4. Technical framework

In this Chapter ...

- **an explanation of the technical framework underpinning licensing in the 800 MHz band**
- **an explanation of the purpose and operation of the section 145 Determination of Unacceptable Interference**
- **an explanation of the Advisory Guidelines that manage in-band and out-of-band interference with other services**
- **other important information about the technical framework**

Overview

The technical framework for the 800 MHz band has been established to potentially support a wide range of radiocommunications services, including mobile and fixed services with narrow-band or wide-band capabilities.

The framework seeks to minimise negotiation necessary between adjacent licensees for the management of in-band and out-of-band interference in most circumstances. Nonetheless, spectrum licensees may negotiate among themselves and, where relevant, with apparatus licensees, for alternative management arrangements about emission levels. Spectrum licensees should note, however, that alternative arrangements are not possible unless all affected and potentially affected licensees agree.

Included in these flexibility provisions is a prescribed *Form of Agreement* (included in the *Radiocommunications Spectrum Marketing Plan (800 MHz Band) 2000* at Licence Schedule 5). The *Form of Agreement* provides a template for any agreements that relate to spectrum licensees agreeing to accept emissions that would, in the absence of those agreements, exceed the core conditions of their spectrum licence(s). For example, spectrum licensees might agree alternative arrangements with other licensees for higher levels of emission outside the frequency band of the spectrum licence, or for higher levels of radiated power across a geographic area boundary, than would have otherwise been allowed. Flexibility within the core conditions of licence gives effect to such arrangements between licensees. Applicants are advised to review carefully the arrangements set out for agreements between spectrum licensees, and between spectrum licensees and others, contained in the *Radiocommunications Spectrum Marketing Plan (800 MHz Band) 2000***.**

The inherent flexibility of a spectrum licence acquired in this allocation is left for the licensee to determine. This should, however, be based on a careful technical and commercial assessment before the auction, in order to confirm that the desired spectrum space is sufficient to sustain the performance of the network and equipment the bidder desires to operate. The spectrum lots and subsequently issued licences are not pre-designed to accommodate any particular network design. They may accommodate the

operation of a particular technology, as well as non-standard equipment, at a particular location and frequency, depending on the size and shape of the licence that a bidder acquires.

The technical framework is crafted using three regulatory elements:

- licence core conditions, which are mandatory requirements made under section 66 of the Act;
- a Determination of Unacceptable Interference for the purpose of device registration, made under section 145 of the Act; and
- Radiocommunications Advisory Guidelines made under section 262 of the Act.

The licence core conditions and the determination of unacceptable interference are used to keep significant levels of emission within the spectrum space of the licence. The advisory guidelines provide a framework for the management of interference with specific devices as required, usually associated with apparatus-licensed and class-licensed services operating within the limits of the 800 MHz band and surrounding spectrum.

The technical framework is predicated on the assumption that:

- spectrum and apparatus licensees will employ good engineering practice in establishing and maintaining their services;
- receivers employed by spectrum licensees will, as a minimum, meet the minimum receiver performance levels set out in Schedule 1 of the *Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed Transmitters - 800 MHz Band) 1998* (see **Attachment 9**); and
- spectrum licensees will be responsible for managing interference that they, or authorised third parties, cause to their own services.

The following general principles are pertinent to this technical framework:

- The ACA has attempted to provide maximum flexibility to spectrum licensees to establish services.
- Emission limits have been specified as absolute power levels (in EIRP) rather than power levels relative to transmitter power, allowing licensees to strike a balance between the maximum radiated power of a device and its out-of-band performance.
- The core conditions indirectly specify frequency stability by requiring the emission limits outside the band to be maintained under all conditions. A licensee is able to balance device emission bandwidth against frequency stability, by providing internal ‘guard bands’ as necessary.
- Spectrum licensees have the responsibility to manage interference that arises within 200 metres of devices registered under their licences.

The interference mechanisms that the technical framework seeks to manage are those caused by:

- unwanted in-band emissions;
- emissions falling outside the frequency band of the licence; and
- intermodulation effects.

These mechanisms are dealt with by a combination of the core conditions relating to out-of-area and out-of-band emissions and those parts of the registration process which give effect to those conditions at the point of registration of devices prior to their operation.

It should be noted that agreements between licensees can only continue to apply while the size and the shape of the spectrum space owned by licensees remain unchanged. Where trading of licences takes place and new boundaries are formed, these agreements will need to be re-negotiated. This re-negotiation can occur at any time, that is, before or after the trade, so that there is no loss of flexibility to licensees.

When trading occurs by means of the division of spectrum space, and agreements are not in place, a check will be required to ensure that existing devices still meet the requirements of the licence within the changed spectrum space.

