersection between the first Fresnel zone and the ground are noted.

* Topographic information required for the preparation of propagation path profiles can be obtained from topographic maps, preferably those with the largest available scale. Topographic maps of 1:100,000; 1:50,000 and 1:25,000 scales are generally available from State Mapping Authorities. The Department generates most of its profiles by computer from a digital terrain data base produced by the Australian Survey Office.

2.7.2 Selection of propagation model

When the profile has been drawn it is necessary to select a suitable propagation model. The various models specified in these guidelines are:

- **The 'Free Space' Model**

  Where a radio path is neither obstructed by the terrain, or interfered with by reflections from it, the only attenuation is that due to free space attenuation (see 2.8.1). For free space conditions to apply, the ray line must have at least 0.6 Fresnel radius clearance from the ground and the ground must not be likely to cause strong reflections (e.g. sea water, flat cleared earth).

- **The Free Space Model with Diffraction**

  Where free space conditions would apply, except that a hill protrudes into the first Fresnel radius, the profile can be modelled by free space with diffraction over a knife edge (see 2.8.4) or over a cylinder (see 2.8.6) depending on the shape of the hill. The model can be extended to diffraction over a number of obstacles.

- **The Smooth Spherical Earth Model**
  (Diffraction over Smooth Spherical Earth)

  This model is suitable where the terrain intruding into the first Fresnel zone is smooth and clearance is less than 0.6 Fresnel radius, particularly for longer paths where diffraction around the curvature of the earth is significant (see 2.9).

- **The Plane Earth Model**

  This model is considered suitable when the terrain is relatively flat so that reflection is important and clearance over the terrain is less than about one Fresnel radius. It is particularly applicable for short distances and low height antennas over flat terrain. The model is extended to irregular terrain, which is unsuitable for the free space model or the smooth earth model (see 2.10).

- **Epstein and Peterson Model**

  This model is specifically designed for a typical broadcasting situation where there is free space conditions at the transmitting end of the path but not at the receiving end. It also allows for diffraction losses over an intermediate knife-edge obstruction (see 2.11).

- **Sporadic E Model**

  This model is based on statistical studies of sporadic E propagation and only applies to Band I television channels (see 2.12).

  Figures 71, 72 and 73 have been provided to aid in the selection of an appropriate model, and in the selection of a suitable earth plane for the plane earth method.

2.8 Free space model

Where the ray line clearance is sufficient over the total length of a propagation path to ensure that the presence of the ground would have no influence upon propagation, free space propagation conditions are said to exist.

2.8.1 Free space transmission loss

Free space propagation may be calculated in two ways:

1. The field strength may be calculated at a point located at some appropriate distance from the transmitter, and in a given direction by the expression:

   $$E = 106.9 + 10 \log p - 20 \log d \qquad (12)$$

   where:

   E is the field strength, in dB referred to a field strength of 1µV/m (dBµV/m);

   p is the effective radiated power in the direction of the point in question, in kW;

   d is the distance to the point in question, in km.

2. The free space transmission loss (between half wave dipoles) may be calculated by the expression:

   $$L_{fs} = 28.1 + 20 \log f + 20 \log d \qquad (13)$$

   where:

   L_{fs} is the free space transmission loss, in dB;

   F is the frequency, in MHz;

   d is the distance between dipoles, in km

The free space transmission loss represents the difference (in dB) between the transmitted power and power available at the terminals of a receiving antenna, where both receiving and transmitting antennas are dipoles.

A useful general expression for determining received power is:

$$P_r = P_t + G_r - L_{fs} \qquad (14)$$

where:

P_r is the received power, in dB with respect to 1 watt (dBW);

P_t is the effective radiated power in the direction of the receiver, in dBW;

G_r is the gain of the receiving antenna with respect to a half wave dipole, in dB;

L_{fs} is the free space transmission loss, in dB.

Where free space propagation conditions are present, the nomogram at figure 32 may be used to determine field strength and received power between half wave dipoles with sufficient accuracy for most purposes.

2.8.2 Excessive ray line clearance

Where the ground is very smooth or water is present over the area from which reflections could reach a receiving antenna, checks should be made to ascertain that the ray line clearance does not become equivalent to the radius of an even-numbered Fresnel zone (the n^{th} Fresnel zone radius is equal to: $H_1 \sqrt{n}$).

A ray line clearance equivalent to the radius of an even-numbered Fresnel zone would favour the situation where a considerable reduction in the median field strength could occur at the receiving terminal. Such a situation would occur as a result of cancellation between the direct and ground-reflected signals. A ray line clearance equivalent to the radius of an odd-numbered Fresnel zone would favour an increase in the received field strength.

The cancellation caused by interaction between the direct and the reflected signals usually reduces with increased ray line clearance since the ‘smooth’ area required for a reflection co-efficient of -1 increases rapidly. This cancellation effect can normally be ignored for clearances over land paths greater than the radius of the third Fresnel zone.

Point-to-point radio paths are often designed with a first Fresnel zone clearance of only 0.6 (i.e. a clearance between the ray line and the most critical terrain feature over which it passes equivalent to 60% of the radius of the first Fresnel zone at that point). Such a path provides sufficient clearance for free space propagation conditions to apply and minimises the possibility of signal cancellation that could occur due to the interaction of direct and ground-reflected signals.

However, although such an approach minimises fading effects caused by increases in the value of k, it is necessary to ensure that the ray line clearance is sufficient to cater for possible decreases in the value of k. In the latter case the effective reduction in clearance results in a reduction of signal strength at the receiving location due to the occurrence of diffraction losses.

The following measures are considered acceptable to reduce fading due to reflection effects:

- adjusting the antenna heights so that the area of reflection is moved closer to one end of the propagation path or to an area where rough terrain would inhibit reflections;
- relocating one terminal so that terrain obstructions block reflections;
- using space or frequency diversity to overcome the effects of fading for a particular condition at a given time; and
- in the case of the sea, reflections from vertical polarisation are generally less than with horizontal polarisation, and reflection effects are reduced.

2.8.3 Diffraction over isolated obstructions

This relates to situations where free space propagation conditions would exist if it were not for the presence of one or more prominent obstructions, usually hills or mountains. To estimate the resultant diffraction losses, it is necessary to idealise the form of the obstructions. The following two sub-sections deal with idealised cases of perfectly absorbing knife edges of negligible thickness. Thick, smooth obstructions with well-defined radii of curvature at the top are discussed in section 2.8.7.

Real obstructions have more complex forms, so that the estimates provided by the methods outlined in these sub-sections should be regarded only as approximations.

2.8.4 Diffraction over a single knife edge

In the case of an ideal knife edge, all of the geometrical parameters may be lumped together in a single dimensionless parameter (H/H_1)[31]. (See also Report 715[19].)

where:

H is the height of the top of the obstruction above the ray line joining the transmitting and receiving antennas (if the top of the obstruction is below this line, H is negative);

H_1 is the first Fresnel zone radius at the point along the ray line where the obstruction occurs (refer to equation 11);

H and H_1 are expressed in the same units.

For values of (H/H_1) more positive than —0.6, the diffraction loss (L_{dif}) caused by the presence of the obstruction may be obtained from the expression:

$$L_{dif} = 10 + 20 \log \left[\sqrt{(H/H_1)^2 + 0.5} + (H/H_1)\right] - \frac{1}{(H/H_1)^2 + 1} \qquad (15)$$

Where (H/H_1) is in the range —0.6 to +1.0, L_{dif} may be approximated by the expression:

$$L_{dif} = 6 + 11(H/H_1) \qquad (16)$$

Knife edge diffraction loss (relative to free space) may also be estimated through the use of the nomogram at figure 38.

The total transmission loss for this idealised path would then be obtained from the expression:

$$L_{tot} = L_{fs} + L_{dif} \qquad (17)$$

where:

L_{tot} is the total transmission loss, in dB;

L_{fs} is the free space transmission loss, in dB;

L_{dif} is the diffraction loss produced by the knife edge, in dB.

The geometrical construction for two knife edge obstructions is illustrated at figure 39.

Method:

. the basic free space transmission loss is calculated for the path length in question, using equation 13 or figure 32;

. diffraction losses attributable to the individual obstructions are then calculated, using equation 15 or figure 38;

. the total transmission loss is the sum of the free space transmission loss and the individual diffraction losses.

The diffraction loss, with the largest value of H, is calculated first, as though it were the only obstruction. The loss attributable to the second obstruction is then calculated on the basis of its height with respect to the ray line between the relevant path terminal and the top of the first obstruction.[37] The diffraction losses attributable to multiple knife edge obstructions may be calculated in a similar way, taking each obstruction systematically. An example of a typical case is shown diagrammatically in figure 39A.

The individual obstacle losses are obtained using the values of d_1, d_2 and H, which are detailed in table 2.1.

Table 2.1
Multiple Knife Edge Obstruction

Obstacle Parameter	M_1	M_2	M_3	M_4	M_5
d_1	a	c	a + b + c	d	c
d_2	b + c	b	d + e + f	e + f	f
H	H_1	H_2	H_3	H_4	H_5

The total propagation loss is given by:

$$a = a_0 + a_{ml} + a_{m2} + a_{m3} + a_{m4} + a_{m5} \qquad (18)$$

It has been found that this method gives significant errors when two major obstructions having the same individual loss occur close together.

2.8.6 Diffraction over rounded obstructions

A propagation path with a single isolated terrain feature that provides the horizons for both terminals may often be considered as having a single rounded obstruction, rather than a knife edge between the terminals.

The diffraction loss over an isolated rounded obstruction may be computed using Report 715[19]. This calculation may be arranged in terms of a curvature factor A, from the following three factors:

H_1 the first Fresnel zone radius at the point along the ray line where the obstruction occurs, in metres (refer to equation 11).

λ the wavelength, in metres.

r the effective radius of curvature at the top of obstruction, in metres (i.e. r is the product of k and the actual radius of curvature).

The curvature factor A is represented by the expression:

$$A = (\lambda^{0.66} r^{0.33})/H \qquad (19)$$

To calculate the diffraction loss over a rounded obstruction, reference should be made to figure 40. This figure also uses a symbol H:

H the height of the top of the obstruction above the ray line, in metres.

The parameter (H/H_1) shown on the horizontal axis of figure 40 represents the ratio of the height of the obstruction (relative to the ray line) with respect to the radius of the first Fresnel zone at that point.

The diffraction loss (relative to free space) may then be read directly from the vertical axis on figure 40 for values of A in the range 0 to 1.5.

It will be noted that the curve A = 0 represents diffraction over an ideal knife edge while the curve A = 1.5 is representative of diffraction over a smooth spherical earth.

For diffraction over multiple rounded obstructions the procedure is similar to that described in section 2.8.5, except that the curvature factor (A) is calculated for each obstruction and the individual diffraction losses are derived from figure 40.

4.8.7 Clutter losses

Clutter due to buildings, trees or similar obstructions will cause losses additional to the free space losses. This is not normally a problem with point-to-point services but if free space calculations or the spherical earth or the plane earth methods of 2.9 and 2.10 are used to predict the coverage of low power stations, the predictions will be optimistic by the amount of clutter loss. This loss depends in a complex way on the frequency, density and height of clutter and the angle of arrival. It may vary from essentially zero up to 20 dB or more[40], depending on the degree of clutter actually present in any given case.

Suburban clutter losses do not have to be applied where it is reasonable to assume that receiving antennas can be mounted above roof-top height.

The clutter loss figures must not be applied to the curves given in figures 21 to 27 (CCIR curves).

Clutter loss factors, the manner in which they should be applied and the values that should be used are the subject of further study in the CCIR and in the Department and may be subject to alteration.

Typical clutter loss allowances are given in table 2.2[42] below:

Table 2.2
Clutter Loss Allowances

Coverage Area Type	VHF	UHF
Urban	8 dB	12 dB
Suburban	6 dB	8 dB
Wooded	4 dB	8 dB
Rural	2 dB	4 dB
Receiver Foreground:	Change above by:	
Slope facing Tx	-2 dB	-4 dB
Slope facing away from Tx	2 dB	4 dB

2.9 Smooth Spherical earth model

In circumstances where the terrain intruding into the first Fresnel zone is smooth (i.e. no significant terrain irregularities), propagation losses may be calculated on the basis of diffraction of radio waves over a smooth spherical earth (Report 715[19]). This method is not widely used because of the constraints placed upon it.

This method will produce fairly accurate results, subject to the following conditions being met:

- The ray line clearance does not always exceed about 60% of the first Fresnel zone radius. Where the ray line clearance always exceeds this value, approximations used in the mathematical model upon which the calculation technique is based become invalid. Under these circumstances free space propagation conditions may be assumed to exist.
- If the ray line intersects the ground, the height of the resultant positive obstruction does not exceed greatly the maximum value of the radius of the first Fresnel zone.
- Such a situation would only be encountered where the receiving terminal is well beyond the radio horizon of the transmitting terminal. Although the method for calculating diffraction loss over a spherical earth technically remains valid for long, over-the-horizon paths, tropospheric forward scatter soon becomes the principal propagation mechanism over such paths.
- The receiving terminal is located in such a position and at such an elevation that the incoming signal is not subject to additional attenuation due to surrounding "clutter". If such clutter is present, allowance should be made for it in accordance with 2.8.7.

Method:

Where a path profile suggests that the diffraction loss could be estimated on the basis of diffraction over a spherical earth, the nomograms at figures 33 and 34 should be used.

- Figure 33 may be used (on a basis of k = 1.33) to estimate the loss (relative to the free space transmission loss) due to the effect of distance between the transmitting and receiving terminals.
- Figure 34 is used to identify ‘height-gain’ factors for the transmitting and receiving antennas. When using this nomogram, the height used is the actual height of the antenna above the surface of the earth.
- If alternative values of k are to be taken into account, losses may be calculated by using the frequency scale k = 1, but by replacing the frequency in question by a hypothetical frequency equal to f/k^2 for figure 33 and $f/\sqrt{k}$ for figure 34.
- The total transmission loss (L_{tot}) may then be calculated by the expression:

$$L_{tot} = L_{fs} - (A + B + C) \qquad (20)$$

where:

L_{fs} is the free space transmission loss, in dB, determined from equation (13) or figure 32;

A is the signal level, in dB, relative to free space determined from figure 33;

B is the 'height-gain' factor, in dB, for the transmitting antenna determined from figure 34;

C is the 'height-gain' factor, in dB, for the receiving antenna determined from figure 34;

Note 1: For VHF transmissions (i.e. frequencies less than 300 MHz) where the propagation path is over sea water and vertical polarisation is employed, a notional frequency (f_1) should be substituted for the actual frequency by the expression:

$$f_1 = f - 0.06\,(300 - f) \qquad (21)$$

where f is the actual frequency of the transmission, in MHz.

The notional frequency, f_1, is then employed when using figures 33 and 34.

Note 2: Very close to the ground the field strength is practically independent of the height of a receiving antenna. This phenomenon is more significant in the case of vertically polarised transmissions over sea water than in other instances. Even then, with a notional receiving antenna height of 10 metres above local ground level the phenomenon only becomes significant at frequencies below about 100 MHz.

The heavy vertical limit line AB, included in figure 34, may be used to determine the effective height of a relatively low antenna where vertically polarised transmission over a sea water path is encountered. If the straight line drawn between ‘frequency’ and ‘height of antenna’ intersects AB, the real antenna height should be replaced by a larger value, so that the straight line just touches the top of the limit line at A.

Note 3: If the sum of the height gain values derived from figure 34 and the diffraction loss value derived from figure 33 is positive, this would imply an overall transmission loss less than the free space transmission loss and the method is invalid.

2.10 Plane earth model

This is the preferred model where the ray line has between first Fresnel and almost zero clearance over flat terrain, or where there is irregular terrain unsuitable for the free space/diffraction model. It is based on the classic plane earth model with ground reflection.[32]

In the simple classic model, the plane of reflection is found and the heights of the transmitting and receiving antennas above this plane measured using the terrain profile. The loss can then be calculated using the nomogram of figure 35 or equation 22. Where the profile is more complex, the method establishes a notional plane earth and deals also with terrain irregularities by constructing a 'shadow loss triangle' from which the obstruction losses can be found from the nomogram of figure 36. It can thus be satisfactorily applied to a wide variety of terrain.

The selection of an appropriate earth plane containing the plane of reflection is not difficult when the profile is over relatively flat terrain. It is much more difficult to select an appropriate earth plane when the terrain is irregular, and figures 71, 72 and 73 have been provided to assist in the selection process. The selection of an appropriate earth plane requires judgement and experience and is a vital part of the calculation process. Selection of inappropriate earth planes may lead to substantial errors.

Note: The plane earth transmission loss between half wave dipoles (L_{pe}) may be calculated from the expression:

$$L_{pe} = 115.7 - 20 \log h_1 - 20 \log h_2 + 40 \log d \qquad (22)$$

where:

h_1, h_2 are the effective transmitting and receiving antenna heights, in metres;

d is the distance between transmitting and receiving terminals, in km.

Alternative Method

An alternative method that is satisfactory under some circumstances is described below. Its use should be confined to those situations where the first Fresnel zone cuts the earth profile in regions that are flat or undulating, i.e. reasonable reflection areas.

The effective transmitting and receiving antenna heights are equivalent to the values of the first Fresnel zone radii at the point where they intersect the ground closest to the respective antennas.

Method:

. to construct a substitute plane earth model, the effective antenna heights are subtracted from the actual heights of the antennas to give points from which the substitute plane earth can be drawn. The shadow loss triangle is constructed with the substitute plane earth as its base and its other two sides drawn so that all obstructions apparent along the path are enclosed within the shadow loss triangle. An example of such a construction is shown at figure 37;

- the plane earth transmission loss may be calculated from equation 22. Alternatively, the nomogram at figure 35 may be used to derive the received power over a plane earth between half wave dipoles with 1 kW transmitter power (1 kW ERP);
- the shadow loss introduced by the terrain irregularities may be derived from the nomogram at figure 36;
- the total transmission loss may be calculated by adding the shadow loss derived from figure 36 to the plane earth attenuation derived from equation 17;
- Alternatively, the received power (assuming 1 kW ERP transmitter and a half wave dipole receiving antenna) may be determined by subtracting the shadow loss derived from figure 36 from the received power value derived from figure 35.

Note 1: Due to the simplified method of constructing the shadow loss triangle, care should be taken when applying this model. Statistically, 50% of results should be accurate to within ±6 dB while for 90% of results the accuracy expected is within ±12 dB.

Note 2: Due to the approximation employed in developing equation 22 and figure 35, values of the plane earth transmission loss are only valid when the calculated transmission loss exceeds the free space transmission loss. It is therefore always important to calculate free space transmission losses for all paths under consideration so that comparisons may be made.

Note 3: This method takes no account of clutter loss, i.e. losses due to trees and buildings in front of the receiving antenna. If such clutter is present, allowance should be made for it in accordance with 2.8.7.

Note 4: The field strength obtained by this method is the field strength exceeded for 1% of locations, 90% of the time (E 1,90). If it is desired to know the field strength exceeded for 50% of the time it can be obtained with sufficient accuracy by adding 1 dB in the cases of Bands I and II, 2 dB in the case of Band III, and 3 dB for Bands IV and V. To then obtain the received field strength exceeded for 50% of locations the appropriate clutter loss is subtracted in accordance with section 2.8.7.

2.11 The ‘Epstein and Peterson’ propagation model

This model was developed principally for making quasi point-to-point calculations between a transmitter and a domestic receiving location when the propagation path is obstructed by rugged terrain[40].

The model is based upon a point-to-point free space propagation path with a factor included to take account of diffraction losses associated with obstructions that may occur along the propagation path, and a so called 'clutter loss' factor (L_c). The clutter loss curve and the geometrical construction for the calculation of angles of arrival of the signal are reproduced at figures 41 and 42.

To estimate the overall transmission loss using this model the following method is employed:

- the basic free space transmission loss is calculated for the path length in question, using equation 13 or figure 32;
- the diffraction loss caused by the presence of the obstruction is calculated from equation 15 or determined by reference to figure 38. This model treats the obstruction as an ideal knife edge.
- the clutter loss factor is determined by reference to figures 41 and 42;
- the three loss components are summed, providing an estimate of the total path transmission loss.

The clutter loss factor is designed to take into account the loss that occurs in normal domestic receiving locations due to the presence of surrounding houses, trees, etc. However, it is considered inappropriate to attempt to apply the clutter loss values derived from figure 41 to any other propagation model.

The clutter loss factors are based on measurements carried out on the east coast of the USA in well-populated areas. Experience shows that they are too high in the lightly developed or open areas of inland Australia, and may lead to substantial errors at UHF. The factors are more appropriate for urban and suburban areas.

2.12 Propagation beyond the radio horizon

VHF and UHF radio waves may propagate well beyond the horizon with the potential to cause interference by such mechanisms as ducting and tropospheric scatter (Recommendation 370-5[19, 28]). Because of the variable nature of such propagation, the only model provided is the statistical model of section 2.6. Figures 43–46, which show field strengths exceeded for 1% of the time at 50% of locations, have been provided to give additional information for off-air relay input signals.

These curves are based on data obtained from overseas propagation studies and it is known that some flat, coastal and over-water propagation paths in Australia may produce levels close to free space propagation for a small percentage of the time. Although a small percentage of the time in total, individual occurrences may persist for some hours. No specific information is available because of the lack of locally obtained data. If it is thought that there may be problems the only available recourse at present is to conduct a prolonged measurement campaign. The CCIR has done studies in the Middle East and Eastern Mediterranean that may be useful (see Report 239-6[19] and Ref 47).

2.12.1 Sporadic E propagation

Within Band I, sporadic E propagation (reflection from ionised patches in the E layer of the ionosphere) can be a potential source of interference. This mode of propagation occurs principally during the summer months with peak activity around noon and early evening.

Signals from transmitters in the range 800 to 2600 kilometres may be received at field strength levels several orders of magnitude greater than those which would be expected on the basis of diffraction around the curvature of the earth. They may, on occasions, be comparable with free space values and can produce severe interference to reception of broadcasting services as a result.

Although sporadic E propagation is seasonal, propagation conditions may be such that when it does occur, high unwanted signal levels can be maintained for several hours. Figures 47 and 48, based on Recommendation 534-2[17] shall be used to estimate field strength levels that may be experienced as a result of sporadic E propagation.

Within Band I strong anomalous propagation can also occur over long north-south paths spanning the magnetic equator. Interference due to this effect (known as transequatorial propagation) is best controlled by avoiding the allocation of Band I channels (particularly channels 0 and 1) north of latitude 20°S.

2.12.2 Signal fluctuations[44]

On radio paths longer than about 50 kilometres, fading of the wanted signal and possible enhancement of unwanted signals may occur. Variations in the refractive index of the atmosphere can cause level variations (fading) of VHF and UHF signals over a given propagation path. Generally, the extent of signal fluctuations increases as the path length increases (at least within the range of distances considered appropriate for broadcasting purposes).

When considering the fading range of a signal that presents a potential source of interference, the propagation curves at figures 21, 24 and 25 may be used for estimating field strength levels expected to occur at 50% of locations for 50% of the time. The propagation curves at figures 43 to 46 may be used for estimating field strength levels that may be expected to occur at 50% of locations for 1% of the time.

The fading range may be taken to be the difference in field strength levels thus determined.

When the fading range of an unwanted signal is greater than 10 dB over a given path, the signal may be considered to result from propagation over a long distance. If this signal was being considered as a potential source of interference, protection ratios appropriate for tropospheric interference should be used when calculating the usable field strength of the wanted signal. If the fading range is less than 10 dB, protection ratios appropriate for continuous interference should be used.

2.13 Estimation of signal levels at off-air relay sites

The median input signal levels at transposer sites (and intermediate off-air relay sites) may be estimated using point-to-point calculations.

The estimate of transmission losses along a propagation path will also be affected by fading of the signal. The extent to which fading will occur will be dependent upon path length, reflection co-efficient of the intervening terrain and changes in values of k, and will be frequency dependent.

Figure 49 may be used to provide an estimate of the fading margin (reduction in signal level with respect to the median value) which would be exceeded for no more than 0.1% of the time for most practical propagation paths, as a function of distance, frequency and environment.[28]

Where the diffraction loss is very likely to be influenced by changing values of k, such as for propagation paths across water or smooth terrain or paths where the receiving terminal would be close to or beyond the radio horizon, calculations for various values of k should be made to assess the likely impact of changes in the radio refractive index of the atmosphere. A value of k as low as 0.7 is often considered when high reliability is required of a point-to-point link.

PART 3A: MF AM RADIO

3A.1 Introduction

Part 3 of the planning guidelines provides basic information for planning broadcasting services. Part 4 provides supplementary notes; its section numbers correspond to those of Part 3 to assist with the reference of topics that may need further elaboration. For example, MF Radio Coverage Criteria is under 3A.5 and a further explanation is given under 4A.5.

The letter A refers to MF radio, B to VHF-FM radio and C to television.

The propagation calculations required for planning MF broadcasting services are dealt with in part 2.

It is recognised that the guidelines for MF radio require revision. An appropriate receiver bandwidth needs to be specified, and the transmitted bandwidth, receiver noise bandwidth and protection ratios related to it. Changes are also required so that transmitters may be dimensioned to cover a service area, rather than having their power tied to a particular kind of licence or service category. Because a revision aimed at correcting these problems will require major study and a considerable time to implement, it has been decided to publish the MF guidelines in their present form. When the MF guidelines have been revised they will be republished.

3A.2 Frequency assignment

3A.2.1 Channel assignment

The band allocated to MF broadcasting in Region 3 by the International Telecommunications Union and adopted in the Australian Table of Frequency Allocations is from 526.5 kHz to 1606.5 kHz. Assignments are to be made to channels within this band.

Each channel is designated by its nominal carrier frequency. Nominal carrier frequencies are the 120 integral multiples of 9 kHz in the range 531 kHz to 1602 kHz. New assignments will not be made on the 531 kHz and 1602 kHz channels because the sidebands from these channels may extend outside the broadcasting band. Existing stations with these frequency assignments may retain them.

Only services with a cymomotive force (CMF) not exceeding 220 volts in any direction will be assigned one of the following channels:

567 kHz, 765 kHz, 1215 kHz, 1476 kHz, 1485 kHz, 1494 kHz, 1584 kHz, 1593 kHz and 1602 kHz.

The Department is responsible for the international co-ordination of MF frequency assignments with the International Telecommunications Union (refer Part 3).

3A.3 Channels

3A.3.1 Channel separation

Services with extensive (80% of the population or greater) overlap of service areas will not be assigned channels separated from each other by less than 45 kHz.

Services with significant (up to 20% of the population) overlap of service areas will not be assigned channels separated from each other by less than 27 kHz.

3A.3.2 Channel sharing

It is preferred:

. that services employing directional antennas share their channel with services of similar power and with similar antennas; and

. that low power services employing omnidirectional antennas share their channel with other low power omnidirectional services.

Services of low power and employing omnidirectional antennas will normally be assigned local channels. Alternatively a low power service employing an omnidirectional antenna may be assigned a channel already utilised by services employing directional antennas, where that assignment would not significantly impede further development of that channel by additional services employing directional antennas.

3A.4 Polarisation and receiving antenna discrimination

AM medium frequency broadcasting transmissions shall be vertically polarised.

Receiving antenna discrimination due to polarisation or directivity shall not be taken into account in the planning of services.

3A.5 Coverage criteria

3A.5.1 Usable field strength

The usable field strength (Eu) at any location is the minimum value of field strength from a wanted transmission necessary to overcome anticipated levels of atmospheric and man-made noise and radio interference from other services, at that location. The method[43] used also takes into account the effects of self-fading, receiver deficiencies and receiver sensitivity.

3A.5.2 Coverage areas

The ‘coverage area’ of a station is that area wherein technically adequate reception can be obtained with the notional receiving system.

The primary (night-time) coverage area of a station is that area wherein its field strength is equal to, or greater than, the night-time usable field strength.

The daytime coverage area of a station is that area wherein its field strength is equal to, or greater than, the daytime usable field strength.

3A.5.3 Man made radio noise levels

For planning purposes, the protected field strength in the presence of man made radio noise alone (I_M) is determined by selection from the following table:

Table 3A.1
Protected Field Strength in the Presence of Man Made Radio Noise Alone

Environment	Protected Field Strength in the Presence of Man Made Radio Noise Alone
Rural	0.5 mV/m (54 dBμV/m)
Suburban	2.5 mV/m (68 dBμV/m)
Urban	10.0 mV/m (80 dBμV/m)

For planning purposes, it may be assumed that cities of more than 10,000 people are ‘urban’ and that towns with from 2,000 to 10,000 people are ‘suburban’. Areas not classified as either urban or suburban are ‘rural’. These should not be taken as absolute criteria and a sensible graduation from one level to another (rather than quantum jumps) should be applied.

Planners may propose classifications on other grounds if they consider that special circumstances apply to a particular town or city.

3A.6 Interference – radio frequency protection ratios

For planning purposes, 'protection ratios' are of assistance in the assessment of coverage by a service. (See glossary for definition.)

When the field strength of an unwanted signal is known, the minimum field strength necessary for adequate reception (referred to in these guidelines as the protected field strength) can be obtained from multiplication by the protection ratio. The protection ratios to be used are given below. In all cases the wanted signal is the groundwave signal of the wanted service.[1]

Table 3A.2
Protection Ratios

	Protection Ratio
Non-synchronised	
Median skywave signal of wanted service	+14 dB
Median skywave or groundwave of another service on the same channel	+30 dB
Synchronised	
Groundwave signal of synchronised service (mono)	+8 dB
Skywave signal of synchronised service (mono)	+14 dB

(No guidance can be given on synchronised operation of stereo services at the present time.)

Various protection ratios must also be applied to signals on channels close in frequency to the desired signal, or channels with various harmonic relationships to the receiver local oscillator and IF frequencies, because of the finite resolution and linearity of practical receivers. These protection ratios are given in the notional receiver specification (3A.15).

3A.7 Interference – man made radio noise levels

The tabulated values of necessary minimum field strengths in the presence of man made noise levels alone (3A.5.3), have been based on Australian conditions.

3A.8 Interference – atmospheric radio noise levels

For planning purposes the level of field strength necessary for satisfactory reception in the presence of atmospheric noise is derived as follows[3]:

$$A = F_{am} - 6{\cdot}5 - 20 \log f$$

where:

A is the protected field strength in the presence of atmospheric radio noise alone (dB relative to 1 µV/m)

f is frequency in MHz

F_{am} is the expected median value of atmospheric noise at 1 MHz, for 1 Hz bandwidth (dB above thermal noise). F_{am} may be derived either from figure 50 or from table 3A.3. (The Department's computer program for atmospheric noise uses linear interpolation of table 3A.3)

A protection ratio of 30 dB, receiver noise bandwidth of 16 kHz, and a ratio of upper decile to median value of 17 dB have been assumed.

Table 3A.3
Values of Atmospheric Noise Levels
F_{am} (dB): 1600-2000 hours, LT, Summer

Lat	Longitude (°E)															
°S	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180
0	72	72	73	73	73	70	69	69	69	67	67	65	63.5	62	60	59
5	72	74	75.5	77	77	76	75	75	75	75	75	72	70	69	67	60
10	71	75	78	80	82	84.5	85.5	85	83.5	82	80.5	78	75	73	72	71
15	67	70	75	80	81	85	85	85	84	82	80	79	78	77	76	76
20	64	67	70	74	75	77	78	78	78	77	77	76.5	76	76	75.5	75
25	61	63	66	68	70	72	73	73	73	73	73	73	73	73	72	72
30	56	60	62.5	64	66	68	69	70	70	70	70.5	71	71	71.5	71.5	71
35	49	52	56	58	60	61	62	64	65	66	67	67.5	68	68	69	67
40	42	45	48	50	53	53	56.5	57	58.5	60	61	62.5	63	63	63	62.5
45	35	37	39	40	43	45	47	50	52	54	55	56	57	59	59	58
50	24	25	27	29	30	35	36	38	40	42	45	46	47	48	49	49

3A.9 Interference – significant interference

3A.9.1 Occurrence

Significant interference is considered to result from any of the following situations:

- the groundwave field strength of a wanted service exceeds 1000 mV/m;
- anywhere within the service area, the daytime usable field strength exceeds the groundwave field strength of a wanted service; and
- anywhere within the 10 mV/m groundwave field strength contour of a wanted service, the night-time usable field strength exceeds the groundwave field strength of that service.

3A.9.2 Maximum field strength

Approval will not be given for a new site or a radiation level variation at an existing site where more than 100 persons or 1.0% of the population residing within the service area of the service (whichever is the greater) would be subject to significant interference due to its field strength being in excess of 1000 mV/m.

The licensee of a service, or the authority responsible for a service, shall satisfy all reasonable complaints of significant interference which occur within its 1000 mV/m field strength contour.

3A.10 Calculation of usable field strength –summation of interference

The calculation of the usable field strength in the presence of a number of sources of interference (whether due to self-fading, co-channel or adjacent channel interference, atmospheric and man-made noise, receiver characteristics or internal receiver noise) is to be performed in accordance with Recommendation 499-1[43], with the addition of a 6 dB exclusion principle, as follows:

> considering the protected field strength resulting from each individual source of interference acting alone, in order of decreasing magnitude, add the squares of the field strengths and extract the square root of the sum, excluding those components which are less than 50% of the root sum squared value of the higher components already included.

3A.11 Transmitter power

3A.11.1 Transmitter Power

The maximum transmitter power for new services and power increases of existing services is as follows:

- National ABC transmitters 10 000 watts
- all others 5 000 watts

The actual operating power for services where the cymomotive force is specified not to exceed 220 volts in any direction may be adjusted as necessary to achieve the specified cymomotive force. In other cases the power must be one of the following powers:

500 watts
1 000 watts
2 000 watts
5 000 watts
10 000 watts
50 000 watts (existing services only)

[These criteria are under review]

3A.11.2 Propagation tests

The maximum CMF permissible for propagation tests is 220 volts.

Transmissions for propagation testing will be authorised only between the hours of local sunrise and local sunset at the transmitter site (figure 51).

3A.12 Transmitting antenna radiation pattern

3A.12.1 Radiation Levels

Methods of calculation of the radiation level from an MF antenna system for particular azimuth and elevation angles are described in 4A.12.

If the CMF of the new or modified service exceeds 220 volts, a directional antenna will normally be required with a radiation pattern such that the radiation towards existing or proposed co-channel and adjacent channel stations does not significantly reduce coverage within their service areas. The Department may require additional protection for future development of the MF broadcasting band.

This requirement may be waived if the CMF does not exceed 700 volts and if the transmitter site is located north of parallel of latitude 26 degrees south and west of the meridian of longitude 140 degrees east.

3A.12.2 Shared radiating systems

The shared use of a radiating system by two or more services may be practicable if the frequency difference between the services is greater than 63 kHz (omnidirectional antennas) or 153 kHz (directional antennas).

3A.12.3 Day/Night Specifications

No variation in radiation pattern on a day/night basis is permitted. Where necessary, service specifications may permit operations only during the daytime.

3A.13 Siting if transmitter

3A.13.1 Transmitting system location

Where possible, new transmitting sites are to be located in close proximity to existing services providing coverage of the region. Sharing of sites is preferred where feasible.

Sites shall be selected to ensure that the urban centres and general area to be covered will receive a signal which exceeds the night-time usable field strength.

Sites are to be selected which do not present a hazard to air navigation and which do not unduly intrude on the environment. The broadcaster is responsible for obtaining all necessary approvals from federal, state and local government planning authorities.

A generally flat site with soil of good conductivity is preferred. It is to be sufficiently removed from nearby metallic structures to ensure that parasitic re-radiation does not result in non-compliance with the technical conditions. Alternatively, the licensee or responsible authority shall undertake to modify those structures to ensure compliance.

In the case of an existing station relocating its transmitter to a new site, the technical conditions of the station at the new site must be such that it can reasonably be anticipated that the existing coverage of its principal service area would generally be retained.

3A.14 Low power stations

Low power stations are used to provide additional or fill-in services to well defined areas. They normally use simple radiating structures to reduce cost and are normally located near to the area to be served. Low power stations are subject to similar siting constraints as high power stations, but the lower powers make this less difficult.

Use of the low power channels as provided for in the Geneva Plan is preferred for low power services.

3A.15 Reference receiver

The guidelines are based on the assumption that the receiver population will have certain characteristics. These characteristics are set out below.

The system is considered to comprise the following elements:

- antenna
- receiver

The characteristics of each of these elements will be described in turn.

3A.15.1 Antenna

The type of antenna may be either a ferrite rod or whip.

Ferrite Rod Antenna

- vertically polarised
- oriented for maximum response of desired signal

The horizontal radiation pattern has a response at ±90 degrees from the angle of maximum response which is -15 dB with respect to the maximum response. (Note: This response is not taken into account in planning.)

Whip Antenna

- vertically polarised
- omnidirectional

3A.15.2 Receiver type

The electronic circuitry is that of a single conversion superheterodyne.

3A.15.3 Tuning accuracy*

The receiver tuning is capable of being readily set such that the carrier frequency of the desired service is within ±1 kHz of the centre of the intermediate frequency passband.

The dial is always so adjusted, and readjusted if necessary, to compensate for drift in the local oscillator frequency.

3A.15.4 Local oscillator frequency

The frequency of the local oscillator is greater than the frequency of the signal desired to be received.

3A.15.5 Intermediate frequency

The centre of the intermediate frequency passband is within ±2.5 kHz of 455 kHz.

3A.15.6 Sensitivity*

In the absence of man-made electrical noise, atmospheric noise and interference from other services, a field strength of not more than 0.5 mV/m, (54 dBµV/m) is required to achieve 30 dB audio frequency signal to noise ratio.

3A.15.7 Selectivity[1, 43]

Planning is based on the selectivity of a narrow bandwidth receiver which results in the application of the following protection ratios:

Table 3A.3
Protection Ratios from Interfering MF-AM Broadcasting Services

Channel Separation	RF Protection Ratio
0 kHz	30 dB
±9 kHz	+9 dB
±18 kHz	-24 dB

3A.15.8 Ultimate selectivity*

With typical transmitted bandwidths, stations of generally similar coverage area and providing coverage of the receiving location are adequately separable with 45 kHz channel separation. Stations of generally dissimilar coverage but with the coverage overlap area including the receiving location are adequately separable with 27 kHz channel separation.

3A.15.9 Spurious responses[12]

The minimum required field strength to obtain 30 dB signal to interference ratio for reception on channels near a harmonic of the IF is as follows:

Second Harmonic	(909 kHz)	80 dBµV/m
Third Harmonic	(1359 kHz, 1368 kHz)	82 dBµV/m

Where an unwanted signal and the receiver local oscillator differ in frequency by approximately the IF the necessary RF protection ratio is -20 dB.

Where an unwanted signal and the second harmonic of the receiver local oscillator differ in frequency by approximately the IF the necessary RF protection ratio is -20 dB.

Where the second harmonic of an unwanted signal is approximately the same frequency as the wanted signal, the necessary RF protection ratio is -77 dB plus half the magnitude of the field strength of the wanted signal in dBμV/m.

Where the second harmonic of an unwanted signal and the receiver local oscillator differ in frequency by approximately the IF, the necessary RF protection ratio is -70 dB plus half the magnitude of the field strength of the wanted signal in dBμV/m.

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* Insufficient information is available to enable an accurate value to be assigned for this parameter. However, the quoted value is considered to be reasonable and may be used until such time as technical studies provide a better estimate.

MF RADIO
SUMMARY OF REQUIREMENTS

Guide-lines Para.	Interference Mechanism	Exclusions	Protec-tion Ratio	Minimum Field Strength (dBμV/m)	Comments
3A.6	Co-channel skywave, groundwave	MF freq F	30 dB	NA	Separate service areas.
3A.15.7	First adjacent channel	F ± 9 kHz	9 dB	NA	Separate service areas.
3A.15.7	Second adjacent channel	F ± 18 kHz	-24 dB	NA	Separate service areas.
3A.15.7	Third adjacent channel	F ± 27 kHz	-27 dB	NA	Can be used for service areas which overlap up to 20% of the population.
3A.3.1	Fourth adjacent channel	F ± 36 kHz			Can be used for service areas which overlap up to 80% of the population.
3A.6	Own skywave signal	F	14 dB	NA	
3A.15.9	F = 2×IF F = 3×IF	909 kHz 1359 kHz, 1368 kHz	NA NA	80 82	
3A.15.9	F_{uw} - LO = 455 kHz	F + 910 kHz	-20 dB	NA	Image interference.
3A.15.9	2LO - F_{uw} = 455 kHz	2F + 455 kHz	-20 dB	NA	
3A.15.9	F = 2×F_{uw}	F/2	X dB	NA	X = [0.5 (FS wanted signal in dBμV/m) - 77] dB
3A.15.9	2F_{uw} - LO = 455 kHz	F/2 + 455kHz	Y dB	NA	Y = [0.5 (FS wanted signal in dBμV/m) - 70] dB
3A.5.3	Man made noise: - rural - suburban - urban		 NA NA NA	 0.5 mV/m 2.5 mV/m 10.0 mV/m	
3A.8	Atmospheric noise			A dBμV/m	A= F_{am} - 6.5 - 20logF
3A.15.6	Receiver noise			0.5 mV/m	

F	= frequency of wanted signal	LO	= local oscillator frequency
F_{uw}	= frequency of unwanted signal	F_{am}	= from figure 50 or table 3A.1

<u>Interference Summation</u> (3A.10)

$$Eu = \sqrt{\sum_k (Prk + Gk)^2 + \sum_k (Pck + Gk)^2 + \sum_k (Pck\ Sk)^2 + I_A^2 + I_M^2 + I_N^2 (P_F F)^2}$$

Note: Components which are less than 50% of the RSS value of the higher components already included are to be excluded. For an explanation of symbols see 4A.10.

PART 3B: VHF FM RADIO

3B.1 Introduction

Part 3 of the Planning Guidelines provides the basic information required for planning broadcasting services. Part 4 provides supplementary notes. The section numbers in part 4 are directly related to those in part 3 to assist with the cross-reference of topics that may need further elaboration. For example, FM Radio Coverage Criteria are dealt with in 3B.5 and a further explanation is given in 4B.5.

Parts 3A and 4A refer to MF Radio, 3B and 4B to VHF-FM Radio and 3C and 4C to Television.

Propagation calculations required for planning of VHF-FM services are dealt with in part 2.

3B.2 Frequency assignment

3B.2.1 General considerations

In order to utilise the VHF-FM band as efficiently as possible, the Department is preparing a national channel allotment plan. This plan will specify the channels to be used for transmitters and transposers within the service areas of existing and proposed high power services. This detailed plan will not be available in a published form for some time.

In the first instance, the Department should be provided with broad details of the proposed transmitting arrangements – site, antenna height, estimated effective radiated power (ERP), service area – and asked to provide frequency planning information.

In general, therefore, it will not be necessary to allot channels, and the planning work will be restricted to site selection and setting the ERP so that the protection criteria of the guidelines are met.

In some cases temporary frequency assignments may be necessary because the presence of Band II television stations may prevent the most suitable channels from being used.

Occasionally, a new requirement not covered by the channel allotment plan will arise within the service areas of the existing or proposed high power broadcasters, and in those cases the frequency selection procedures of 3B2.2 should be followed.

Assignment of channels in remote areas is covered in 3B2.3.

3B.2.2 Frequency selection procedure

The frequency selection procedure is as follows:

(a) determine available channels based on co-ordination with existing and planned VHF-FM services and in accordance with the national channel allotment plan or the simplified remote area plan as appropriate;

(b) select transmitter site(s) suitable to ensure adequate coverage of the proposed service area;

(c) for the selected site(s) calculate the required ERP at various bearings to provide adequate coverage of the proposed service area;

(d) calculate VHF-FM signal levels and hence achieved protection ratios at the service area boundary(ies) of existing or planned TV or VHF-FM services which share common or adjacent channels with the proposed VHF-FM service;

(e) calculate reciprocal signal levels and hence achieved VHF-FM protection ratio(s) at the VHF-FM service area boundary (repeat as necessary for all potentially available VHF-FM channels);

(f) based on the results of (d) and (e) select a suitable channel (if any) from those determined in step (a); and

(g) if there is no satisfactory result, review the available transmitter sites, and, if possible the proposed service area, with a view to reducing the ERP in the direction of the radio or television services which would suffer interference, and repeat steps (c) to (f).

3B.2.3 Simplified planning rules for remote areas

Simplified channel selection rules are applied in remote areas. This region can, in general, be taken as the area outside the service areas of the existing terrestrial television broadcasters. However, the service areas of Broken Hill, Mt Isa, Darwin and Kalgoorlie are included in the remote area.

Frequency selection is made from the following table, for the particular type of service required:

Table 3B.1
VHF-FM Standard Groups

Service	First Choice	Second Choice	Third Choice	Transposers
Public/Commercial 1 #	102.1 MHz	101.9 MHz	101.7 MHz	95.3 MHz
Public/Commercial 1 *	102.9	102.7	102.5	96.1
Commercial 3	103.7	103.5	103.3	96.9
ABC3	104.5	104.3	104.1	97.7
as required	105.3	105.1	104.9	98.5
ABCRR	106.1	105.9	105.7	99.3
Commercial 2 *	106.9	106.7	106.5	100.1
ABCRN	107.7	107.5	107.3	100.9

* Preferred choice for antennas shared with ABC. A 1.6 MHz spacing should be used where possible.

\# Preferred choice for antennas separate from ABC.

An appropriate channel from the first choice group is chosen and checked by the procedure of 3B2.2 to see if it can be assigned. If it is not possible to assign the first choice channel then the appropriate second choice channel is chosen, and if the second choice assignment is not possible, then the third choice channels are used.

The transposer group is provided for use where it is necessary to avoid adjacent channel transposition from an off-air input signal. It is to be used only if more than one channel is required and they cannot be accommodated within the normal groups. Preferably, if only one or two channels are required, the existing group may be extended downwards.

The transition between the conventional planning process and the simplified planning process is accomplished in the following manner:

. Within the remote area, and more than 150 km from the terrestrial television service areas, the simplified plan may be generally followed without restraint. However, in a few cases such as in areas adjacent to high power Band II television services, some care may be required to prevent interference to existing assignments.

. Within the remote area, but less than 150 km from the terrestrial television service areas, channel assignments will require co-ordination with existing frequency assignments. The simplified plan may still be used if it does not result in interference.

3B.2.4 Overlapping service areas overlap rules

For the frequency differences specified, the following overlap rules apply:

800 kHz	may be used to serve the same service area;
600 kHz	may have partially overlapping service areas;
400 kHz	may not have overlapping service areas, except if they carry identical programs when a small overlap may be permissible;
200 kHz, 0 kHz	will not be assigned to the same or adjacent service areas.

3B.2.5 Stations with wide geographical separation

Stations will not be assigned frequencies separated by less than 400 kHz unless the necessary protection ratios are met.

3B.3 Channels

Each channel is designated by its nominal carrier frequency.

The channels are spaced every 200 kHz between 88 MHz and 108 MHz, starting at 88.1 MHz, i.e. 88.1, 88.3, 88.5 ... 107.7, 107.9 MHz. Where necessary, to optimise channel allotments, a frequency offset of 100 kHz may be used.

3B.4 Receiving antenna system

3B.4.1 Polarisation

Polarisation of transmissions may be horizontal, vertical or mixed (circular, 45° slant); mixed polarisation is preferred. Optimum polarisation depends upon the type of service intended (i.e. fixed installations or mobile) and upon the terrain. Both horizontally and vertically polarised receiving antennas are expected to be widely used.

These guidelines are therefore based on mixed polarisation; the orthogonal discrimination of receiving antennas must not be used in planning services.

3B.4.2 Directivity

It is recognised that most receiving antennas have poor directivity. However, if necessary, up to 6 dB directivity for all azimuth angles greater than 90° from the wanted signal may be assumed for planning purposes (Recommendation 419[43]).

3B.5 Coverage criteria

3B.5.1 Coverage area

The coverage area of a transmitter is the area in which a specified standard of reception can be obtained with a reference receiver and antenna installation at 50% of locations.

The edge of the coverage area occurs at the point where the median field strength has fallen to the 'usable field strength', a figure set by interference from other unwanted signals or receiver noise (3B.7). In addition, adequate coverage requires freedom from subjective degradation by multi-path distortion and man-made noise.

Coverage of a proposed service area may be estimated from a knowledge of the coverage achieved by existing services at the proposed transmitting site. If the service is not to be co-sited with other services then it may be necessary to conduct a propagation test from the proposed transmitting site. The transmitting antenna height needs to be as close as practicable to that of the proposed service to enable an accurate estimate of coverage to be made. The effect of any potential sources of interference can also be more reliably assessed through examination of existing services or by conducting propagation tests.

Where suitable field strength measurements cannot readily be undertaken, calculation methods may be used to assist with estimating coverage and likely interference levels (refer to part 2). However, there are inherent inaccuracies in propagation predictions and they should be treated with caution.

3B.5.2 Field strength predictions

Field strength predictions are estimated at a receive antenna height of 10 metres above ground level.

3B.5.3 Minimum field strength values

The field strengths (from Recommendation 412[43]) listed in table 3B.2 are considered to provide adequate reception in the absence of interference from other radio services. The field strengths for urban and suburban areas allow for the normal generation of electrical interference by domestic and industrial equipment.

Table 3B.2
Minimum Field Strength for Adequate Reception of FM Transmissions in the Presence of Noise
(50% of receiving locations, 50% of the time)

Environment	Mono	Stereo
Rural	48 dBµV/m (0.25 mV/m)	54 dBµV/m (0.5 mV/m)
Suburban	60 dBµV/m (1.00 mV/m)	66 dBµV/m (2.0 mV/m)
Urban	70 dBµV/m (3.00 mV/m)	74 dBµV/m (5.0 mV/m)

'**Urban**' refers to a significant area with buildings predominantly more than two stories high.

'**Suburban**' refers to a significant area occupied predominantly by single or two storey dwellings, either single or multi-unit.

For planning purposes it may be assumed that the central core of cities of more than 20,000 people is 'urban' and that communities of more than 200 people are 'suburban'. However, planners may propose other classifications if they consider that special circumstances apply to a particular town or city. Such circumstances could include atypical development, or high levels of electrical noise.

'**Rural**' refers to those areas which have not been classified as 'urban' or 'suburban'.

Planning for metropolitan areas and country towns is to be based on stereophonic reception. The field strength required for a suburban environment is considered to be generally adequate for mobile reception as long as the field strength for the vertically polarised component is in accordance with that given in the table.

3B.5.4 Maximum field strength

Transmitting stations shall be located so that not more than 1% of the total population throughout the service area reside in an area which has a field strength greater than 110 dBμV/m. The relative height of the transmitting antenna above ground level and its vertical radiation pattern may be used to assist in meeting this condition.

Under no circumstances should a transmitting facility be sited so that a significant proportion of the population to be served receives a field strength of more than 120 dBμV/m (1 V/m). (A 'significant proportion' constitutes 0.1% of the population or 100 persons, whichever is less.)

Note that these are maximum levels, based on the signal handling capabilities of receivers in the absence of specific interference mechanisms. Where a specific interference mechanism exists it may further limit the maximum field strengths which can be used. For example, where a VHF-FM service is to be sited close to or within a town with rural grade VHF television coverage, lower levels of field strength will probably be necessary if interference to television reception is to be avoided (3C.8.2 and 3C.BB.1.7).

3B.5.5 Protection of existing services

Within the service area of a station, its signals will be protected from significant interference from other services provided that its field strength equals or exceeds the values for stereo reception given in table 3B.2. For example, a station which serves rural areas will have any parts of it with a field strength of 54 dBμV/m (0.5 mV/m) or more protected from interference. Stations which have no rural areas (e.g. low power metropolitan stations) will have any parts of their service area with a field strength of 66 dBμV/m or more protected from interference.

Outside the specified service area no protection against interference will be provided.

If an existing service is modified to provide at least 54 dBμV/m (or 66 dBμV/m in a suburban area) to an area within its service area which did not previously receive 54 dBμV/m (or 66 dBμV/m) reception in this area will be protected against interference as far as is practicable.

3B.6 Interference and usable field strength

Interference from other services may cause higher levels of field strength to be necessary for an adequate service than the minimum field strengths specified in the table of 3B.5.3. The level of field strength needed to provide adequate reception in the presence of an interfering signal(s) is referred to as the usable field strength (Eu).

The Eu for a particular interfering signal considered to be acting alone is calculated as the algebraic sum of the required RF protection ratio (see glossary) and the field strength of the particular interfering signal (in dB). The protection ratios required are discussed in the following sections.

Where there are several interfering signals, the Eu of each considered to be acting alone is calculated separately and combined by the process described in 3B.10. If an existing service has its Eu increased by a new or proposed service when calculated by this process it is considered to suffer interference. A service is said to be protected when planning proceeds on the basis that it will not be allowed to suffer interference as defined above.

If the Eu, as calculated above, is less than the minimum field strength in table 3B.2, the minimum field strength figure shall be used; if the Eu, as calculated above, is greater, the calculated Eu shall be used.

3B.6.1 Continuous and tropospheric interference

Different values of protection ratio are specified for interference which is continuous, and interference which has level variations due to propagation effects (tropospheric interference).

The protection ratios given for tropospheric interference are for field strengths which are not exceeded for more than 10% of the time. These field strengths may be predicted using the curves at figures 22 and 23.

3B.7 Interference between VHF - FM services

3B.7.1 Co-channel and adjacent channel interference

The following protection ratios, based on Recommendation 412[43] and local measurements, in terms of wanted to unwanted field strengths are considered adequate to overcome interference from other VHF-FM services.

Table 3B.3
Protection Ratios VHF-FM Services
(based on the provision of a stereo service)

Nominal Frequency Difference	Stereo	
	Continuous Interference	Tropospheric Interference
0 kHz: co-channel	45 dB	37 dB
100 kHz: half channel	42 dB	34 dB
200 kHz: adjacent channel	25 dB	17 dB
300 kHz	4 dB	0 dB
400 kHz	-18 dB	-18 dB
500 kHz	-19 dB	-19 dB
600 kHz	-20 dB	-20 dB
700 kHz	-22 dB	-22 dB
800 kHz	-24 dB	-24 dB

3B.7.2 Intermodulation interference between VHF-FM services

Third order intermodulation ($F_1 = 2 \times F_2 - F_3$; where F_1 is wanted; F_2 and F_3 are interfering) is a significant interference mechanism with 800 kHz spacing between carrier frequencies[50]. It is level dependent and above 75 dBμV/m may cause performance degradation in receivers with efficient receiving antennas even though all signals have the same field strength. Because domestic and mobile FM receivers generally have low height and inefficient antenna systems, these effects do not occur in practice until much higher field strengths. At normal field strengths intermodulation products from other VHF-FM services will not generally be a problem provided that the signal levels of all services are maintained as closely as possible at the same level.

Intermodulation is an important form of degradation and should be minimised as far as possible by the use of shared transmitting antennas and similar transmitter powers for those frequency triads causing intermodulation. If antenna sharing is not possible, co-sited transmitters with antenna patterns designed as far as possible to provide similar signal strengths, particularly above 75 dBμV/m, should be used.

Where, for some reason, unequal transmitter powers are used at a site, frequencies should be arranged as far as possible to minimise possible interference between intermodulation triads.

3B.7.3 I.F. Interference between VHF-FM services

Limitations are placed on assignments for transmitters whose coverages overlap in areas of high signal strength and whose difference in carrier frequency is close to the FM receiver intermediate frequency (10.7 MHz). The interference depends on the absolute level of the unwanted signal at the receiver input, and the actual frequency difference[50]. Based on a notional receiving antenna and an expected spread of field strengths with location, interference may be expected to become significant when the field strength of the unwanted signal exceeds the value in the table:

Table 3B.4
Maximum Field Strength

Frequency Difference (MHz)	10.7	10.6, 10.8	10.5, 10.9	10.4, 11.0	10.3, 11.1
Max Field Strength (dBµV/m)	66	74	90	100	105

Assignments with frequency differences of 10.7 ±0.2 MHz should also be avoided in communities which have relatively few radio broadcasting channels in use, in order to eliminate the possibility of local oscillator interference. Assignments in areas which have large numbers of radio broadcasting channels in use should minimise the incidence of frequency differences of 10.7 ±0.2 MHz where possible.

3B.7.4 Receiver generated interference

Not withstanding that 96.3 MHz and 107.1 MHz are the ninth and tenth harmonics of the 10.7 MHz IF, with the possibility of interference, they may be freely assigned to any service.

3B.8 Interference from VHF-FM to television and other services

VHF-FM services may directly interfere with television channels 3, 4 and 5 because they occupy the same frequency band; they may indirectly interfere with other VHF television channels by the generation of intermodulation and harmonic products within the television receiver. They may also interfere with non-broadcasting services in adjacent bands.

3B.8.1 Interference to channels 3, 4 or 5 television services

VHF-FM services shall be planned to avoid interference to television services operating on channels 3, 4 and 5, using the following procedure:

. find the field strength of the desired television service at the service area boundary closest to the FM transmitter using field strength coverage maps, if available, or by calculation (denote this value or 50 dBµV/m, whichever is the greater, by F_1);

. calculate the field strength at this location, of the interfering FM station from figure 22 if the interference is tropospheric; or figure 21 if the interference is continuous (denote this value by F_2);

- determine an allowance for rejection of the unwanted signal by the television receiving antenna from 3.C.4 (denote this value by F_3. which will be negative since it describes attenuation of the unwanted signal);
- the wanted/unwanted signal strength ratio (R) is given by:

  $R = F_1 - (F_2 + F_3)$ (where all values are in dB)
- frequencies will not be assigned where R is less than the required protection ratios given by the appropriate curve (A, B or C) of figure 68;
- the choice between curves A, B and C is made as follows:

  curve A sizeable towns
  curve B well populated rural areas
  curve C sparsely populated areas.

Where FM transmitters are co-sited with television transmitters operating on channel 3, 4 or 5 and the services have similar power levels, the following restrictions on frequency assignments are applied:

Table 3B.5
Channel Restrictions (Band II Television)

TV Channel	FM Frequency Range Not Permitted
3	88.1 - 94.9 MHz
4	89.1 - 103.9 MHz
5	96.1 - 107.9 MHz

3B.8.2 Intermodulation interference from VHF-FM stations to TV services

Very strong VHF-FM signals may generate harmonics or intermodulation products in the RF stages of TV receivers, which can cause interference if the frequency relationships are correct.

Co-sited VHF-FM and TV transmitters may be assumed to be free of this kind of interference. Where a VHF-FM station is within, or close to, the service area of a TV transmitter and is not co-sited, interference to television reception may occur when the VHF-FM signal is within the following frequency ranges:

Table 3B.6
Frequency Ranges Causing Intermodulation Interference with Television Reception

TV Channel	Mechanism	FM Frequency Range	Protection Ratio
0	RF = FM - 0	91.3 - 98.3 MHz	
1	IF = FM - 1	88.5 - 94.1 MHz	
2	IF = FM - 2	95.5 - 101.1 MHz	
5A	IF = 5A - FM	101.3 - 106.9 MHz	
6, 7, 8, 9, 10, 11	RF = 2×FM or RF = $FM_1 + FM_2$	as appropriate	-20 dB

The above frequency assignments are to be avoided where possible. If they cannot be avoided then they may be used, subject to the following provisos:

- that the VHF-FM transmitter is sited so that the population receiving a high field strength from it is kept as low as possible (usually the requirements of 3.B.5.4 will be adequate); and
- that the area concerned is not within the service area of a Band II television service.

Intermodulation interference can be avoided if TV receivers are fitted with filters to reject the unwanted signals, although this will be difficult if a substantial proportion of the population have masthead amplifiers. Figure 69 shows the protection ratios necessary to avoid intermodulation interference for most TV receivers not fitted with filters.

3B.8.3 Secondary causes of VHF-FM interference to television reception

Interference to reception of channels 4 or 5 may occur due to FM receiver local oscillator radiation.

Where there is a community which receives a field strength of less than 70 dBμV/m of the desired channel 4 or 5 service an FM service which might be received in that town should have the following restrictions applied:

Table 3B.7
Channel Restrictions for Interference to Television FM - Local Oscillator Interference

TV Channel	FM Frequency Range Not Permitted
4	88.1 - 89.3 MHz
5	91.1 - 94.3 and 95.3 - 96.3 MHz

3B.8.4 Interference to aeronautical services

The only non-broadcasting services immediately adjacent in frequency to the FM band are the aeronautical services above 108 MHz.

3B.8.5 Adjacent channel interference to aeronautical services

Frequency assignments for wide and medium coverage stations near the upper edge of the band will be co-ordinated by the Department with the appropriate aviation authority.

3B.8.6 Local oscillator interference to aeronautical services

The local oscillator frequency of FM receivers falls in the band segment 98 MHz to 118.6 MHz, the upper part of which (108 MHz upward) is used for aeronautical services. Use of FM channels which result in receiver local oscillator frequency falling on, or within, 15 kHz of local aeronautical services will be co-ordinated by the Department with the appropriate aviation authority.

3B.8.7 Second harmonic interference to aeronautical services

VHF-FM transmitters sited near airports may interfere with DME equipment operating at 206 MHz. Frequency assignments near 103 MHz for wide and medium coverage services will be co-ordinated by the Department with the appropriate aviation authority.

3B.8.8 Intermodulation interference between services

This form of interference occurs in the presence of one or more strong unwanted signals when the nonlinearity of a receiver front end generates intermodulation products which fall within the bandwidth of the receiver tuned to the wanted service:

e.g. $F_1 \pm F_2 = F_3$ or $2 \times F_1 \pm F_2 = F_3$ etc.

where F_1 and F_2 are unwanted and F_3 is the wanted signal.

A similar effect may occur when one of the signals is wanted and the unwanted signal is close to a frequency multiple of the wanted signal. This results in a spurious signal being generated which is close in frequency to the wanted signal:

e.g. $F_1 - n \times F_3 = F_3$

where F_1 is the unwanted and F_3 is the wanted signal.

Where such intermodulation products arise and F_3 is the product equal in frequency to an in band frequency of a wanted:

- TV service: the signal strengths of F_1 and/or F_2 should not exceed the signal strength of the wanted (vision) carrier by more than 7 dB (high field strength areas only, nominally >80 dBµV/m unwanted field strength levels);

. VHF-FM service similar to TV;

. aeronautical the signal strengths of F_1 and/or F_2 should not exceed the signal strength of the wanted carrier by more than 50 dB (high field strength areas only, nominally 90 dBμV/m unwanted field strength levels).

Note: Interim figures only. This matter is under review. F_1 and/or F_2 may represent an FM carrier, a TV vision carrier or sound carrier or any other RF source.

3B.9 Interference to VHF-FM from television and aeronautical services

3B.9.1 Band II television to VHF-FM service interference

Except where a frequency is selected for a proposed VHF-FM service which is close in frequency (within ±200 kHz) to the TV carrier or sub-carrier frequencies, it is unlikely that reciprocal interference (from the TV service to the VHF-FM service) will be encountered. However, care should be taken to confirm this on a case by case basis.

Where a planned VHF-FM service is close in frequency to the vision carrier, sound carrier or colour sub-carrier frequency of a nearby TV service, the protection ratios specified as being necessary to overcome VHF-FM to VHF-FM interference shall be used (3B.6.1) to determine whether interference would be likely to occur to the VHF-FM service.

3B.9.2 Interference from channel 0 television stations

Interference from channel 0 to VHF-FM reception may be caused by the generation of second harmonics of the channel 0 carriers in the RF stages of VHF-FM receivers. To avoid this, VHF-FM channels at twice the frequency of TV channel 0 carriers shall only be used in areas served by TV channel 0 if the channel 0 and VHF-FM stations are co-sited, or alternatively if the field strength of TV channel 0 in the same service area common to it and the FM service is everywhere less than 90 dBμV/m (3B.8.2).

3B.9.3 Image interference to VHF-FM reception from aeronautical services

Image interference is not considered to be a significant problem in relation to the planning of VHF-FM services. Under certain circumstances, a small proportion of VHF-FM receivers may suffer interference from image signals (i.e. signals twice the IF above the wanted channel). This is likely to be a problem with some receivers operating in fringe areas in the vicinity of airports or aeronautical installations having transmitters operating on the image frequency of the station to which the receiver is tuned, or on flight paths of aircraft using the image frequency.

3B.10 Calculation of interfering signal levels

The prediction of interfering signal levels is used to determine:

- the effect on other services; and
- the cumulative effect on the proposed service from several sources of possible interference.

Under most circumstances, interfering signal levels may be calculated with sufficient accuracy by using the curves for field strength exceeded at 50% of locations for 10% of the time for tropospheric, or 50%/50% curves for continuous interference. These curves are reproduced in figures 21 to 23 inclusive.

3B.10.1 Interference contributions from several stations

The calculation of the effective interference level (Eu) in the presence of a number of sources of interference (due to co-channel, adjacent channel or receiver characteristics) is to be performed as follows.

Considering the contribution of each interfering signal acting alone in order of decreasing magnitude, add the squares of the voltages of the usable field strength (Ea) and extract the sum, excluding those components whose voltages are more than 6 dB below the root sum squared value (expressed in decibels) of the higher components already included.

The root sum square process may be calculated in decibels using the relationship:

$$Eu = 10 \log \sum 10^{(0.1\ Ea)}$$

where:

Ea is the voltage of an individual contribution.

3B.11 Effective radiated power (ERP)

3B.11.1 Practical tolerances on effective radiated power

The tolerance applied to the ERP shall be kept to a practical minimum. Typical limits for an omnidirectional service are ±2 dB. Greater limits may be specified where it is considered necessary, e.g. antennas mounted on the side of existing television support structures.

3B.11.2 Maximum value of effective radiated power

There is no specific maximum value of ERP designated for FM transmitters. The required value will depend upon the size of the service area, the effective height of the transmitting antenna and the field strength required to provide adequate reception throughout the service area, but interference to other services may limit the permissible ERP and the maximum height of the antenna. Multiple transmitters may be necessary if the service area cannot be covered from a single transmitter.

3B.12 Transmitting antenna radiation pattern

The design of an antenna may provide for either an omnidirectional or a directional horizontal radiation pattern. In addition to the selection of the horizontal pattern in azimuth, the amount of beam tilt and null fill may also be controlled to improve coverage of the service area.

3B.12.1 Beam Tilt

Beam tilt shall be specified for antennas having a relatively narrow vertical radiation pattern, in order to aim the axis of the main vertical beam for optimum coverage of the service area. If the service area extends to (or beyond) the horizon, depression angle at the far edge of the service area may be calculated from:

$$\text{depression angle (degrees)} = 0.0277\sqrt{h}$$

where:

h is the antenna height in metres above the service area.

The beam tilt angle specified may be varied somewhat to suit the width of the vertical radiation pattern, the expected tower sway and so on. In some cases, additional beam tilt may be required to improve close-in coverage, by directing the peak of the main lobe of the vertical radiation pattern at the principal community within the service area.

3B.12.2 Null fill

Null fill is necessary if reception is required at depression angles where a null exists in the vertical radiation pattern of the transmitting antenna - generally for areas close to the transmitter. Null fill shall be specified as a percentage of the maximum relative field, over a specified range of depression angle.

Depression angle below the horizontal may be calculated approximately by:

$$\text{depression angle (in degrees)} = 0.057\left(\frac{h}{d}\right)$$

where:

h is the transmitting antenna height in metres above the area in question

d is the distance in km to the receiving location.

3B.12.3 More complex patterns

Planning considerations may require other constraints to be placed on the vertical radiation pattern:

. it may be necessary to limit the radiation at high depression angles, to avoid high field strengths very close to the transmitter; and

- a more detailed specification of the vertical radiation pattern may be necessary either to optimise field strengths or to reduce the difference between the field strengths produced by the proposed antenna and the antennas of other services.

3B.12.4 Polarisation

Mixed polarisation is preferred. Horizontal or vertical polarisation should only be considered where there are compelling reasons.

3B.13 Siting of transmitters

3B.13.1 Transmitter site selection

Transmitter sites shall be chosen so that field strengths consistent with the guidelines are provided within the service area. Where coverage is doubtful, it is desirable to conduct propagation tests to resolve any uncertainties. Test transmitters should employ an antenna height likely to be used by the proposed service if at all possible. The sites and the ERPs proposed shall be such that the maximum field strength provisions of 3B.5.4 are met, and that unacceptable interference is not caused to other services.

Note that high power VHF-FM radio services may cause serious interference to communications services at the same site, even though the VHF-FM broadcasting service complies with the requirements for out of band radiation and is well separated in frequency from the other services.

As soon as the transmitter site has been selected, the licensee or a body to whom a licence has been offered is required to advise its precise location to the Department. The following details should be forwarded to the State Broadcasting Engineer:

- Australian Metric Grid (AMG) co-ordinates of the transmitter site specified to within preferably 10 metre accuracy; and
- the common name of the site.

The licensee has the responsibility of co-ordinating (prior to installation) with other radiocommunication users established at or adjacent to the site to ensure that operation of the transmitter is compatible with existing services. In other words the licensee is required to take any necessary steps to ensure that radio interference is not caused to other users. A list of users operating at particular sites can be obtained from the State Manager, Radio Frequency Management, of the state concerned.

Transmitting stations shall be sited and designed with due regard to AS2772 (safe limits for electromagnetic radiation).

Sites shall be selected which are not a hazard to air navigation and which have a minimum intrusion on the environment. The planner is responsible for obtaining all necessary approvals from federal, state and local government planning authorities.

Within a service area, as far as possible new VHF-FM radio transmitters should be co-sited with existing VHF-FM radio or television transmitters. Sharing of facilities (tower, antenna, etc.) is preferred where the services are intended to serve the same region. Where stations are co-sited but do not share antennas and/or support structures, the spacing, orientation and height of the support structures and the mounting of the transmitting antennas shall be such as to prevent significant reflections, or re-radiation.

Where stations are not co-sited, the interference requirements of these guidelines will often limit the ERP and hence the coverage below that necessary to cover the service area.

3B.13.2 Siting of high and medium power stations – State capital cities

In the capital cities the dual requirements for the minimisation of interference to television signals and maximisation of productivity of spectrum available for FM services demand that medium and high power VHF-FM transmitting facilities be sited in the immediate proximity of each other and the local television transmitting facilities. It is desirable for all such transmitting facilities to share the same antenna support structure.

The intent of this requirement is to ensure that relative field strength levels may be held within design limits over the bulk of the designated service area. The maximum physical separation between transmission facilities will depend upon a variety of conditions including relative transmitting antenna gains and their horizontal and vertical radiation patterns; position of service areas with respect to transmitter location, etc. Consequently, it is not possible to define explicitly a maximum permissible separation which would ensure that the proximity condition is met. Each case will have to be considered upon its own merits.

3B.13.3 Siting of high and medium power stations – Large towns and environs

In these areas there are usually fewer radio services in all classes and hence there is greater freedom for the allotment of channels to VHF-FM broadcasting services. Where possible, services are to be co-sited.

However, the location of high power television transmission facilities serving large areas may not always be suitable for medium power VHF-FM transmitting facilities where the VHF-FM service has a significantly different service area. Siting of medium power facilities shall be such that there is no significant population within the area where its field strengths is more than 20 dB above that of the local TV and high/medium power services.

When co-siting is not a practical proposition, the transmitter site may be located at, or near, the centre of its intended service area, taking into account conditions such as topographical features affecting coverage, the location of the principal population centres within the service area and interference mechanism covered in these guidelines. Alternatively, if topographic conditions are favourable, it may be possible to establish the site to one side of the area and employ a directional antenna system.

3B.13.4 Siting of low power transmitting facilities

Low power transmitting facilities (ERP of the order 1 kW or less) will in general not be sited in the same general area as the TV and wide/medium power FM transmitting facilities. Therefore, particular care will need to be taken to avoid interference to TV and other FM services. In addition, directional transmitting antennas may need to be used to provide protection to low power FM services in adjacent areas. It is desirable that transmitting sites be located with respect to the service area so as to permit the use of simple transmitting antennas and low power transmitters. It is considered undesirable to use transmitting sites with heights greatly in excess of that required for coverage of the service area.

The peak effective radiated power of a low coverage transmitting facility will not in general be permitted to exceed 1 kW. This requirement may often mean placing the transmitter at, or close to, the centre of the service area.

3B.14 Off-air relay sites and transposers

Transposers need to be sited in locations which provide both a direct line of sight into the required service area and adequate off-air reception in terms of:

- input signal levels from the wanted parent transmitter;
- level of interference from other transmitters; and
- multipath propagation (ratio of wanted to unwanted input signal levels less than 20 dB).

3B.14.1 Input signal levels

The input signal into 50 ohms required for an output signal to noise ratio of 52 dB weighted quasi-peak, assuming equipment noise figures of 5 dB and allowing for cosmic noise and the noise contributions of the transmitter and studio transmitter link, is 0.25 mV.

A signal to noise ratio of 52 dB is applicable to very large installations. For installations serving small communities of approximately 1000 people, an input signal of 0.1 mV will be considered acceptable if it is the best that can reasonably be achieved.

Reliability calculations will not normally be required. The input signals specified provide considerable fading margin and most off-air propagation paths are expected to be relatively short.

3B.14.2 Off-air relay site receiving antenna characteristics

In assessing the level of co-channel interference caused to existing off-air relay installations by a proposed new service, it may be assumed that the existing installation has higher levels of directivity and orthogonal polarisation discrimination than those of the reference receiving system of 3C.15. The levels to be used are set out in table 3B.8.

In planning a new off-air relay installation, it is expected that the above figures will also be used in assessing levels of co-channel interference. Higher values of discrimination may be used, but they will be accepted only if supported by detailed design calculations or by actual measurements. Off-air relay installations are not considered to be subject to any forms of interference other than co-channel interference (and thermal and man-made noise).

Table 3B.8
Co-channel Interference
Antenna Directivity Assumptions for Translators

	Band I	Band II	Band III
Directivity Discrimination (same polarisation)			
0 dB discrimination from 0° to:	40°	40°	30°
Rising linearly to:	70°	70°	60°
With a discrimination of:	10 dB	12 dB	15 dB
Orthogonal and Directivity Discrimination (cross polarisation)			
Discrimination on main axis:	15 dB	15 dB	15 dB
Rising linearly - from:	NA	NA	20°
- to:	NA	NA	60°
With discrimination off axis of:	15 dB	15 dB	20 dB

3B.15 Reference receiver

Preliminary specifications for the reference domestic FM receiving installation are being prepared. Final specifications are to be developed by the Department in consultation with the industry.

Until these specifications are prepared the relevant sections of 3B.4 and 3B.7 are to be used as the basis for planning.

VHF-FM RADIO
SUMMARY OF REQUIREMENTS

Guide-lines Para.	**Interference Mechanism**	**Exclusions**	**Protection Ratio**		**Min. Field Strength**	**Comments**
			Steady	**Tropo.**		
	<u>Co-sited Stations</u>					Co-sited means all stations in each service area are co-sited. Obviously co-channel interference will come from stations in other service areas.
	<u>FM to FM</u>					
3B.7.1	Co-channel	F	45 dB	37 dB		Separate non-adjacent service areas.
3B.7.1	First adjacent channel	F ± 200kHz	25 dB	17 dB		Separate non-adjacent service areas.
3B.7.1	Second adjacent channel	F ± 400kHz	-18 dB	-18 dB		Can be used for adjacent but not overlapping areas.
3B.7.1	Third adjacent channel	F ± 600kHz	-20 dB	-20 dB		Can be used for partially over-lapping areas.
3B.7.1	Fourth adjacent channel	F ± 800kHz	-24 dB	-24 dB		Can be used for same area if field strength differential is less than 20 dB.
3B.7.3	IF beats	10.5 MHz $<F_1 - F_2<$ 10.9 MHz	NA	NA		High field strength areas only. In very high field strength areas 10.4 MHz $<F_1 - F_2<$ 11.0 MHz
3B.5.3	Man-made and receiver noise: - rural - suburban - urban				 0.5 mV/m 2.0 mV/m 5.0 mV/m	 54 dBµV/m 66 dBµV/m 74 dBµV/m
3B.7.4	Self-generated (F=9×IF)	96.3 MHz				Under investigation

VHF-FM RADIO
SUMMARY OF REQUIREMENTS (continued)

Guide-lines Para.	Interference Mechanism	Exclusions	Protection Ratio	Min. Field Strength	Comments
	<u>FM to TV</u>				
3B.8.1	Interference dist TV channels 3, 4 and 5	FM near TV channels	see fig. 68		
3B.8.1	Interference to co-sited TV channels 3, 4 and 5	*			* ch 3, 88.1-94.9 MHz ch 4, 89.1-103.9 MHz ch 5, 96.1-107.9 MHz
3B.8.3	FM local oscillator	#		70 dBµV/m (>100 people)	# ch 4, 88.1-89.3 MHz ch 5, 91.1-94.3 and 95.3 MHz
	<u>TV to FM</u>				
3B.9.1	Co-channel and adjacent		see table 3B.7.1		Insignificant when the difference between carriers is > 200 kHz.
	<u>Non Co-sited Stations</u>				
	<u>FM to FM</u>				
3B.7.2	Intermodulation $F_3 = 2F_1 - F_2$	$F_3 = 2F_1-F_2$			A problem for high levels of unwanted signals and low levels of wanted signals with close frequency spacing (1 MHz).

VHF-FM RADIO
SUMMARY OF REQUIREMENTS (continued)

Guide-lines Para.	Interference Mechanism	Exclusions	Protection Ratio	Comments
	FM to TV			
3B.8.2 & 3C.15	Intermodulation with TV channel:			Not a problem if TV and FM transmitters are co-sited. Interference can be avoided by use of FM rejection filters if necessary.
	channel 0: FM - TV = ch 0 band	91.3-98.3 MHz		
	channel 1: FM - TV = TV IF band	88.5-94.1 MHz		
	channel 2: FM - TV = TV IF band	95.5-101.1 MHz		
	channel 5A: TV - FM = TV IF band	101.3-106.9 MHz		
	Band III TV: $FM_1 + FM_2$ = TV ch #		1.0 mV -13 dB 3.2 mV -10 dB	# High field strength areas only (> 90 dBµV/m for the wanted service).
	Band III TV: 2×FM = TV ch #		1.0 mV -13 dB 3.2 mV - 7 dB	
3C.15	Cross modulation by FM		1.0 mV -47 dB 3.2 mV -46 dB	
	TV to FM			
3B.9.2	Second harmonic of TV channel 0 carriers	92.5, 101.3 and 103.5 MHz		
3B.8.8	TV band III - FM = FM		- 20 dB	High field strength areas only (> 90 dBµV/m for the wanted service).
	Aviation Services			
	Aviation to FM			
3B.9.3	Image inter-ference to FM from aeronautical services	FM = freq. A.S. - 21.4 MHz		Only a problem with low quality receivers in fringe areas near airports or aero-nautical installations.

VHF-FM RADIO
SUMMARY OF REQUIREMENTS (continued)

Guide-lines Para.	Interference Mechanism	Exclusions	Protection Ratio	Comments
	<u>FM to Aviation</u>			
3B.8.5	Adjacent channel: - wide coverage - med. coverage	 >107.5 MHz >107.7 MHz		Co-ordinate with aviation.
3B.8.6	FM Receiver LO radiation	97.3-108 MHz		Co-ordinate with aviation.
3B.8.7	DME = 2×FM (wide and medium coverage services only)	102-104 MHz		Co-ordinate with aviation.
3B.5.4	Maximum field strength	>110 dBμV/m		1% of service area population.
		>120 dBμV/m		Lesser of 0.1% or 100 people.

PART 3C: VHF/UHF TELEVISION

3C.1 Introduction

Part 3 of the Planning Guidelines provides basic information for planning broadcasting services. Part 4 provides supplementary notes. The section numbers correspond with those of part 3 to assist in referring to topics that may need further elaboration.

For example, Television Coverage Criteria is under 3C.5 and a further explanation is given in 4C.5.

The letter 'C' refers to television, 'A' to MF radio and 'B' to VHF FM radio.

The propagation calculations required for planning of television services are dealt with in part 2.

3C.2 Frequency assignment

3C.2.1 General consideration

In order to utilise the television bands as efficiently as possible the Department has prepared national channel allotment plans. These plans specify the channels to be used for transmitters and transposers within the service areas of existing terrestrial television broadcasters.

In general, therefore, it will not be necessary to allot channels, and the planning work will be restricted to site selection and setting the ERP so that the protection criteria of the planning guidelines are met.

Occasionally a new requirement, not covered by the channel allotment plan, will arise within the service areas of the existing television broadcasters, and in those cases the frequency selection procedures of 3C.2.2 should be followed. Assignment of channels in remote areas is covered in 3C.2.3.

3C.2.2 Channel selection procedure

Channels are selected in accordance with the procedure outlined below:

(a) determine potentially suitable channels based on co-ordination with existing and planned television and radio services by reference to the national channel allotment plan, or by use of the simplified channel selection procedures of 3C.2.3;

(b) select transmitter site(s) suitable to ensure adequate coverage of the proposed service area;

(c) for the selected site(s) calculate the required effective radiated power (ERP) at various bearings to provide adequate coverage of the proposed service area;

(d) calculate resultant signal levels and hence achieved protection ratios at the boundary(ies) or other critical zones of existing or planned television services which have common or adjacent channels with the proposed television service;

(e) calculate reciprocal signal levels and hence achieved protection ratio(s) at the proposed service area boundary (repeat as necessary for all potentially available channels);

(f) based on the results of (d) and (e) select a suitable channel (if any) from those determined in step (a); and

(g) if there is no satisfactory result, review the available transmitter sites, and, if possible the proposed service area, with a view to reducing the ERP in the direction of the radio or television services causing the difficulties, and repeat steps (c) to (f).

3C.2.3 Simplified planning rules for remote areas

Simplified channel selection rules are applied in remote areas. ‘Remote areas’ can, in general, be taken as the area outside the service areas of existing terrestrial television broadcasters. However, the service areas of Broken Hill, Mt Isa, Darwin and Kalgoorlie are included in the remote area.

Frequency selection is made from the following table, for the particular type of service required:

Table 3C.1
Standard Television Channel Groups-Remote Area Planning

Service	First Choice	Second Choice	Third Choice	Transposers
Unassigned	Ch 60 (751.25 MHz)	Ch 59 (744.25 MHz)	Ch 58 (737.25 MHz)	Ch 45 (646.25 MHz)
Unassigned	Ch 63 (772.25 MHz)	Ch 62 (765.25 MHz)	Ch 61 (758.25 MHz)	Ch 48 (667.25 MHz)
Commercial	Ch 66 (793.25 MHz)	Ch 65 (786.25 MHz)	Ch 64 (779.25 MHz)	Ch 51 (688.25 MHz)
ABC	Ch 69 (814.25 MHz)	Ch 68 (807.25 MHz	Ch 67 (800.25 MHz)	Ch 54 (709.25 MHz)

An appropriate channel from the first choice group is chosen and checked by the procedure of 3C.2.2 to see if it can be assigned. If it is not possible to assign the first choice channel then the appropriate second choice channel is chosen, and if the second choice assignment is not possible, then the third choice channels are used. The transposer group is provided for use where the input signal is provided by off-air reception of one of the three first choice groups, and it is necessary to avoid adjacent channel transposition problems.

VHF channels may be assigned:

- where a VHF channel is already established;
- the additional service will operate from the same site (not necessarily shared);
- only one additional service is proposed; and
- a band III channel is available.

3C.2.4 Channel assignment limitations

Channel assignment is affected by the presence of existing co-channel and/or adjacent channel services and limitations in the ability of the television receiver to reject unwanted signals. Limitations are placed on channel assignments as set out below.

3C.2.5 Limitations imposed by co-channel services

The same channel will not be assigned to services which have coverage areas which overlap or coverage areas which are immediately adjacent.

3C.2.6 Limitations imposed by receiver adjacent channel characteristics

VHF Channels which are contiguous will not be assigned to services with similar coverage areas. (For planning reasons UHF channels will be usually separated by two channels at any one site.)

Table 3C.2
Adjacent Channel Exclusions

	Channel in Use	Channel Excluded
VHF	1	2
	2	1
	3	4
	4	3, 5
	5	4
	6	7
	7	6, 8
	8	7, 9
	9	8
	10	11
	11	10
UHF	n	n + 1(2)

3C.2.7 Image interference limitations

No restrictions are placed on VHF channel assignment because of image interference, if the transmitters are co-sited and the lower frequency transmitter is of equal or greater power level than the higher frequency transmitter (both facilities with similar radiation patterns).

In other cases, a channel will not be assigned in an area if:

. its frequency difference with respect to the local oscillator frequency of television receivers tuned to another channel in the same area; or

. the frequency difference between another channel in the same area with respect to the local oscillator frequency of television receivers tuned to the wanted channel,

lies within the intermediate frequency pass band of the television receiver.

Table 3C.3
Image Interface Exclusion

	Channel in Use	Image Channel Excluded
VHF	2	5A
	5	6
	5A	10
UHF	n	n + 10

3C.2.8 Harmonic relationship limitations

A channel will not be assigned in an area where a low order harmonic of its vision or sound carrier lies within the frequency limits of another channel in use in the same area, unless the transmitters are co-sited and the higher frequency transmitter is of equal or greater ERP at all significant azimuth and depression angles than the lower frequency transmitter.

Table 3C.4
Harmonic Relationship Constraints

	Channel Proposed	Channel Harmonically Related
VHF	0	4
	0	5A
	2	8
	4	8
UHF	n	Nil

3C.2.9 Intermodulation limitations

The fifth higher channel of UHF channels will not be assigned in the same area. Channel 0 and channel 1 will not be assigned to television services in the same area, unless the transmitters are co-sited and of equal power level (both facilities with similar radiation patterns).

Table 3C.5
Intermodulation Constraints

	Channel Proposed (F_1)	Channel Affected (F_2)	Cause
VHF	0	1	$2 \times F_1 - F_2 = I.F.$
UHF	n	n+5	$F_1 - F_2 = I.F.$

3C.2.10 Channel band-plan restrictions

Channels 4, 5 (Band II FM) and 5A will not be assigned to new television services. Channel 0 is to be avoided where possible in urban environments.

Channel 3 will not be assigned in metropolitan areas. The retention of channel 3 in non-metropolitan areas will depend on FM demand and other factors.

Low power stations will be assigned UHF channels except in special circumstances.

Channels 36, 37 and 38 are shared on a primary basis with radionavigation services. Radio astronomy shares channels 39 and 40 on a secondary basis

3C.3 Channels

3C.3.1 Channel designation

A television channel is defined as a frequency band 7 MHz wide assigned to a television service. The channel accommodates vision and sound carriers and sidebands. Each channel is designated by a number or a number and an alphabetic character.

Channel frequencies are specified in terms of the vision carrier frequency, which is nominally 1.25 MHz higher than the lower frequency limit of the channel.

3C.3.2 Frequency allotment plans

A national plan has been developed for the UHF Band on the basis of 21 MHz spacing between vision carrier frequencies of services planned to share a common service area.

A frequency plan for VHF has been developed based on the existing assignments in this band and clearance of stations from Band II and Channel 5A.

3C.3.3 Channel bands and frequencies

The nominal frequency limits for Australian television services and details of Band occupancy are set out below.

Table 3C.6
Television Channel Frequency Limits

VHF		UHF			
BAND I (1)		BAND IV		47	659-666 MHz
0	45- 52 MHz	27 (5)	520-526 MHz	48	666-673 MHz
1	56-63 MHz	28	526-533 MHz	49	673-680 MHz
2	63-70 MHz	29	533-540 MHz	50	680-687 MHz
		30	540-547 MHz	51	687-694 MHz
		31	547-554 MHz	52	694-701 MHz
BAND II (1)		32	554-561 MHz	53	701-708 MHz
3	85-92 MHz	33	561-568 MHz	54	708-715 MHz
4	94-101 MHz	34	568-575 MHz	55	715-722 MHz
5	101-108 MHz	35	575-582 MHz	56	722-729 MHz
				57	729-736 MHz
		BAND V		58	736-743 MHz
BAND III		36	582-589 MHz	59	743-750 MHz
5A (2)	137-144 MHz	37	589-596 MHz	60	750-757 MHz
6	174-181 MHz	38	596-603 MHz	61	757-764 MHz
7	181-188 MHz	39	603-610 MHz	62	764-771 MHz
8	188-195 MHz	40	610-617 MHz	63	771-778 MHz
9	195-202 MHz	41	617-624 MHz	64	778-785 MHz
9A (3)	202-209 MHz	42	624-631 MHz	65	785-792 MHz
10 (4)	208-215 MHz (superseded)	43	631-638 MHz	66	792-799 MHz
	209-216 MHz (current)	44	638-645 MHz	67	799-806 MHz
11 (4)	215-222 MHz (superseded)	45	645-652 MHz	68 (6)	806-813 MHz
	216-223 MHz (current)	46	652-659 MHz	69 (6)	813-820 MHz
12 (3)	223-230 MHz				

Note 1 Television Band I (Channels 0, 1 & 2) and Band II (Channels 3, 4 & 5) are not being considered for new analog television services or for the introduction or ongoing transmission of digital television services.

Note 2 VHF Channel 5A is currently within the Broadcasting Services Bands (BSB) and has been recommended for clearance by the ABA and ACA to allow for the introduction of Low Earth Orbiting (LEO) satellites. Channel 5A is not being considered for new analog television services or for the introduction or ongoing transmission of digital television services.

Note 3 Clearance of radiocommunication services from 202-208 MHz and from 222-230 MHz has allowed a revised channel arrangement to be implemented. The current channel arrangement has two new channels (channels 9A and 12). To accommodate channel 9A, channels 10 and 11 were shifted up in frequency 1 MHz.

Note 4 The majority of existing services on channels 10 and 11 were assigned using the superseded channel arrangement. Services on channels 10 and 11 may be required to shift in frequency to align with the current channel arrangement. Any such requirement will be considered on a case-by-case basis. New services on channels 10 and 11 will be assigned according to the current channel arrangement i.e. channel 10 (209-216 MHz) and channel 11 (216-223 MHz)

Note 5 UHF Television Channel 27 has a bandwidth of 6 MHz and therefore is not currently suitable for digital television services. The ABA and ACA are considering ways of making use of channel 27 as a 7 MHz channel.

Note 6: The ABA and ACA are considering spectrum that may be re-allocated for non-broadcasting purposes due to the increased spectral efficiency with Digital Television. In particular the use of part, or the entire frequency band 806-820 MHz is under consideration. Where practicable the ABA will endeavour to avoid the use of channels 68 and 69.

Note 7: Offsets from these nominal channel frequencies may be applied. In the case of digital television offsets of +125 kHz and –125 kHz may be applied.

3C.4 Receiving antenna system

The guidelines assume that viewers' installations will be equipped with the receiving antennas specified in the reference television receiving system referred to at 3C.15.

Thus the field strengths of the various desired and undesired signals are considered to produce voltages at the receiver terminals which depend on the orthogonal and directivity discrimination of the receiving system.

3C.5 Coverage criteria

Within the service area of a station, its signals will be protected from significant interference from other services provided that its field strength equals or exceeds the values given in table 3C.8. As far as possible, the input signals to off-air relay points will also be protected.

Outside the specified service area no protection against interference will be provided.

If an existing service is modified to provide at least the field strengths of table 3C.8 to an area within its service area which did not previously receive this level, reception in this area will be protected against interference as far as is practicable.

3C.5.1 New services

As far as possible new services should be planned so that they do not suffer interference within their service area.

Outside the service area no protection against interference will be provided.

3C.5.2 Coverage area

The coverage area of a transmitter is the area in which a specified standard of reception can be obtained with a reference receiver and antenna installation at 50% of locations.

The edge of the coverage area occurs at the point where the median field strength has fallen to the 'usable field strength', a figure set by interference from other unwanted signals or receiver noise (3C.6). In addition, adequate coverage requires freedom from subjective degradation due to local effects such as ghosting or man-made noise.

Coverage of a proposed service may be estimated from a knowledge of the coverage achieved by existing services at the proposed transmitting site. If the service is not to be co-sited with other services then it may be necessary to conduct a propagation test from the proposed transmitting site. (The transmitting antenna height needs to be as close as practicable to that of the proposed service to enable an accurate estimate of coverage to be made.) The effect of any potential sources of interference can also be more reliably assessed through examination of existing services or by conducting propagation tests.

Where suitable field measurements cannot readily be undertaken, calculation methods are used to assist with estimating coverage, and likely interference levels (refer to Part 2). However, there are inherent inaccuracies in propagation predictions and they should be treated with caution.

3C.5.3 Subjective analysis scale

The CCIR five grade scale shall be used for assessing picture quality.

Table 3C.7
CCIR Picture Assessment Rating Scale

Grade	Quality	Impairment
5	Excellent	Imperceptible
4	Good	Perceptible
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

3C.5.4 Minimum field strength values

The table below lists field strengths which are considered to provide adequate reception in the absence of interference from other services. The field strengths for urban and suburban areas allow for the normal generation of electrical interference by domestic and industrial equipment, and for random variations in level with location.

Table 3C.8
Minimum Field Strength Planning Figures
(50% of receiving locations, 50% of the time)

	Field Strength in dBµV/m (1)				
Environment	Band I	Band II	Band III	Band IV	Band V
Urban	75 (2)	75 (2)	75	80	80
Suburban	65	65	65	72	76
Rural	50	50	50	62	67
Rural Towns	- (2)	- (2)	- (2)	64	67

Note 1: dBµV/m is dB above 1 microvolt per metre (mV/m).

Note 2: In industrialised urban areas median field strengths as high as 85 dBµV/m for Band I and 80 dBµV/m for Band II may be necessary to overcome localised man-made interference. In rural towns the required field strength will depend largely on the level of electrical interference, which will depend in turn on the standard of construction of the power distribution system. Field strengths as low as 50 dBµV/m may be satisfactory in electrically quiet towns, particularly at Band III, while field strengths of 65 dBµV/m or even higher may be required in noisy towns, particularly at Bands I and II.

‘**Urban**’ refers to a significant area with buildings predominantly more than two stories high.

'**Suburban**' refers to a significant area occupied predominantly by single or two storey dwellings, either single or multi-unit.

For planning purposes it may be assumed that the central core of cities of more than 20,000 people is 'urban' and that communities of more than 200 people are 'suburban' but a sensible transition from the lower to higher field strength should be used. The 200 and 2,000 population figures should be seen as transition points. Planners may propose other classifications if they consider that special circumstances apply to a particular town or city. Such circumstances could include atypical development, or high levels of electrical noise.

'**Rural towns**' refers to towns which, because of flat terrain, limited extent and lower level of man-made clutter, can generally be expected to have more uniform field strength than suburban areas. No specific maximum population is specified for rural towns as the maximum size is strongly dependent on terrain type and type of development but towns of up to 10,000 people or higher could be suitable. The classification is not suitable for hilly towns. When a low power transmitter is to be provided specifically for a rural town, the installation is normally sited and dimensioned to provide at least a suburban grade of service.

'**Rural**' refers to those areas which have not been classified as 'urban', 'suburban' or 'rural towns'.

3C.5.5Maximum field strength

Transmitting stations shall be located so that not more than one percent of the total population throughout the service area reside in an area which has a field strength greater than 110 dBµV/m. The relative height of the transmitting antenna above ground level and its vertical radiation pattern may be used to assist in meeting this condition.

Under no circumstances should any transmitting facility be sited such that a significant proportion of the population to be served receives a field strength greater than 1 V/m. A 'significant proportion' constitutes 0.1% of the population to be served or 100 persons, whichever is the lesser.

3C.6 Interference – protection ratios

A service is considered adequate if 50% of receivers are not reduced below a subjective impairment grading of 3, for more than 10% of the time (tropospheric interference); or below a subjective impairment grading of 4, for more than 50% of receivers for 50% of the time (continuous interference).

Interference from other services may cause higher levels of field strength to be necessary for an adequate service than the minimum field strengths specified in table 3C.8. The level of field strengths needed to provide adequate reception in the presence of an interfering signal(s) is referred to as the usable field strength (Eu).

The Eu for a particular interfering signal considered to be acting alone is calculated as the algebraic sum of the required RF protection ratio (see glossary) and the field strength of the particular interfering signal (in dB) minus the discrimination due to receiver antenna directivity and cross-polarisation discrimination. The protection ratios required are discussed in the following sections.

Where there are several interfering signals, the Eu of each considered to be acting alone is calculated separately and combined by the process described in 3C.7.4.1. If the Eu, as calculated above, is less than the minimum field strength in table 3C.8 the minimum field strength figure shall be used; if it is greater, the Eu, as calculated above, shall be used.

When an existing service has its Eu increased by a new or proposed service as calculated by this process it is considered to suffer interference. A service is said to be protected when planning proceeds on the basis that it will not be allowed to suffer interference as defined above.

3C.6.1 Continuous and tropospheric protection ratios

Different values of protection ratio are specified for interference which is continuous, and interference which has level variations due to propagation effects (tropospheric interference).

The protection ratios given for tropospheric interference are for field strengths which are not exceeded for more than 10% of the time. These field strengths may be predicted using the curves at figures 22 and 23.

3C.7 Co-channel interference[18]

3C.7.1 Non-synchronised vision carriers

The required co-channel interference protection ratio depends on the frequency offset, and the precision with which the offset is maintained. Except in special circumstances the following offsets and protection ratios shall be employed:

Table 3C.9
Television Channel Frequency &
Protection Ratios for Co-channel Operation

Nominal Offset	Non-Precision Offset (±500 Hz)			Precision Offset (±1 Hz)		
(Times Line Frequency)	T	C	Frequency Offset	T	C	Frequency Offset
0	45	52	0	-	-	-
- 5/3	30	40	-26 000 Hz	22	27	-26 025 Hz
- 10/3	30	40	-52 000 Hz	22	27	-52 050 Hz

T : tropospheric interference protection ratio (dB)
C : continuous interference protection ratio (dB).

The protection ratios are valid up to about 50 kHz if multiples of the line frequency are added to the offset. (Earlier VHF offsets used a +1/3, -1/3 scheme; +1/3 is equivalent to -5/3, and -1/3 is equivalent to -10/3 for non-precision offset purposes.)

An offset of at least 5/3 line frequency is required to obtain sufficient protection between the sound carriers if a precision offset is used.

Other offset arrangements are described in 4C.7.

3C.7.2 Synchronised vision carriers

A special case exists where two transmitters carry the same program and their vision carrier frequencies are synchronised so that no frequency difference occurs on a long-term basis, and short-term variations are reduced to a negligible value. (Non frequency changing transposers produce signals of this type.)

The protection ratios required are then the same as those specified for the limits imposed on coverage by reflections as detailed in 3C.9.2. The synchronisation of vision carriers and synch pulse generators produces a delayed interfering signal, similar to a reflection.

3C.8 Interference - receivers

3C.8.1 Interference from Receiver Deficiencies

Various protection ratios must also be applied to signals on channels close in frequency to the desired signal, or channels with various harmonic relationships to the receiver local oscillator and IF frequencies, because of the finite resolution and linearity of practical receivers. These protection ratios are given in the technical specification for the Australian Reference Television Receiving System in 3C.15.

3C.8.2 Limits imposed on coverage by interference caused by local oscillator radiation from domestic receivers

The local oscillator signal generated in a television receiver is nominally 36.875 MHz higher in frequency than the selected vision carrier frequency. Channel pairs which may give rise to local oscillator radiation interference are listed in the table below, together with the estimated minimum field strengths of the higher channel necessary to avoid interference.

Table 3C.10
Minimum Field Strengths to protect against
Local Oscillator Radiation Interference

Channel Pairs	1, 4	2, 5	5, 5A	5A, 6	6, 10	7, 11	UHF (n, n+5)
Min Field Strength (dBµV/m)	49	52	87	85	73	73	92

Channel pairs other than 1, 4 and 2, 5 are also expected to cause some problems in distribution systems unless higher than minimum levels or better isolation than specified in AS 1367 are employed.

3C.9 Interference - miscellaneous

3C.9.1 Limits imposed on coverage by interference from other services (e.g. VHF-FM)

Services operating in frequency bands close to, or within, television bands may reduce the coverage of television stations. The protection ratios required to provide satisfactory reception in the presence of in-channel CW, frequency modulated and amplitude modulated signals are determined by using the curves in figure 68. The curves assume no control of relative frequency between carriers.

The choice between curves A, B, and C is made as follows:

curve A	sizeable towns
curve B	well populated rural areas
curve C	sparsely populated areas.

As the signal from a transmitter can overload a receiver and cause serious interference, even when the frequency is well removed from the carrier frequency of the wanted television service, the levels of wanted and unwanted signals are assumed to be below the overload threshold of receivers (3C5.5).

Other interference mechanisms connected with VHF-FM services are covered in 3B.7.3 and 4B.7.3.

3C.9.2 Limits imposed on coverage by reflections (ghosting)

Television signals which have adequate field strength and are free of interference from other services and noise may still be unsatisfactory because of ghosting.

Ghosting is caused by delayed reflections from surrounding terrain, buildings and structures. Its subjective effect depends on the amplitude, delay and RF phase of the ghost signal relative to the direct signal, and on the number of ghost signals present.

The curves in figure 70 indicate the relative level of reflected signals at the input of the receiver for picture impairment ratings of 3, 4 or just perceptible as a function of the delay of the reflected signals.

Ghosting is an important consideration in the planning of non-frequency changing translators (4C.14.4).

3C.9.3 Co-channel interference to sound

The protection ratios required for interference between television sound carriers are lower than those for the vision signals, when the correct frequency offsets are used. Consequently, it is not necessary to specify a separate protection ratio for the sound signals[18].

3C.9.4 Interference with radionavigation services

Co-ordination of UHF channels 36, 37, 38 in the frequency band 582-603 MHz with radionavigation services will be arranged by the Department.

3C.10 Interference - summation

3C.10.1 Calculation of interfering signal levels

The prediction of interfering signal levels is used to determine:

- the effect on other services; and
- the cumulative effect on the proposed service from several sources of possible interference.

Field strengths are predicted using the propagation prediction methods of Part 2. The relative voltages at the receiver terminals are then derived using the receiving antenna characteristics of 3C.15.

3C.10.2 Interference contributions from several stations

The calculation of effective interference level (Eu) in the presence of a number of sources of interference (due to co-channel, adjacent channel or receiver characteristics) is to be performed as follows.

Considering the interfering contributions in order of decreasing magnitude, add the squares of the voltages of the individual values of usable field strength (Ea) and extract the sum, excluding those components whose voltages are more than 6 dB below the root sum squared value (expressed in decibels) of the higher components already included.

Note: The root sum squared process may be calculated in decibels using the relationship:

$$Eu = 10 \log \sum 10^{(0.1Ea)}$$

3C.11 Effective radiated power (ERP)

3C.11.1 Practical tolerance on ERP

The tolerance to apply to the radiation pattern shall be kept to a practical minimum. Typical limits for an omnidirectional service are ±2 dB. Wider limits may be acceptable in special circumstances, such as the use of an existing antenna support structure.

3C.11.2 Maximum value of ERP

The required value of the ERP of each transmitter will depend upon the size of the service area, the effective height of the transmitting antenna and the field strength needed to provide adequate reception throughout the service area. Interference to other services may limit the permissible ERP and the maximum height of the antenna.

Multiple transmitters may be necessary if the specified service area cannot be covered from a single transmitter.

3C.12 Transmitting antenna radiation pattern

The design of an antenna may provide for either an omnidirectional or a directional horizontal radiation pattern. In addition to the selection of the horizontal pattern in azimuth the amount of beam tilt and null fill may also be controlled to improve coverage of the service area.

3C.12.1 Beam tilt

Beam tilt shall be specified for antennas having a relatively narrow vertical radiation pattern to aim the axis of the main vertical beam for optimum coverage of the designated service area. If the service area extends to (or beyond) the horizon, depression angle of the far edge of the service area may be calculated from:

$$\text{depression angle (degrees)} = 0.0277\sqrt{h}$$

where:

h is the antenna height in metre above the service area.

The beam tilt angle specified may be varied somewhat to suit the width of the vertical radiation pattern, and the expected tower sway.

In some cases, extra beam tilt to that specified above may be necessary to direct the peak of the main lobe of the vertical radiation pattern at the principal community within the service area.

3C.12.2 Null fill

Null fill is necessary if reception is required at depression angles where a null exists in the vertical radiation pattern of the transmitting antenna - generally for areas close to the transmitter. Null fill is to be specified as a percentage of the maximum relative field, over a specified range of depression angle.

Depression angle below the horizontal may be calculated approximately by:

$$\text{depression angle (degrees)} = 0.057 \left(\frac{h}{d}\right)$$

where:

h is the transmitting antenna height in metres above the area in question

d is the distance in km to the near edge of that area.

3C.12.3 More complex patterns

Planning considerations may require other constraints to be placed on the vertical radiation pattern:

. it may be necessary to limit the radiation at high depression angles, to avoid high field strengths very close to the transmitter; and

. a more detailed specification of the vertical radiation pattern may be necessary either to optimise field strengths or to reduce the difference between the field strengths produced by the proposed antenna and the antennas of other services.

3C.12.4 Polarisation

Television services may have either horizontal or vertical polarisation. In the absence of other planning consideration, it is preferred that UHF main stations have horizontal polarisation.

3C.13 Siting of transmitters

Transmitter sites shall be chosen so that field strengths consistent with the Guidelines are provided in the service area.

The sites and the ERPs proposed shall be such that the maximum field strength provisions of 3C.5.4 are met, and that unacceptable interference is not caused to other services.

Note that high power television services may cause serious interference to nearby communication services even though the television service complies with the requirements for out of band radiation and is well separated in frequency from the other services.

As soon as a transmitter site has been selected, the licensee or a body to whom a licence has been offered is required to advise its precise location to the Department. The following details should be forwarded to the State Broadcasting Engineer:

- Australian Metric Grid (AMG) co-ordinates of the transmitter site specified to within preferably 10 metres accuracy; and
- the common name of the site.

The licensee has the responsibility of co-ordinating (prior to installation) with other radiocommunication users established at or adjacent to the site to ensure that operation of the transmitter is compatible with existing services. In other words the licensee is required to take any necessary steps to ensure that radio interference is not caused to other users. A list of users operating at particular sites can be obtained from the State Manager, Radio Frequency Management, of the state concerned.

Transmitting stations shall be sited and designed with due regard to AS 2772 (safe limits for electromagnetic radiation).

Sites shall be selected which are not a hazard to air navigation and which have a minimum intrusion on the environment. The broadcaster is responsible for obtaining all necessary approvals from federal, state and local government planning authorities.

Within a service area, as far as possible, new television transmitters should be co-sited with existing television and VHF-FM transmitters. Sharing of facilities (tower, antenna, etc.) is preferred where the services are intended to serve the same region. Where stations are co-sited but do not share antennas and/or support structures, the spacing, orientation and height of the support structures and the mounting of the transmitting antennas shall be such as to prevent significant reflections, or re-radiation.

3C.14 Off-air relays and transposers

The planning of transposers requires examination of the following additional factors:

- input signal requirements;
- preferred input/output channel combinations;
- possibility of using non-frequency changing re-broadcasting facilities;
- benefits to be derived from diversity reception; and
- cumulative effect on system performance parameters of the operation of a series of transposers operating in tandem or the use of a series of program links.

3C.14.1 Off-air relay input signal requirements

The input signal requirements into 50 ohms for an output video signal to noise ratio of 52 dB, assuming equipment noise figures of 6 dB (VHF) and 8 dB (UHF) and allowing for the effects of cosmic noise, are as follows:

Table 3C.11
Off-air Relay Input Signal Requirements

Band	I	II	III	IV	V
Input (mV)	1.5	1.1	1.0	1.3	1.3

The input signals for Bands I and II are based on antenna noise figures (due to cosmic noise) of 9.5 dB and 2.5 dB respectively. These figures should be taken into account in assessing the noise figure to be used for Bands I and II.

A signal to noise ratio of 52 dB is applicable to large populations. Reduced signal to noise and reliability requirements are applied to transposers and off-air relay sites for facilities serving smaller populations. Table 3C.12 sets out the required reliability and median input signal required for various served populations, based on thermal noise considerations.

Reliability, for the purposes of this section, is defined as the proportion of time which the weighted video signal/noise ratio would exceed 28 dB, ignoring effects other than the propagation path.

Reliability at the 99.9% level may be assessed using figure 49. Reliability at the 99.99% level may be assumed to require another 10 dB fading margin.

Transposers and off-air relay sites are also required to be substantially free of interference from other services.

Table 3C.12
Input Signal Reliability Requirements Off Air Relay

Population	Required Reliability	Required Weighted Video S/N Ratio	Input Voltage 50 ohms for Noise Figure Shown			
			6 dB	7 dB	8 dB	9 dB
> 100 000	99.98	52	1.0	1.1	1.3	1.4
20 000	99.94	51	0.9	1.0	1.2	1.3
10 000	99.19	50	0.8	0.9	1.0	1.1
5 000	99.8	48	0.6	0.7	0.8	0.9
3 000	99.7	46	0.5	0.55	0.62	0.7
1 000	99.5	43	0.35	0.39	0.44	0.5
500	99.3	41	0.28	0.32	0.35	0.39
	99.1	38	0.20	0.22	0.25	0.28
		28	0.06	0.07	0.08	0.09

3C.14.2 Off-air relay site receiving antenna characteristics

In assessing the level of co-channel interference caused to existing off-air relay installations by a proposed new service, it may be assumed that the existing installation has higher levels of directivity and orthogonal polarisation discrimination than those of the reference receiving system of 3C.15.

The levels to be used are set out in the table below:

Table 3C.13
Co-channel Interference Antenna
Directivity Assumption for Off-Air Relay

	Band I	Band II	Band III	UHF
Directional Discrimination (same polarisation)				
0 dB discrimination 0° to	40°	40°	30°	20°
Rising linearly to	70°	70°	60°	60°
With a discrimination of	10 dB	12 dB	15 dB	18 dB
Orthogonal & Directivity Discrimination (cross polarisation)				
Discrimination on main axis	15 dB	15 dB	15 dB	15 dB
Rising linearly - from	NA	NA	20°	50°
- to	NA	NA	60°	60°
With discrimination off axis of	15 dB	15 dB	20 dB	25 dB

In planning a new off-air relay installation, it is expected that the above figures will also be used in assessing levels of co-channel interference. Higher values of discrimination may be used, but they will be accepted only if supported by detailed design calculations or by actual measurements.

3C.15 Reference television receiving system

The reference television receiving system is defined by the Department's Document 556 published in June 1986. A copy of this document is included here as attachment 3C.BB.

TELEVISION
SUMMARY OF REQUIREMENTS

Guide-lines Para.	Interference Mechanism	Exclusions	Protection Ratio		Min. Field Strength	Comments
			Steady	Tropo.	dBµV/m	
	FM to TV and TV to FM					See FM summary tables.
	TV to TV (co-sited)					
3C.2.3 & 3C.7.1	Co-channel: zero offset 1/3 non-precision 1/3 precision	N	 52 dB 40 dB 27 dB	 45 dB 30 dB 22 dB		Separate service areas not immediately adjacent.
3C.2.4	Adjacent channel					
	- lower adjacent	N±1 if immediately adjacent	0.32mV -12 dB 1.0 mV -4 dB 3.2 mV -3 dB			Not allocated to services with similar coverage areas - (1,2), (3,4,5), (6,7,8,9), (10,11) and all UHF channels are immediately adjacent.
	- upper adjacent Band I	N±1 if immediately adjacent	0.32mV -6 dB 1.0 mV +2 dB 3.2 mV +6 dB			
	- upper adjacent Bands II, III, IV and V		0.32mV -14 dB 1.0 mV -7 dB 3.2 mV 0 dB			
3C.8.2	Local oscillator radiation	1, 4 2, 5 5, 5A 5A, 6 6, 10/7, 11 UHF N, N+5			49 52 87 85 73 92	The high numbered channel requires the field strength shown when the lower numbered channel is used by a significant proportion of the population.
3C.5.4	Thermal and man-made noise: VHF - urban - suburban - rural - rural towns				 75 65 50 *	* Depends on electrical noise level.

TELEVISION
SUMMARY OF REQUIREMENTS (continued)

Guide-lines Para.	Interference Mechanism	Exclusions	Protection Ratio		Min. Field Strength	Comments
			Steady	Tropo.	dBµV/m	
3C.5.4 (cont.)	UHF Band IV - urban - suburban - rural - rural towns				 80 72 62 64	
	UHF Band V - urban - suburban - rural - rural towns				 80 76 67 67	
3C.2.8	Band plan restrictions	3, 4, 5, 5A				New services not to be placed on these channels.
3C.2.5	Image interference	VHF	-15 dB			OK in the same service area.
		UHF	-1 dB			Not in the same service area.
	<u>TV to TV (non co-sited)</u>					
3C.2.5	Image interference (F_{uw} - LO = IF)	2, 5A 5, 6 5A, 10				Not to be allocated to cover the same area unless co-sited.
3C.2.6	Harmonic relationship $F_2 = 2\times F_1, 3\times F_1$	0, 4 0, 5A 2, 8 4, 8				Not to be allocated to cover the same area unless co-sited.
3C.2.7	Intermodulation relationship: $2\times F_1 - F_2 = IF$ $F_1 - F_2 = IF$	 0, 1 N, N+5				Not to be allocated to cover the same area unless co-sited.
	<u>Miscellaneous</u>					
3C.9.2	Ghosting		see fig. 70			15-30 dB
3C.9.4	Radionavigation services	36, 37, 38				Department will arrange co-ordination.

TELEVISION
SUMMARY OF REQUIREMENTS (continued)

Translator input voltage (50 W) = field strength + net antenna gain - 20 $\log_{10}\left(\frac{F}{39.5}\right)$

Field Strengths Required to Produce the Voltages of the Reference Receiver

Reference Receiver Voltages	Field Strengths (dBµV/m)									
	Urban/Suburban					Rural				
	Band I	Band II	Band III	Band IV	Band V	Band I	Band II	Band III	Band IV	Band V
0.32 mV	50	54	60	67	69	48	51	57	64	66
1.0 mV	60	64	70	77	79	58	61	67	74	76
3.2 mV	70	74	80	87	89	68	71	77	84	86

TECHNICAL SPECIFICATION FOR THE AUSTRALIAN REFERENCE TELEVISION RECEIVING SYSTEM

(Extract from DOC 556)

3C.BB 1 Receiver characteristics

3C.BB 1.1 Noise figure

The noise figure of the tuner is as follows:

Band I	8.0 dB
Bands II and III	6.0 dB
Band IV	10.0 dB
Band V	11.0 dB

Note: Other sections of the receiver will contribute an additional amount to receiver noise.

3C.BB 1.2 Noise limited sensitivity

The noise limited sensitivity for an effective luminance bandwidth of 4 MHz is as follows:

Band I	43 dBµV
Bands II and III	41 dBµV
Band IV	45 dBµV
Band V	46 dBµV

Note: These figures are mathematically related to the receiver noise figures.

3C.BB 1.3 The maximum usable input signal

The maximum usable input signal is:

Bands I, II & III	110 dBµV
Bands IV & V	100 dBµV

3C.BB 1.4 Lower adjacent channel interference protection*

The lower adjacent channel interference protection (upper channel is wanted) ratios in Bands I, II, III, IV and V are:

Wanted Vision Carrier Voltage (into 75 ohms at the input terminals)	Protection Ratio
0.32 mV	-12 dB
1.0 mV	-4 dB
3.2 mV	-3 dB

Note: From limited tests conducted with an interfering dual sound television signal[58], it was found that the following protection ratios were required:

Wanted Vision Carrier Voltage (into 75 ohms at the input terminals)	Protection Ratio
0.32 mV	-10 dB
1.0 mV	-2 dB
3.2 mV	-1 dB

3C.BB 1.5 Upper adjacent channel interference protection*

The upper adjacent channel interference protection (lower channel is wanted) ratios are:

Wanted Vision Carrier Voltage (into 75 ohms at the input terminals)	Frequency Band I	Frequency Bands II, III, IV and V
0.32 mV	-6 dB	-14 dB
1.0 mV	+2 dB	-7 dB
3.2 mV	+6 dB	0 dB

3C.BB 1.6 Image channel interference protection*

The Image Channel Interference Protection ratio is:

Wanted Vision Carrier Voltage (into 75 ohms at the input terminals)	Frequency Bands II and III	Frequency Bands IV and V
1.0 mV	-15 dB	-1 dB
3.2 mV	-15 dB	+1 dB

* The protection ratios quoted refer in all cases to the ratios at the input to the receiver and relate that level of interference which can be described as just perceptible.

3C.BB 1.7 VHF-FM interference protection*

The VHF-FM Interference Protection ratios for Band III television channels are as follows:

Wanted Vision Carrier Voltage (into 75 ohms at the input terminals)	1.0 mV	3.2 mV
Harmonic Interference	-13 dB	-10 dB
Intermodulation Interference	-13 dB	-7 dB
Cross-modulation Interference	-47 dB	-46 dB

3C.BB 1.8 Maximum local oscillator voltage

The maximum local oscillator voltage appearing at the input terminals is 50 dBmV rms in Bands I, II, III, IV and V.

The maximum local oscillator voltage appearing between the mains line and neutral connections at a point as close as possible to the point of entry of the leads into the receiver is:

Bands I, II and III 40 dBμV
Bands IV and V 30 dBμV

3C.BB 1.9 Frequency range

In the VHF Bands, the receiver is capable of tuning to all Australian channels in Bands I, II and III.

In the UHF Bands, the receiver is capable of tuning to all Australian channels in Bands IV and V.

3C.BB 1.10 Co-efficient of reflection

The co-efficient of reflection is 0.5 in Bands I, II, III, IV and V.

3C.BB 1.11 Intermediate frequency (IF)

The nominal intermediate frequency is 36.875 MHz.

3C.BB 1.12 Intermediate frequency interference protection*

To be specified.

3C.BB 1.13 Fine-tuning range

The receiver is capable of accommodating offsets of the carrier frequencies up to ±10/3 of the horizontal line frequency.

3C.BB.2 Antenna characteristics

3C.BB 2.1 Gain

The available gain of the antenna across the bandwidth of each of the channels in the respective Bands has the following values:

Band	Urban/Suburban	Rural
I	2 dB	4 dB
II	4 dB	7 dB
III	5 dB	8 dB
IV	8 dB	11 dB
V	9 dB	12 dB
Ch. 5A	2 dB	6 dB

The gain is expressed relative to that of a half-wave dipole and is assumed to be the same for both horizontal and vertical polarisation.

The antenna impedance shall be matched to the nominal impedance of the system used.

3C.BB 2.2 Directivity discrimination

The median values of directivity discrimination that are available in suburban areas for either horizontal or vertical polarisation in Bands I, II, III, IV and V are shown in figure 74.

Note: For precise details reference should be made to the DOC report on antenna measurements[52] and to the report on the analysis of measurements.[54]

3C.BB 2.3 Orthogonal wave polarisation discrimination

The median values of orthogonal wave polarisation discrimination that are available in suburban areas for either horizontal or vertical polarisation in Bands I, II, III, IV and V are shown in figure 75.

Note: The values of discrimination are likely to be better in open country and worse in urban areas or places where the receiving antenna is surrounded by obstacles.

3C.BB 2.4 Antenna cable loss

To be specified.

Note: As a guide, for planning purposes the following details and values may be assumed for cable loss pending investigation and verification:

cable length	15 metres	
cable type	RG 59	
cable loss	Band	dB
	I	1.0
	II	2.0
	III	3.0
	IV	4.0
	V	5.0

3C.BB 3. Definitions used in reference receiving system specification

Vision carrier voltage

The root mean square (rms) value of the carrier at peak synchronising level.[56]

Interference protection ratio

The ratio of the wanted vision carrier voltage at the receiver input terminals to the unwanted vision carrier voltage at the same terminals when there is just discernible interference to the picture.[56]

Note: This ratio, when expressed in decibels, could be positive or negative in value. Negative values are obtained when the receiver is able to sustain an unwanted signal level in excess of that of the wanted signal.

Noise figure

The ratio of the total noise power per unit bandwidth (at a corresponding output frequency) delivered by the system into an output termination to the portion thereof engendered at the input frequency by the input termination, whose noise temperature is standard (290 K at all frequencies).[55]

Noise limited sensitivity

The vision carrier voltage at the input terminals of the receiver at which the video signal to noise ratio (luminance, unweighted) is equal to 26 dB.[56]

Maximum usable input signal

The vision carrier voltage for a single signal at the input terminals of the receiver at which just discernible overload effects on the picture, sound or synchronising stability occur.[56]

Adjacent channel interference

Interference to a television signal caused by television transmissions on channels adjacent to the wanted signal.[56]

Local oscillator voltage

This arises from local oscillator signals (fundamental and harmonics) which appear at the input terminals of the receiver or which are transmitted down the mains lead.[56]

Note: The local oscillator voltage is a measure of the local oscillator radiation which can occur from the antenna.

VHF-FM intermodulation interference

That interference to a television signal by an interfering signal within the pass-band of the wanted television channel arising from the intermodulation products between two unwanted FM sound broadcast signals.[56]

VHF-FM cross-modulation interference

Interference to a television signal which occurs when the television vision carrier is modulated with the audio signal of the VHF-FM broadcasting service due to non-linearities within the receiver.[56]

Note: The effect is normally associated with high input voltage levels and is not to be confused with intermodulation interference.[56]

Local oscillator voltage

This arises from local oscillator signals (fundamental and harmonics) which appear at the input terminals of the receiver or which are transmitted down the mains lead.[56]

Note: The local oscillator voltage is a measure of the local oscillator radiation which can occur from the antenna.

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Interference to a television signal which occurs when the television vision carrier is modulated with the audio signal of the VHF-FM broadcasting service due to non-linearities within the receiver.[56]

Note: The effect is normally associated with high input voltage levels and is not to be confused with intermodulation interference.[56]

VHF-FM harmonically related frequency interference

Interference to a television signal caused by a VHF-FM sound broadcast transmission on a frequency which is harmonically related to frequencies within the passband of the television channel.[56]

Frequency bands

The frequency bands for Australian television services are as defined in the Australian television transmission standard.[26]

Antenna gain

The ratio in decibels of the power delivered to a 75 ohm resistive load when the antenna is optimally oriented in the uniform field of a plane linearly polarised electro-magnetic wave, to the power available from a half-wave dipole optimally oriented in the same electro-magnetic field.[57]

Directivity discrimination

The ratio in decibels of the output voltage from the antenna measured in a given direction to the output voltage measured in the direction of maximum response in the same electromagnetic field and the same plane of polarisation.[56]

Orthogonal wave polarisation discrimination

The ratio in decibels of the output voltage from the antenna measured in a given direction but in an orthogonal field to the output voltage measured in the direction of maximum response in the same electromagnetic field and with the antenna oriented in the co-polar plane.[56]

PART 4A: MF AM RADIO

Notes on broadcasting planning

4A.1 Introduction

Part 4A consists of additional notes to the main guidelines, Part 3A – MF Radio. The essential planning material is in 3A and 4A provides additional comments and gives examples of the processes involved in the use of 3A. The section headings in this part relate directly to the equivalent headings in 3A and if further explanation of a topic in 3A is required, the appropriate section in 4A is easily located. Where no comment is considered necessary in part 4, headings only are provided to preserve the structure.

The propagation calculations are covered in part 2.

4A.2 Frequency assignment

4A.2.1 Procedure

The established national infrastructure for MF radio services largely limits the possible options for new or modified services. To carry out the necessary frequency selection and analysis process, certain information will be needed about the preferred frequency for an area, and established and proposed services. The MF channel allocation maps for existing services are contained in the Department's publication, 'Channel Allocation Maps, Existing MF AM Radio Services'.

Information about established services is also available in the book 'Radio Broadcasting and Television Stations', published by the Department. This publication does not contain information about services that may be in the final stages of planning.

Relevant frequency planning information is also available in response to a formal request. The information that can be provided may include any or all of the following, depending on the stated needs:

. details of proposed stations; and

. interference levels at a proposed site on a specific frequency (or frequencies).

The listing of proposed stations would not normally show allotments that are under consideration for a possible future service, because these frequencies are subject to change during the preliminary planning process. However, the Department may reserve some frequencies in advance, where planning policy considerations so determine. With the above exceptions, frequencies will not be reserved in advance of detailed planning and acceptance of a complete planning proposal or licence application.

As the information on new or proposed services will change as services are added, it should not be requested until required for detailed engineering planning.

Written requests for frequency planning information should clearly indicate the locality of interest, the type of service proposed (e.g. MF radio).

The Department may formally discuss the feasibility of frequency assignment proposals, in advance of the applicant submitting a completed formal proposal or licence application. A written outline of the technical proposal should be forwarded to the Department for examination before a meeting is held.

4A.2.2 Selection of possible frequency alternatives

The procedure for selecting a suitable frequency can be broken down into a series of steps to provide a short list from which detailed engineering calculations can determine a suitable option.

- Assume a new assignment is to be made without any variation to characteristics of existing and planned services.
- Where it is known that the service must be assigned a generally low frequency channel in order to adequately cover a service area; delete all channels of unacceptably high frequency.
- Where a low power service employing an omnidirectional antenna is proposed; delete all channels which are not local.
- Where a service employing a directional antenna is proposed delete all local channels.
- Delete all channels which, if assigned, would be separated by less than 27 kHz from the channel of an existing or planned service and which would result in significant overlap of coverage areas with that service.
- Delete all channels which, if assigned would be separated by less than 45 kHz from the channel of an existing or planned service and which would result in extensive overlap of coverage areas with that service.
- In the case of a new or amended service permitted to operate both day and night, delete all channels where the protected ground wave field strength in the presence of skywave interference from existing and planned services alone (on the same and adjacent channels) would not be less than 10 mV/m.

Where a shared antenna is proposed, delete those channels:

- within 63 kHz of the channel of a sharing service if both services employ omnidirectional antennas; and
- within 153 kHz of the channel of a sharing service, if either service or both services employ directional antennas.

Where a proposed site location has been determined and it is known that no alternatives are available then delete those channels where necessary radiation limitation requirements are incompatible with coverage area objectives or cost-effective radiating facilities.

4A.3 Channels

4A.3.1 International channel allocation plan

The 9 kHz channel spacing plan was agreed to by Australia at the Regional Administrative LF/MF Broadcasting Conference (Regions 1 and 3) at Geneva in 1975. The 'Geneva Plan' was subsequently implemented on 23 November 1978.[1]

The 1485 kHz, 1584 kHz and 1602 kHz channels are designated 'Low Power Channels' in the Geneva Plan with a maximum radiation limit of 300 V (although an Australia Protocol to the Agreement reserved the right to use these channels for services with radiation level in excess of 300 V under certain circumstances). For planning purposes within Australia the 567 kHz, 765 kHz, 1215 kHZ, 1476 kHz, 1494 kHz and 1593 kHz channels have also been included.

The maximum cymomotive force has been set at 220 V.

4A.3.2 International coordination

The Geneva plan requires that new or modified services be coordinated with other countries where the services of that country may be affected to limit the potential of interference between services. The International Frequency Registration Board of the International Telecommunication Union (ITU) is the responsible body for assignment co-ordination.

In the countries close to Australia there has been a practice to coordinate new proposals before submission to the ITU to assist the processing of the submissions. A draft Memorandum of Understanding between Australia, New Zealand and Papua New Guinea exists to support this arrangement. An informal arrangement also exists with other Pacific countries including Fiji and Vanuatu.

4A.4 Polarisation – receiving antenna system

Reserved.

4A.5 Coverage criteria – calculating usable field strength[43]

The method used calculates the field strengths necessary to overcome atmospheric and man-made noise, interference from other radio services, self fading, receiver deficiencies and receiver sensitivity.

I_A = the protected field strength in the presence of atmospheric radio noise alone (3A.8).

I_M = the protected field strength in the presence of man made radio noise alone (3A.3).

I_N = minimum usable sensitivity of the notional receiver.

I_N = 54 dBμV/m (0.5 mV/m).

Then:

$I_{Rk} = P_{Rk}\, G_k$
$I_{Gk} = P_{Ck}\, G_k$
$I_F = P_F\, F$
$I_{Sk} = P_{Ck}\, S_k$

(1) The daytime usable field strength (Eu (day)) is to be calculated by a summation in accordance with 3A.10 of all of the following, considering all existing and planned services:

I_A, I_M, I_N and for each k: I_{Rk}, I_{Gk}

(2) The night-time usable field strength (Eu (night)) is to be calculated by a root sum squared summation in accordance with 3A.10 of all of the following, considering all existing and planned services:

I_A, I_M, I_N, I_F and for each k: I_{Rk}, I_{Gk}, I_{Sk}

Definitions:

G_k = the groundwave field strength of the k-th unwanted transmitter (in μV/m);

S_k = the median skywave field strength of the k-th unwanted service (μV/m);

F = the field strength of the unwanted median skywave signal of the wanted service (μV/m);

P_{Ck} = the radio frequency protection ratio associated with the k-th unwanted signal due to co-channel or adjacent channel effects, expressed as a numerical ratio;

P_{Rk} = the radio frequency protection ratio associated with the k-th unwanted signal due to receiver deficiency effects, expressed as a numerical ratio.

P_F = the radio frequency protection ratio associated with the unwanted skywave signal of the wanted service due to self-fading.

I_{Gk} = the protected field strength in the presence of a groundwave signal of the k-th unwanted service alone and as a result of co-channel or adjacent channel interference (µV/m);

I_{Sk} = the protected field strength in the presence of a skywave signal of the k-th unwanted service alone (µV/m);

I_F = the protected field strength in the presence of the unwanted skywave signal of the wanted service alone (µV/m);

I_{Rk} = the protected field strength in the presence of a groundwave signal of the k-th unwanted service alone and as a result of interference due to receiver deficiencies (µV/m);

4A.6 Interference – radio frequency protection ratios

'Protection ratios' are of assistance in the assessment of coverage by a service. A radio frequency protection ratio is defined as the ratio of the minimum field strength necessary to obtain adequate reception in the presence of a single unwanted signal, to the field strength of that unwanted signal.

Thus when the field strength of an unwanted signal is known, the minimum field strength necessary for adequate reception can be obtained by multiplication with the protection ratio. The protection ratios to be used are given in 3A.6 and 3A.15. In all cases the wanted signal is the groundwave signal of the wanted service.

The self-fading, co-channel and adjacent channel protection ratios have been based upon Ref 1 and modified where necessary for Australian conditions.

4A.7 Interference – man-made radio noise levels

Reserved.

4A.8 Interference – atmospheric radio noise levels

The values of F_{am} given are those for 1600-2000 hours local time, in summer.[3] These are the highest levels encountered.

4A.9 Significant interference

Reserved.

4A.10 Calculation of usable field strength – summation of interference

4A.10.1 Summation example

The procedure to follow is outlined as an example:

. Calculate the individual values of usable field strength (Ea) of the wanted service, considering each source of interference acting alone.

E.g. if the service is subject to interference from two sources

(a) co-channel interference from a distant transmitter with an estimated field strength of 32 dBµV/m.

(b) adjacent channel interference from a transmitter separated by 9 kHz from the wanted signal with an estimated field strength of 48 dBµV/m.

Then the individual interference contributions would be as follows:

(a) Co-channel Interference

The required wanted to unwanted signal strength ratio for protection against co-channel interference is 30 dB;

Ea = 30 + 32 = 62 dBµV/m

(b) Adjacent Channel Interference

The required wanted to unwanted signal strength ratio for protection against adjacent channel interference is 9 dB;

Ea = 9 + 48 = 57 dBµV/m

. Determine the RSS value of the combination of the sources of interference, i.e. the resultant RSS value (Eu) is determined using the formula:

Eu = 10 log Sum 10 (exp(0.1 Ea))

In the above example Eu = 63.2 dBµV/m

. 6 dB Exclusion Principle

If a potential source of interference occurs where Ea is –6dB or less with respect to the calculated value of Eu, then it may be regarded as being insignificant.

If, for example, a third source of interference were present with a resultant Ea equal to say 50 dBµV/m then this may be considered as having no effect upon the value of Eu as its value is more than 6 dB less than that of Eu.

4A.10.2 Interference level summation - root sum square

The root sum squared method of interference level summation is generally accepted as the best means of assessing the likely impact of variations in assignment characteristics[43].

A difficulty with the method, however, is the potential for a succession of minor changes to develop in the long term into a significant increase in calculated interference level and hence reduce the 'sensitivity' to further increases.

Application of the 6dB exclusion principle ensures that this does not occur and that only perceivable increases in interference are reflected in the calculated value.

4A.10.3 Total interference contribution from a number of stations

The root-sum-square (RSS) method (incorporating a 6 dB exclusion principle) shall be used when calculating the total interference contribution involving a number of interfering stations.

4A.11 Transmitter power

4A.11.1 Power limitation

Discrete values of operating power at approximately 3 dB intervals are generally accepted as an aid to efficient planning of services. Operation at intermediate powers would not result in significantly improved reception in any situation.

4A.11.2 Day/night specifications

Although it is recognised that substantial improvements in daytime coverage can be achieved by operating with higher power and/or an omnidirectional antenna during the day, the primary matter to consider is the coverage of the station's service area. Bearing this in mind, it would not be appropriate to modify the technical conditions of a station in such a way that the coverage of the service area may be unnecessarily degraded.

In times of emergency operation (for example, if a mast in a directional aerial system fails) this restriction may be waived for a limited period of time while the fault is being rectified. Although services restricted to daytime-only operation are permitted, it is considered that at present there are generally channels available for these facilities which would provide comparable coverage, both day and night, provided directional antennas are installed.

It is recognised that the definition of daytime operation as being between the hours of local sunrise and local sunset at the transmitter site, for the purposes of avoiding skywave interference, is an approximation only.

However, skywave propagation basically depends on the point of ionospheric reflection being in darkness and this point may be up to 1000 kilometres from the transmitter site. Furthermore the onset of skywave propagation is not instantaneous but rather a gradual onset or decay as the ‘D-layer’ forms and disperses.

For planning purposes the approximation is reasonable.

4A.12 Transmitting antenna radiation pattern

4A.12.1 Radiating systems

Directional antennas are widely used in Australia to exploit the MF broadcasting spectrum efficiently. They are generally employed for all new services with operating powers greater than 500 watts, except in northwest Australia where the low transmitter density and remoteness allow the use of omnidirectional antennas.

4A.12.2 Sharing radiators

The sharing of radiating systems between two or more services is considered to be cost-effective, especially in the case of low power national/commercial sharing arrangements in remote areas. Shared directional antenna systems are recommended for metropolitan areas where land availability is limited; the Department will endeavour to coordinate suitable channels and radiation patterns.

The minimum separations of 63 kHz (omni) and 153 kHz (directional) reflect current practice. The Department will consider detailed engineering proposals with closer spacing.

4A.12.3 Radiation levels

The definitions and equations for calculating radiation patterns are provided in attachment 4A.AA. They are based on the 'Driving Point Impedance Method' detailed in Ref 13 and some equations drawn from Ref 14. The equations for mutual impedance between masts are taken from Ref 16, together with the definitions of sine and cosine integrals from Ref 15.

The omnidirectional method provides for a tower of any electrical height. Similarly, the directional method is completely general and provides for any number of towers of arbitrary physical configuration and height, with any loop current parameters.

The equations do, however, assume infinitely thin radiators and hence sinusoidal current distribution. This is a particularly good approximation for masts of electrical height less than about 130 electrical degrees. For masts of somewhat greater height the approximation for planning purposes is still quite good except for minima in the vertical radiation pattern. For skywave radiation the CMF is not therefore considered to fall below a certain value dependent upon the radiated power.

The methods assume zero losses, which is considered reasonable in view of the high electrical efficiency of usual radiating systems and the extended positive tolerance placed on permitted operating power. It is also assumed that an equivalent electrical height can be estimated from a knowledge of the physical mast structure, i.e. physical height, physical diameter, top capacitive loading, series inductive loading, etc.

Several graphs are provided to demonstrate the relationships between various parameters.

Figure 52 shows, for an omnidirectional radiator, the values of cmf along the ground and loop radiation resistance against electrical mast height. Figure 53 illustrates CMF from an omnidirectional radiator against elevation angle for several electrical mast heights.

Figures 54 and 55 are graphs of magnitude and phase of loop mutual impedance against electrical mast height and electrical mast spacing, for equal height masts. Graphs for unequal height masts are available from the literature[13], and from the Department.

4A.12.4 Loop mutual impedance graphs

The graphs provide plots of both magnitude and phase of the loop mutual impedance between two equal height, ideal monopole radiators. The equations used to generate the attached plots are detailed in attachment 4A.AA and have been based upon Ref 16.

Assumptions include perfect ground conductivity, infinitely thin radiators, no nearby metallic structures and no electrical loading. The graphs provide results of sufficient accuracy for broadcasting planning.

The independent variable is the mast height which is in equivalent electrical degrees and is plotted over the range 60 to 210. The dependent variable is the loop mutual impedance, either magnitude in ohms (for the first graph) or phase in electrical degrees (for the second graph). Several curves are plotted, each with constant mast spacing (in electrical degrees), for values in the range 75 to 360 in increments of 15.

4A.13 Siting of transmitter

Siting transmitter systems in close proximity or sharing facilities minimises the area subject to big differences in field strength and hence the likelihood of harmful interference due to receiver deficiencies.

In view of the diversity of local government bodies it is recommended that the relevant shire council or municipality be approached for advice in relation to relevant legislation and necessary approvals for new site development.

The radiation pattern shape realised will more closely approach the calculated omnidirectional or directional pattern with a flat site; and electrical losses in the radiating system are lower when located on ground of good conductivity.

The theoretically predicted radiation pattern can only be approached when the level of undesired parasitic re-radiation is negligible. If a re-radiating structure is less than about 120 degrees electrical height at the frequency of interest then it can generally be sufficiently detuned by insulating the base of the structure from the ground.

In the case of other nearby broadcasting services the mast base can be isolated by a simple wavetrap at the base which is in series with the transmission line, series resonant at the wanted frequency and parallel resonant at the unwanted frequency. For masts of greater electrical height more sophisticated measures may need to be employed such as the erection of a cage of thin wires surrounding the re-radiating structure. It may be necessary to incorporate detuning stubs in adjacent power lines if they have overhead earthing wires.

4A.14 Low power stations

Reserved.

4A.15 Reference receiver

A reference receiver for use in MF planning is under development. When this development is completed, protection ratios and noise bandwidths will be appropriately revised to suit the characteristics of the reference receiver.

CALCULATION OF RADIATION LEVELS OF MF ANTENNAS

The radiation level from an MF AM antenna system is to be determined by the following method:

1. Omnidirectional antennas

Definitions:

E = cymomotive force (volts);
P_r = radiated power (watts);
G = height of mast (electrical degrees);
R = loop radiation resistance (ohms);
E_s = cymomotive force in the horizontal plane (volts);
φ = azimuth of radiation clockwise from true north (degrees);
Θ = elevation of radiation up from the horizontal (degrees);
f = vertical radiation characteristic;
γ = Euler's constant (0.577216);
R_c = characteristic impedance of free space (376.710Ω);
π = Pi (3.14159);
Si = sine integral function;
Ci = cosine integral function.

Method:

$$Si(x)=\sum_{n=0}^{\infty} \frac{(-1)^n x^{2n+1}}{(2n+1)\,(2n+1)!}$$

$$Ci(x)=\gamma + \ln(x) + \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{2n\,(2n+1)!}$$

$$R = 29.9978\ \{[\gamma + \ln(2G) - Ci(2G)] + \tfrac{1}{2}\,[Si(4G) - 2\,Si(2G)]\sin(2G) + \tfrac{1}{2}\,[\gamma + \ln(G) - 2\,Ci(2G) + Ci(4G)]\cos(2G)\}$$

$$E_s=(1-\cos G)\sqrt{\frac{29.9978\,P_r\,R_c}{\pi R}}$$

$$f=\frac{\cos(G\sin\Theta)-\cos G}{(1-\cos G)\cos\Theta}$$

$E = E_s f$ (for skywave radiation E never falls below $50\sqrt{\frac{P_r}{1000}}$)

2. Directional antenna array (no parasitic elements)

Definitions:

E = cymomotive force (volts);

P_r = radiated power (watts);

n = number of elements in the array;

φ_i = azimuth orientation of i-th mast clockwise from true north with respect to reference point (degrees);

S_i = spacing of i-th mast from reference point (electrical degrees);

G_i = height of i-th mast (electrical degrees);

ψ_i = phase angle of loop current in i-th mast with respect to reference phase (electrical degrees);

M_i = ratio of magnitude of loop current in i-th mast to reference magnitude;

S_{ik} = spacing between the i-th and k-th masts (electrical degrees);

R_{ik} = loop mutual resistance between the i-th and k-th masts (ohms);

X_{ik} = loop mutual reactance between the i-th and k-th masts (ohms);

Z_{ik} = magnitude of loop mutual impedance between the i-th and k-th masts (electrical degrees);

γ_{ik} = phase angle of the loop mutual impedance between the i-th and k-th masts (electrical degrees);

R_{ii} = loop radiation resistance of the i-th mast (ohms);

E_{is} = cymomotive force of the i-th mast as an isolated omnidirectional radiator radiating power P_r (volts);

E_i = cymomotive force of the i-th mast (volts);

β_i = phase angle of the cymomotive force of the i-th mast (electrical degrees);

φ = azimuth of radiation clockwise from true north (degrees);

Θ = elevation of radiation up from the horizontal (degrees);

f_i = vertical radiation characteristic of i-th mast;

γ = Euler's constant (0.577216);

R_c = characteristic impedance of free space (376.710Ω);

π = Pi (3.14159);

Si = sine integral function;

Ci = cosine integral function.

Method:

$$\mathrm{Si}(x)=\sum_{n=0}^{\infty}\frac{(-1)^n\, x^{2n+1}}{(2n+1)\,(2n+1)!}$$

$$\mathrm{Ci}(x)=\gamma+\ln(x)+\sum_{n=0}^{\infty}\frac{(-1)^n\, x^{2n}}{2n\,(2n+1)!}$$

$$\begin{aligned}R_{ii} = 29.9978\ \{ & [\gamma+\ln(2G_i)-\mathrm{Ci}(2G_i)] \\ & + \tfrac{1}{2}\,[\mathrm{Si}(4G_i)-2\,\mathrm{Si}(2G_i)]\sin(2G_i) \\ & + \tfrac{1}{2}\,[\gamma+\ln(G_i)-2\,\mathrm{Ci}(2G_i)+\mathrm{Ci}(4G_i)]\cos(2G_i)\ \}\end{aligned}$$

$$E_{is}=(1-\cos G_i)\sqrt{\frac{29.9978\ P_r\,R_c}{\pi R_{ii}}}$$

$$S_{ik}=\sqrt{S_i^2+S_k^2-2S_iS_k\cos(\varphi_k-\varphi_i)}$$

$$u_{0ik}=\sqrt{S_{ik}^2+G_i^2}\ -G_i$$

$$u_{lik}=\sqrt{S_{ik}^2+(G_k-G_i)^2}\ +(G_k-G_i)$$

$$v_{0ik}=\sqrt{S_{ik}^2+G_i^2}\ +G_i$$

$$v_{lik}=\sqrt{S_{ik}^2+(G_k-G_i)^2}\ -(G_k+G_i)$$

$$w_{lik}=\sqrt{S_{ik}^2+(G_k+G_i)^2}\ +(G_k+G_i)$$

$$x_{lik}=\sqrt{S_{ik}^2+(G_k+G_i)^2}\ -(G_k-G_i)$$

$$y_{0ik}=S_{ik}$$

$$y_{lik}=\sqrt{S_{ik}^2+G_k^2}\ +G_k$$

$$s_{lik}=\sqrt{S_{ik}^2+G_k^2}\ -G_k$$

$$R_{ik} = 15 \{ \cos(G_k - G_i) [Ci(u_{lik}) - Ci(u_{0ik}) + Ci(v_{lik}) - Ci(v_{0ik}) + 2\,Ci(y_{0ik}) - Ci(y_{lik}) - Ci(s_{lik})]$$

$$+ \sin(G_k - G_i) [Si(u_{lik}) - Si(u_{0ik}) + Si(v_{0ik}) - Si(v_{lik}) - Si(y_{lik}) + Si(s_{lik})]$$

$$+ \cos(G_k + G_i) [Ci(w_{lik}) - Ci(v_{0ik}) + Ci(x_{lik}) - Ci(u_{0ik}) + 2\,Ci(y_{0ik}) - Ci(y_{lik}) - Ci(s_{lik})]$$

$$+ \sin(G_k + G_i) [Si(w_{lik}) - Si(v_{0ik}) + Si(u_{0ik}) - Si(x_{lik}) - Si(y_{lik}) + Si(s_{lik})] \}$$

$$X_{ik} = 15 \{ \cos(G_k - G_i) [Si(u_{0ik}) - Si(u_{lik}) + Si(v_{0ik}) - Si(v_{lik}) + Si(y_{lik}) - 2Si(y_{0ik}) + Si(s_{lik})]$$

$$+ \sin(G_k - G_i) [Ci(u_{lik}) - Ci(u_{0ik}) + Ci(v_{0ik}) - Ci(v_{lik}) - Ci(y_{lik}) + Ci(s_{lik})]$$

$$+ \cos(G_k + G_i) [Si(v_{0ik}) - Si(w_{lik}) + Si(u_{0ik}) - Si(x_{lik}) + Si(y_{lik}) - 2Si(y_{0ik}) + Si(s_{lik})]$$

$$+ \sin(G_k + G_i) [Ci(w_{lik}) - Ci(v_{0ik}) + Ci(u_{0ik}) - Ci(x_{lik}) - Ci(y_{lik}) + Ci(s_{lik})] \}$$

$$Z_{ik} = \sqrt{R_{ik}^2 + X_{ik}^2}$$

$$\gamma_{ik} = \tan^{-1}\left(\frac{X_{ik}}{R_{ik}}\right)$$

$$R_i = \sum_{\substack{k=1 \\ k \neq i}}^{n} M_k Z_{ik} \frac{\cos(\psi_k - \psi_i + \gamma_{ik})}{M_i}$$

$$E_i = E_{is} \sqrt{\frac{R_{ii}}{R_i + \sum_{\substack{k=1 \\ k \neq i}}^{n} \left(\frac{M_k}{M_i}\right)^2 R_k}}$$

$$f_i = \frac{\cos(G_i \sin\Theta) - \cos G_i}{(1 - \cos G_i)\cos\Theta}$$

$$\beta_i = S_i \cos\Theta \cos(\varphi_i - \varphi) + \psi_i$$

$$E = \sqrt{\sum_{i=1}^{n} [(E_i f_i \cos\beta_i)^2 + (E_i f_i \sin\beta_i)^2]}$$

(for *skywave* radiation E never falls below $50\sqrt{\frac{P_r}{1000}}$)

(for *groundwave* radiation E never falls below $10\sqrt{\frac{P_r}{1000}}$)

The Department will make available a computer program for this calculation, implemented in Microsoft Basic/MS DOS.

Alternative Method:

An alternative simpler method, suitable for equal height, two mast arrays giving approximately the same answer as the above calculations can be derived from the following relationships:

CMF = (CMF of single mast) (Gain over single mast) f_1

$$\text{Gain over single mast} = \sqrt{\frac{1 + M_2^2 + 2M_2 \cos(\psi + S\cos\varphi\cos\Theta)}{1 + M_2^2 + 2M_2\left(\frac{R_{12}}{R_{11}}\right)\cos\psi}}$$

$$f_1 = \frac{\cos(G \sin\Theta) - \cos G}{(1 - \cos G)\cos\Theta}$$

Note: $M_1 = 1$, $G_1 = G_2 = G$

CMF of single mast is found from figure 52.

R_{11} is found from figure 52.

R_{12} is calculated from $R_{12} = Z_m \cos\gamma_m$.

Z_m, γ_m are found from figures 54 and 55 (magnitude, phase angle of mutual impedanceimpedance).

PART 4B: VHF FM RADIO

Notes on broadcasting planning

4B.1 Introduction

Part 4B consists of additional notes to the main guidelines, Part 3B – VHF FM Radio. The essential planning material is in 3B. Part 4B provides additional comments and gives examples of the processes involved in the use of 3B. The section headings in this part relate directly to the equivalent headings in 3B and if further explanation of a topic in 3B is required, then the appropriate section in 4B is easily located. Where no comment is considered necessary in part 4, headings only are provided to preserve the structure.

The propagation calculations for VHF-FM are covered in part 2.

4B.2 Frequency assignment

To carry out the necessary frequency selection and analysis process, certain information will be needed about the preferred frequency groupings for an area, together with information regarding established and proposed services which must be taken into consideration.

Information about established services is available in the book *Radio and Television Broadcasting Stations*, published by the ABA. This publication does not contain information about services that may be in the final stages of planning.

Relevant frequency planning information is also available from the Department in response to specific requests. The information provided may include:

. an indication of the preferred channel group for the area in question; and

. information from the national frequency allotment plans (when available).

Frequencies will not normally be reserved in advance of detailed planning and acceptance of a complete planning proposal or licence application. However, the Department may reserve some frequencies in advance, where planning policy considerations so determine.

Written requests for frequency planning information should clearly indicate the locality of interest and the type of service proposed (e.g. MF, VHF-FM, TV).

The Department may discuss the feasibility of specific frequency allotment proposals with a proposed sponsor or licence applicant in advance of their submission of a completed planning proposal or licence application. A written outline of the technical proposal should be forwarded to the Department for initial consideration before a meeting is held.

4B.3 Channels

4B.3.1 Channel numbering

The channels are to be designated by the nominal carrier frequency.

4B.4 Receiving antenna system

4B.4.1 Polarisation characteristics

Horizontal polarisation provides the best stereophonic service to fixed installations in moderately hilly terrain. The service to car radios is poor due to low antenna pickup and the presence of nulls (standing waves) which cause interruptions to reception in moving vehicles (mobile flutter).

By comparison, vertical polarisation can provide inferior stereophonic reception at fixed installations in moderately hilly terrain due to greater long range reflections and poor H-plane directivity of domestic receiving antennas, resulting in distortion. However, in flat open country there is not much to choose between vertical and horizontal polarisation for reception at fixed installations. Vertical polarisation provides a relatively good service to car radios irrespective of terrain conditions.

Circular or alternatively 45 degree slant polarisation caters for best reception by mobile and fixed installations. Either polarisation avoids annoying reception features in the mobile service caused by nulls with horizontal polarisation together with low antenna pickup, and permits the use of horizontally polarised receiving antennas for best stereophonic reception at fixed installations in moderately hilly terrain.

4B.5 Coverage criteria

4B.5.1 Minimum field strength

The necessary minimum field strengths specified in section 3B.5.3 are those needed to overcome interference from industrial and domestic equipment, or natural noise.

In the absence of interference from industrial and domestic equipment a field strength (measured at 10 m above ground level) of at least 48 dBμV/m is considered adequate to give an acceptable monophonic service and a field strength of 54 dBμV/m can give an acceptable stereophonic service.

For planning purposes the minimum field strength at which protection against interference shall be provided is 54 dBμV/m. This field strength is considered suitable to provide adequate reception in a rural environment, and under most circumstances, when this field strength is protected, mono reception should be available down to a field strength of 48 dBμV/m.

4B.5.2 Usable field strength

A usable field strength is calculated for each region within a station's service area. This is the lowest level of field strength that should be planned for the region to ensure that a technically acceptable grade of service will be available.

In the absence of interference from other services, the usable field strength at a receiving location is generally determined by the level of noise at that location and is equivalent to the minimum field strength as defined in section 3B.5.3.

In urban and suburban areas, the predominant noise will be from domestic electrical appliances, electric power lines and motor vehicles. In quiet rural areas, however, the predominant noise is expected to be VHF-FM receiver thermal noise. Since electrical noise levels generally increase with increases in residential and industrial development, the minimum required signal levels vary with the character of the receiver location.

In the presence of interference from other services, the actual (interference limited) usable field strength of a service may be in excess of the minimum (noise limited) field strength.

4B.5.3 Measurement height

All field strength predictions and measurements are made at a height of 10 metres above ground level.

It is necessary to adopt a standard height and this height is already used for television field strength measurements and for many field strength prediction curves. It also minimises ground and obstruction effects. When conducting field strength measurements several measurements should be made and the median derived to minimise the effect of local disturbances.

4B.5.4 Maximum field strength

As a high field strength may cause receiver overload which may produce spurious unwanted signals in the receiver, the field strength is limited to 110 dBμV/m.

4B.6 Interference and usable field strength

When considering the potential to cause interference to reception of an existing broadcasting service (or conversely, when considering the potential for an existing broadcasting service to cause interference to reception of a proposed new service) specific ratios of wanted to unwanted signal levels are nominated as suitable 'protection ratios' to be applied under various circumstances.

It should be noted that these guidelines do not contain protection ratios as such which may be applied to interference due to natural or man made noise. In the absence of interference from other services, adequate coverage of a service area may be said to be achieved in circumstances where the mean field strength is equal to, or greater than, the relevant level specified in 3B.5.3.

Where interference from other services is the limiting factor, adequate coverage will be achieved when conditions outlined above are met. Specific values of protection ratios to be applied when considering various sources of interference are identified in section 3B.7.

4B.6.1 Continuous and tropospheric interference

Differing protection ratios for continuous and tropospheric interference are specified. This is an attempt to take into account the subjective annoyance of interference which, on the one hand is present the whole time and on the other hand only becomes apparent occasionally. For small percentages of the time a higher level of interference can be tolerated than would be acceptable on a continuous basis.

An acceptable method of deciding whether the interference is continuous or tropospheric is based on the 'fading range' of the interfering signal. The fading range is the difference (in dB) between the field strengths exceeded for 1% of the time and 50% of the time. A value of 10 dB is taken to be the cut-off between continuous and tropospheric interference, i.e. if the fading range is less than 10 db then the interference is taken as being continuous.[44]

4B.7 Interference between VHF-FM services

Reserved.

4B.8 Interference from VHF-FM to television and aeronautical services

Reserved.

4B.9 Interference to VHF-FM from television and aeronautical services

Reserved.

4B.10 Total interference contribution from a number of stations

The root-sum-square (RSS) method (incorporating a 6 dB exclusion principle) should be used when calculating the total interference contribution involving a number of interfering transmissions.

The procedure to follow is outlined as an example:

. Calculate the individual values of usable field strength (Ea) of the wanted service, considering each source of interference acting alone.

eg. if the service is subject to interference from two sources:

(a) co-channel interference from a distant transmitter (tropospheric interference) with an estimated field strength of 19 dBµV/m;

(b) adjacent channel interference from a nearby transmitter (continuous interference) with an estimated field strength of 32 dBµV/m.

Then the individual interference contributions would be as follows:

(a) Co-channel Interference

The required wanted to unwanted signal strength ratio for protection against co-channel tropospheric interference is 37 dB (see 3B.7.1);

Ea = 37 + 19 = 56 dBµV/m

(b) Adjacent Channel Interference

The required wanted to unwanted signal strength ratio for protection against adjacent channel continuous interference is 27 dB (see 3B.7.1);

Ea = 27 + 32 = 59 dBµV/m

. Determine the RSS value of the combination of the sources of interference, i.e. the resultant RSS value (Eu) is determined using the formula:

$$Eu = 10 \log \sum 10^{(0.1\ Ea)}$$

In the above example Eu = 60.8 dBµV/m

. 6 dB Exclusion Principle

If a potential source of interference occurs where Ea is –6 dB or less with respect to the calculated value of Eu, then it shall be disregarded.

If, for example, a third source of interference were present with a resultant Ea equal to say 54 dB then this may be considered as having no effect upon the value of Eu as its value is 6.8 dB less than that of Eu.

It should be noted that the above calculations have been made on the assumption that the receiving installation incorporates an omnidirectional antenna system, i.e. the actual calculated values of unwanted field strength have been used in determining a value for Eu.

In addition, note that a contribution due to the presence of noise has not been included in the calculation. Where the calculated Eu does not exceed the minimum field strength value due to noise alone, then the coverage area of the transmitter under consideration would still be noise limited.

Therefore, in the above example, stereo coverage in a suburban area would still be limited by noise while the rural coverage would be limited by interference (refer to section 3B.5.3.).

4B.11 Effective radiated power (ERP)

Reserved.

4B.12 Transmitting antenna radiation pattern

Directional antennas may be useful in providing a required ERP in given directions for coverage purposes, while at the same time avoiding interference to other services by restricting the ERP in the direction of those services.

In other cases directional antennas may conserve transmitter power with a consequent cost saving and a better engineered solution.

The consideration of siting, transmitter power and antenna radiation pattern is an iterative process that depends on channel availability within each individual area under consideration.

4B.13 Siting of transmitters

The coverage and interference requirements of the guidelines dictate that transmitting locations have certain typical characteristics. They will generally need line of sight to the principal community in the service area; wide and medium coverage services will usually require high sites in sparsely settled areas although most low powered services will not; and all sites will need a transmitting antenna clear of structures or natural obstructions which could cause shadow losses or reflections.

Several lower power sites may provide better coverage than a single higher powered site, while still meeting the interference requirements of the guidelines. The availability of an off-air signal at relay sites may also be a consideration in some cases.

4B.13.1 Co-siting

Co-siting of VHF-FM and TV services which have similar service areas has two important planning advantages:

- the quality of reception is improved because interference between services is minimised when all signals have similar levels; and
- the reduced interference allows greater utilisation of the VHF-FM frequency spectrum.

Transmitting facilities are considered to be effectively co-sited if no significant proportion of the population to be served is in areas where large differences in field strengths occur.

In areas where there are a large number of FM services and these services are assigned frequencies close together, co-siting of transmitters is particularly important. The ‘worst-case’ situation, where co-siting would be essential, would be where a number of services are assigned frequencies 800 kHz apart and it is necessary for the transmitting facilities to be situated in a built-up area. In this instance not only should the facilities be situated in the same immediate area but they should, if possible, transmit from the same tower and use the same antenna.

Where there is no suburban development in the immediate vicinity of the transmitter sites, they may be separated by quite some distance and still be considered to be co-sited. For instance, if FM transmitting facilities are situated in an elevated area to one side of the area to be served, they could be separated by up to 5 km without gross differences in received signal strengths occurring.

There are other advantages in co-siting. A smaller number of sites will result in lower establishment cost per facility, less impact on the environment and less difficulty of installation of receive aerials - since all fixed receiver antennas would be pointing in the one direction, it would be possible to use one antenna for all VHF services.

4B.13.2 Maximum levels of field strength

Above a field strength of about 110 dBμV/m (at 10 m above ground level) a significant proportion of FM receivers may suffer from overloading due to the high signal levels. Even if a receiver is not overloaded it may suffer from adjacent channel interference such that, in the presence of a very strong signal, a weaker signal cannot be received clearly.

The 110 dBμV/m field strength ‘contour’ is to be estimated using free-space propagation and including a nominal 2 dB clutter loss component. Allowance shall be made for the vertical radiation pattern of the transmitting antenna. Because there will usually be no significant obstructions in the immediate foreground of transmitting sites the use of free space propagation (including clutter loss) to estimate the 110 dBμV/m field strength 'contour' is considered accurate to within $\pm$3 dB.

4B.14 Translator and off-air relay facilities

4B.14.1 Determination of technical conditions at transposer sites

In planning the installation, the design objectives will be related to the population to be served. Where there is no financial penalty in providing a technically superior service, this is obviously preferred. The essential consideration is to ensure reliability of the signal and an appropriate field strength level throughout the area to be served.

4B.14.2 Median input signal levels

The main requirements of transposer input signals are the median input signal level, the reliability of the signal and the quality of the received signals.

The median input signal levels at transposer sites (and intermediate off-air relay sites) are determined using calculations based on point-to-point propagation.

Details pertaining to these calculations are given in part 2 of these guidelines.

4B.14.3 Signal variations

For radio paths in excess of 50 km, consideration must be given to fading of the wanted signal and enhancement of unwanted signals. Statistical variations of field strengths as a function of distance, frequency, effective transmitting antenna height and environment are discussed in part 2 of these guidelines.

4B.14.4 Benefits derived from diversity reception

The reliability of propagation paths which are subject to severe fading may be greatly improved in some circumstances by the use of diversity reception techniques.[46]

4B.15 Reference receiver

Reserved.

PART 4C: VHF/UHF TELEVISION

Notes on broadcasting planning

4C.1 Introduction

Part 4C consists of additional notes to the main guidelines in Part 3C – VHF/UHF Television. The essential planning material is in 3C. Part 4C provides additional comments and gives examples of the processes involved in the use of 3C. The section headings in this part relate directly to the equivalent headings in 3C and if further explanation of a topic in 3C is required, then the appropriate section in 4C is easily located. Where no comment is considered necessary in part 4, headings only are provided to preserve the structure.

The propagation calculations are covered in part 2.

4C.2 Frequency assignment

To carry out the necessary frequency selection and analysis process, certain information will be needed about the preferred frequency groupings for an area, and established and proposed services.

Information about established services is available in the book *Radio and Television Broadcasting Stations*[7], published by the ABA. This publication does not contain information about services that may be in the final stages of planning.

Relevant frequency planning information is available in response to specific requests. The information that can be provided includes:

. an indication of the preferred channel or channel group for the area in question; and

. information from the national frequency allotment plan (when available)

Frequencies will not normally be reserved in advance of detailed planning and acceptance of a complete planning proposal or licence application. However, the Department may reserve some frequencies in advance, where planning policy considerations so determine.

Written requests for frequency planning information should clearly indicate the locality of interest and the type of service proposed (e.g. MF, VHF-FM, TV).

The Department may discuss the feasibility of frequency assignment proposals, in advance of the applicant submitting a completed formal proposal or licence application. A written outline of the technical proposal should be forwarded to the Department for initial consideration before a meeting is held.

4C.3 Channel frequencies

Reserved.

4C.4 Receiving antenna system

Reserved.

4C.4.2 Polarisation

The receiving antenna polarisation discrimination applies within and beyond the radio horizon as propagation through the troposphere generally does not change the polarisation of the transmitted signal.

4C.5 Coverage criteria

In the absence of interference from other services, the minimum field strength which would provide adequate reception at a receiving location is determined either by the level of man-made (electrical) noise at that location or by factors such as receiver noise, cosmic noise, antenna gain and transmission line loss.

For the VHF bands in urban and suburban areas, the predominant noise will be interference from domestic electrical appliances, electric power lines and motor vehicles. In quiet rural areas, however, the predominant noise is expected to be TV receiver thermal noise, as it is generally for the UHF band.

Since electrical noise levels generally increase with increases in residential and industrial development, the minimum required VHF signal levels vary with the character of the receiving location.

Energy levels from sources of man-made interference within the five TV bands are greatest in Band I and in general, tend to decrease as the transmission frequency increases, particularly above 100 MHz. The most significant exception relates to car ignition interference which increases with increase in frequency.

However, this creates reception problems only near major roads and is largely of an intermittent nature and therefore no provision has been made for its effect in the planning guidelines. Furthermore, this interference can normally be controlled by suitable suppression devices.

In the presence of interference from other services, the actual (interference limited) usable field strength of a service may exceed the minimum (noise limited) field strength.

The nomination of a minimum field strength as a planning guide assumes as a reference a notional receiving system, and does not imply that levels lower than this value would prevent reception of an acceptable grade of service if an adequate receiving facility were provided. Similarly, it does not guarantee that an acceptable grade of service would be achieved at field strength levels higher than the minimum field strength if the receiving installation is deficient in some way.

4C.5.1 Measurement height

All field strength predictions (and measurements) are for a height of 10 metres above ground level. As field strength generally increases with height, it is necessary to adopt a standard height; 10 metres has been widely used for field strength measurement and prediction. This height is also typical of a receiving installation near the edge of the coverage area.

Several measurements should be made and the median derived to minimise the effect of local disturbances.

4C.5.2 Maximum field strength

As a high field strength may cause receiver overload which may produce spurious unwanted signals in the receiver, the field strength is limited to 110 dBμV/m.

4C.6 Interference protection ratios

4C.6.1 Protection ratios

When considering the potential to cause interference to reception of an existing broadcasting service (or conversely, when considering the potential for an existing broadcasting service to cause interference to reception of a proposed new service) specific ratios of wanted to unwanted signal levels are nominated as suitable 'protection ratios' to be applied under various circumstances.

Where a source of potential interference does not vary markedly with time it is said to be continuous, and the protection ratio is chosen so that a minimum subjective picture impairment rating of 4 can be achieved by at least 50% of receivers within any community in a station's service area for at least 50% of the time.

In circumstances where the potential interfering signal is not continuous in nature, whether brought about as result of 'tropospheric' (long distance) propagation or some other intermittent source of interference, the protection ratio is chosen so that a minimum subjective picture impairment rating of 3 can be achieved by at least 50% of receivers within any community in a station's service area for at least 90% of the time.

It should be noted that these guidelines do not contain protection ratios as such which may be applied to interference due to natural or man-made noise. In the absence of interference from other services, adequate coverage of a service area may be said to be achieved in circumstances where the mean field strength is equal to, or greater than, the relevant level specified in section 3C.5.4.

Where interference from other services is the limiting factor, adequate coverage will be achieved when conditions outlined above are met. Specific values of protection ratios to be applied when considering various sources of interference are identified in sections 3C.7, 3C.15 and part 3B.

4C.6.2 Continuous and tropospheric interference

Differing protection ratios for continuous and tropospheric interference are specified. This is an attempt to take into account the subjective annoyance of interference which, on the one hand is present the whole time and on the other hand only becomes apparent occasionally. For small percentages of the time a higher level of interference can be tolerated than would be acceptable on a continuous basis.

An acceptable method of deciding whether the interference is continuous or tropospheric is based on the 'fading range' of the interfering signal. The fading range is the difference (in dB) between the field strengths exceeded for 1% of the time and 50% of the time. A value of 10 dB is taken to be the cut-off between continuous and tropospheric interference, ie if the fading range is less than 10dB then the interference is taken as being continuous.[44]

4C.7 Interference - offset techniques and co-channel interference

The picture display system of a television receiver functions as a comb filter, tending to reduce perception of signals which bear certain relationships to the line and frame frequencies. The offset technique makes use of this phenomenon. An interfering co-channel is demodulated as a signal whose frequency is the difference between the wanted and the interfering signals. By choosing this difference frequency appropriately the subjective effect of the interfering channel is reduced.

The table[18] shows the normally accepted protection ratios for various frequency differences.

Table 4C.1
Protection Ratios

Multiples of 1/12 line frequency	0	1	2	3	*4	5	6	7	*8	9	10	11	12
Transmitter Stability													
±500 Hz (non-precision offset)													
Tropospheric	45	44	40	34	30	28	27	28	30	34	40	44	25
Continuous	52	51	48	43	40	36	33	36	40	43	48	51	52
±1 Hz (precision offset)													
Tropospheric	30	34	30	26	22	22	24	22	22	26	30	34	30
Continuous	36	38	34	30	27	27	30	27	27	30	34	38	36

* Protection ratios applicable when preferred offset frequencies are used.

The protection ratios given are valid up to about 50 kHz if multiples of the line frequency (H) are added to the offset.

Precision offset frequencies (i.e. using offsets which use the filtering effects which occur at television frame rates) are calculated as shown below.

The preferred value is finely adjusted so that it is greater or less than multiples of one third of the line frequency by certain odd number multiples of the frame frequency (V/2).

O.F. = m x H ± (2n + 1) V/2 Hz
O.F. = m x 15625 ± (2n + 1) 25 Hz
O.F. = offset frequency
m = 0, 1, 2, 3 ...
n = is a whole number in the vicinity of 104 which provides an offset frequency not more than ±150 Hz removed from that particular multiple of one third of the line frequency.
V = field frequency

This relationship provides the required difference between the nominal frequencies of the two carriers. Each of the carrier frequencies needs to be maintained within ± 1 Hz and the line frequencies maintained with a stability equal to or better than 1×10^{-6}, for the precision offset protection ratios given in the table to be attained.

The protection ratios obtained through the application of precision offsets, presumes that the amplitude of the short-term instability of the carrier frequencies is maintained within acceptable limits and which will depend on the frequency of the deviations corresponding to the instability.

4C.8 Interference - receiver deficiencies

4C.8.2 Limits imposed on coverage by interference caused by local oscillator radiation from domestic receivers

The local oscillator signal generated in a television receiver is nominally 36.875 MHz higher in frequency than the vision carrier frequency of the wanted television service.

For example, the local oscillator of a receiver tuned to channel 7 (vision carrier 182.25 MHz) will have a nominal local oscillator frequency of 219.125 MHz. This lies within the frequency band of channel 11 (215-222 MHz) and a signal may be radiated from the antenna installation causing interference to other receivers tuned to a wanted channel 11 service. Consequently, due to this interference risk, the channel 7/channel 11 pair or other channel pairs which have a similar frequency relationship are not usually allotted for use in the same region.

4C.9 Interference - miscellaneous

Reserved.

4C.10 Interference - summation

4C.10.1 Total interference contribution from a number of transmissions

The root-sum-square (RSS) method (incorporating a 6 dB exclusion principle) should be used when calculating the total interference contribution involving a number of interfering transmissions.

The procedure to follow is outlined as an example:

. Calculate the individual values of usable field strength (Ea) of the wanted service, considering each source of interference acting alone.

eg. if a TV service is subject to interference from two sources:

(a) Co-channel interference from a distant TV transmitter (tropospheric interference), with an estimated field strength of 22 dBμV/m using a 10 kHz non-precision frequency offset (approximately 8/12 line frequency) between the vision carrier frequencies.

(b) Lower adjacent channel interference from a TV transmitter providing a service to an area adjacent to the service area of the (wanted) TV station under consideration (steady interference), with a field strength of 55 dBμV/m.

Then the individual interference contributions would be as follows:

(a) Co-channel Interference

The required wanted to unwanted signal strength ratio for protection against co-channel tropospheric interference is 30 dB (see 3C.7.1);

Ea = 30 + 22 = 52 dBµV/m

(b) Adjacent Channel Interference

The required wanted to unwanted signal strength ratio for protection against lower adjacent channel interference is –4 dB (see 3C.BB 1.4);

Ea = -4 + 55 = 51 dBµV/m

. Determine the RSS value of the combination of the sources of interference, i.e. the resultant RSS value (Eu) is determined using the formula:

$Eu = 10 \log \sum 10^{(0.1\ Ea)}$

In the above example, Eu = 54.5 dBµV/m

. 6 dB Exclusion Principle

If a potential source of interference occurs where Ea is –6 dB or less with respect to the calculated value of Eu, then it may be regarded as being insignificant.

If, for example, a third source of interference were present with a third source of interference were present with a resultant Ea equal to say 48 dBµV/m then this may be considered as having no effect upon the value of Eu as its value is 6.5 dB less than that of Eu.

It should be noted that the above calculations have been made on the assumption that the receiving installation incorporates an omnidirectional antenna system, ie the actual calculated values of unwanted field strength have been used in determining a value for Eu. Where necessary, allowance should be made for receiving antenna directivity and/or polarisation discrimination as defined in section 3C.15.

In addition, note that a contribution due to the presence of noise has not been included in the calculation. Where the calculated Eu does not exceed the minimum field strength value due to noise alone, then the coverage area of the transmitter under consideration would still be noise limited.

Therefore, if the above example related to a Band III TV service, coverage in a suburban area would still be limited by noise while the rural coverage would be limited by interference (see 3C.5.4).

4C.11 Effective radiated power

Reserved.

4C.12 Transmitting antenna radiation pattern

Directional antennas may be useful in providing a required ERP in given directions for coverage purposes, while at the same time avoiding interference to other services by restricting the ERP in the direction of those services.

In other cases, directional antennas may conserve transmitter power with a consequent cost saving and a better engineered solution.

The consideration of siting, transmitter power and antenna radiation pattern is an iterative process that depends on channel availability within each individual area under consideration.

4C.13 Siting of transmitters

The coverage and interference requirements of the guidelines dictate that transmitting locations have certain typical characteristics. They will generally need line of sight to the principal community in the service area; wide and medium coverage services will usually require high sites in sparsely settled areas although most low powered services will not; and all sites will need a transmitting antenna clear of structures or natural obstructions which could cause shadow losses or reflections.

Several lower power sites may provide better coverage than a single higher powered site, while still meeting the interference requirements of the guidelines. The availability of an off-air signal at relay sites may also be a consideration in some cases.

4C.13.1 Co-siting

Co-siting of VHF-FM and TV services which have similar service areas has two important planning advantages:

- the quality of reception is improved because interference between services is minimised when all signals have similar levels; and
- the reduced interference allows greater utilisation of the frequency spectrum.

Transmitting facilities are considered to be effectively co-sited if no significant proportion of the population to be served is in areas where large differences in field strengths occur.

Where there is no suburban development in the immediate vicinity of the transmitter sites, they may be separated by quite some distance and still be considered to be co-sited. For instance, if the services are situated in an elevated area to one side of the area to be served, they could be separated by up to 5 km without gross differences in received signal strengths occurring.

There are other advantages in co-siting. A smaller number of sites will result in lower establishment cost per service, less impact on the environment and less difficulty of installation of receiving antennas – since all fixed receiver antennas would be pointing in the one direction, it would be possible to use one antenna for all services.

4C.13.2 Maximum levels of field strength

Above a field strength of about 110 dBμV/m (at 10 m above ground level) a significant proportion of receivers may suffer from overloading due to the high signal levels. Even if a receiver is not overloaded it may suffer from adjacent channel interference such that, in the presence of a very strong signal, a weaker signal cannot be received clearly.

The 110 dBμV/m field strength 'contour' shall be estimated using free space propagation and including a nominal 2 dB clutter loss component. Allowance must be made for the vertical radiation pattern of the transmitting antenna. Because there will usually be no significant obstructions in the immediate foreground of transmitting sites the use of free space propagation (including clutter loss) to estimate the 110 dBμV/m field strength ‘contour’ is considered accurate to within ±3 dB.

4C.14 Off-air relay sites and transposers

4C.14.1 Median input signal levels

The main requirements of transposer input signals are the median signal level, quality and reliability.

The median input signal levels at transposer sites (and intermediate off-air sites) are determined using calculations based on point-to-point propagation.

Details pertaining to these calculations are given in part 2.

4C.14.2 Signal variations

For radio paths in excess of 50 km, fading of the wanted signal and enhancement of unwanted signals must be considered. Statistical variations of field strengths as a function of distance, frequency, effective transmitting antenna height and environment are given in part 2.

4C.14.3 Difficulties with re-transmitting frequency combinations

The translation of a VHF input channel to an adjacent VHF channel poses difficulties due to the small percentage frequency difference between the occupied bands of adjacent channels. While adjacent channel translation is practical at VHF its use should be avoided where possible. Good isolation between input and output antennas will be required, and the output power may be limited.

Translation of a UHF input channel to an adjacent UHF channel is much more difficult because of the smaller percentage difference between the occupied bands of the adjacent channels and should not be proposed without consulting transposer manufacturers.

4C.14.4 Non-frequency changing transposers

If the area to be served is well isolated from the surrounding inhabited areas, it may be possible to use a non-frequency changing translator; thereby permitting a simpler, cheaper installation (essentially only an amplifier) and saving the use of another television channel.

However, non-frequency changing translators require very special conditions:

- It must be possible to provide a very high isolation between the output and input antennas, not only to prevent oscillations, but to prevent waveform distortions due to unwanted signals at the input. The isolation needs to be at least 20 dB higher than the gain of the translator.
- The above requirement places limits on the maximum output power and the minimum input signal which can be accommodated.
- The translator must not cause ghosting interference to surrounding inhabited areas, nor suffer ghosting interference in its own service area from the main signal (as defined by section 3C.9.2).

4C.14.5 Reliability and diversity reception

The reliability of propagation paths which are subject to severe fading may be greatly improved in some circumstances by the use of diversity reception techniques.[45]

4C.15 Reference television receiving system

Reserved.

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PART 6: GLOSSARY OF PLANNING TERMS

Terminology adopted in this glossary is based on definitions given in the International Radio Regulations or by other Internationally recognised authorities. Terminology definitions given here are for the express purpose of promoting consistent use of the engineering and technical applications of these guidelines.

Audio-frequency signal-to-interference ratio[43]

Ratio between the values of the voltage of the wanted signal and the voltage of the interference, measured under specified conditions, at the audio-frequency output of the receiver.

This ratio is generally expressed in dB and corresponds closely to the difference in volume of sound (expressed in dB) between the wanted program and the interference.

Audio-frequency protection ratio[43]

Agreed minimum value of the audio-frequency signal-to-interference ratio considered necessary to achieve a subjectively defined reception quality.

This ratio may have different values depending upon the type of service desired.

Beam tilt

The angle of depression of the axis of the main lobe of the vertical radiation pattern of the transmit antenna.

Broadcasting transmitter

A radio transmitter operating for the purpose of the transmission of radio (or television) programs to the general public under the *Broadcasting Act 1942* or the *Broadcasting Corporation Act 1983*.

Channel

Part of the frequency spectrum, the width of which is equal to the necessary bandwidth of the emission, and which is characterised by the nominal value of the carrier frequency.

Coverage area

That area wherein technically adequate reception can be obtained with a notional receiver (and notional receiver antenna installation) based upon Australian standards. It may well (and frequently does) extend beyond the defined 'service area'.

Cymomotive force (CMF)[43]

The product formed by multiplying the electric field strength at a given point in space, due to a transmitting station, by the distance of the point from the antenna. This distance must be sufficient for the reactive components of the field to be negligible; moreover the finite conductivity of the ground is supposed to have no effect on propagation. The CMF is a vector; when necessary it may be expressed in terms of components along axes perpendicular to the direction of propagation. The CMF is expressed in volts; it corresponds numerically to the unattenuated field strength in mV/m at a distance of 1 km.

Effective radiated power (ERP)

The ERP in any given direction is the product of the input power to the antenna and the antenna gain in that direction. The antenna gain is referred to the maximum gain of a half-wave dipole.

Local sunrise

The time at which the uppermost portion of the sun’s disc would just appear above an unobstructed horizon to an observer at mean sea level in a standard atmosphere.

Local sunset

The time at which the uppermost portion of the sun's disc would just disappear below an unobstructed horizon to an observer at mean sea level in a standard atmosphere.

Low coverage service (VHF-FM services)

That service which provides coverage of a sub-metropolitan area, or coverage of a small town and the immediate surrounding area. The average power level of this service ERP in the direction of maximum radiation would not exceed 1 kW ERP.

Medium coverage service (VHF-FM services)

That service which provides coverage of a metropolitan area, or coverage of a large town and surrounding area. The ERP will be dependent upon the size of the area to be served. Where this service is sited near the centre of the area to be served it will use a omni-directional antenna. If the service is sited to one side of the area to be served a directional antenna should be used to ensure the best possible coverage and minimise the unnecessary, and hence wasted power.

Null fill

The process where nulls in the vertical radiation pattern of the antenna are filled in to ensure that areas of poor reception do not occur close to the transmitter site.

Off-air relay

The use of the transmitted signals of a broadcasting station as the input signal of another station, usually of lower power. Use may be either direct, as with a transposer, or indirect via a link.

Radio-frequency wanted-to-interfering signal ratio[43]

Ratio between the values of the radio-frequency voltage of the wanted signal and the interfering signal, measured at the input of the receiver under specified conditions.

This ratio is generally expressed in dB.

Radio-frequency protection ratio[43]

Value of the radio-frequency wanted-to-interfering signal ratio that enable, under specified conditions, the audio-frequency protection ratio to be obtained at the output of a receiver.

These specified conditions include such diverse parameters as spacing of the wanted and interfering carrier, emission characteristics (type of modulation depth, etc.), receiver input and output levels as well as the receiver characteristics (selectivity and susceptibility to cross-modulation, etc.).

Service area (in relation to a licensed service)[9]

The area served pursuant to the licence. It is determined by the Minister under the provisions of the *Broadcasting Act 1942*, and is the area in which the licensee has an obligation to provide an adequate and comprehensive service. It is recognised, however, that because of topographical features there may be pockets of poor reception within such an area.

The Department interprets the service area concept to mean that it has an obligation to provide and/or recommend technical conditions to allow a licensee to serve the people within the licensee's service area, but not elsewhere.

Service area does not have the meaning given in reference 43.

Synchronized network (for medium frequency stations)

A group of transmitters whose carrier frequencies are identical (or differ only slightly, usually by a fraction of a hertz), and which broadcast the same program.

Transposer

A broadcasting station, generally of low power, which obtains its input program directly from the transmission of another broadcasting station and retransmits the program without demodulation to base band.

Usable field strength[43]

The minimum value of field strength necessary to permit satisfactory reception, under specified conditions in the presence of radio frequency noise and interference.

Wide coverage service (VHF-FM stations)

That service which provides coverage of a metropolitan area and adjacent rural area, or regional coverage comparable with that of existing television main stations.