The comments made within this chapter indicating how the interference management regime might affect proposed services and spectrum utility are not intended to be exhaustive. Potential spectrum licensees are reminded to take such expert technical and other advice necessary to inform themselves of possible effects on their proposed services.

Licence Core Conditions

This part of the chapter explains what the core conditions of the licence are intended to achieve (a sample licence can be found in the *Radiocommunications Spectrum Marketing Plan (800 MHz Band) 2000)* (**Attachment 2**), and how the emissions subject to those conditions are further managed under the technical framework.

For each licence, the core conditions set out:

- the geographic area;
- the frequency band;
- the out-of-area emission limits; and
- the out-of-band emission limits.

Geographic area

The geographic area or aggregate of areas within which the operation of radiocommunications devices is authorised by the licence is described in Part 3 of Licence Schedule 1.

Frequency band

The frequency band of the licence within which the operation of radiocommunications devices is authorised by the licence consists of the contiguous range of frequencies between the upper and lower frequency limit set out in Part 2 of Licence Schedule 1.

Out-of-area emissions

Out-of-area emission limits, through the Determination of Unacceptable Interference, protect geographically adjacent licensees. A fixed transmitter operated under an 800 MHz spectrum licence may be located anywhere in the geographic area of the licence. However, emissions from the transmitter must not cause the radiated powers outside the geographic bounds of the licence to exceed the limit imposed by core conditions 3 to 7 of the licence; as mentioned previously these limits can be extended by agreement with adjacent licensees.

Emissions from a fixed transmitter operated under a spectrum licence located anywhere in the geographic area of the licence are limited by core conditions to a horizontally radiated power (measured within a 30 kHz bandwidth) of 59 dBm EIRP. The conditions, therefore, effectively place an overall cap on power at the boundary and also throughout the entire geographic area of a licence.

An additional layer of out-of-area management is imposed at the point of registration of devices; this is discussed in detail in the later section "Determination of Unacceptable Interference".

Out-of-band emissions

Out-of-band emission limits, through the Determination of Unacceptable Interference, protect licensees in adjacent spectrum. Out-of-band emission limits are imposed by core conditions 8 to 15 of the licence. A licensee or accredited person must work out the radiated power of the device within specified bandwidths outside the frequency band of the licence using good engineering practice to establish whether the operation of a device will cause 'unacceptable interference' by breaching these emission limits.

Out-of-band emission limits have been expressed in the form of absolute levels, rather than levels relative to the transmitter output power, to allow licensees to operate transmitters with an optimised balance between power and out-of-band emission suppression. These levels may be varied through negotiated agreement with affected adjacent licensees.

If the power calculated is greater than a figure specified in the relevant licence condition, two things follow:

- if the device is not yet registered - the ACA will generally refuse to register it, because the interference that it would cause will be 'unacceptable interference' within the meaning of section 145 of the Act, (unless, for example, all relevant licensees agree alternative arrangements);

- if the device is already registered - there will be a breach of the core licence condition, unless all relevant licensees have agreed to the alternative arrangements.

The limits for out-of-band emissions have been chosen to enable adjacent STU operation for systems located more than 200 metre apart (within this distance additional interference management measures may need to be taken by licensees- see next section).

Other licence conditions

Whilst core conditions go some way to limit interference to adjacent services their primary purpose is to define the coverage of the spectrum licence. Some additional protection from interference may be required beyond that provided indirectly through the core conditions. One method of implementing this protection is by including other conditions in the licence.

Interference management at sites

The licence includes a condition requiring the licensee to manage interference within 200 metres of a device operated under this licence. This condition has been included due to the difficulty in specifying emission limits to prevent interference between a large range of services that may operate in close proximity at prime radiocommunications sites.

To manage out-of-band interference, spectrum licensees may for example have to utilise guard bands between licensees, install filters at the edges of their spectrum, and/or negotiate with adjacent licensees either to employ transmitter filtering or avoid placing transmitters near the frequency boundary at certain locations.

Determination of Unacceptable Interference

Before a transmitter can be operated under a spectrum licence its details must be recorded in the register. The ACA may refuse to register a device if the licensee or accredited person cannot show that the requirements deemed to prevent unacceptable interference are met. These requirements are detailed in the relevant determination made by the ACA under section 145 of the Act - the *Radiocommunications (Unacceptable Levels of Interference – 800 MHz Band) Determination 2000* (**Attachment 5**).

The Determination sets out basic requirements to manage unacceptable levels of interference:

- that the core conditions of the licence are met;
- that specified device boundary criteria are met; and
- that specified device deployment constraints are met; and
- that full details of the transmitter are provided for the register.

Device Boundary Criteria

Before registering a device a licensee or accredited person must, in addition to checking that the core conditions are maintained, calculate the device boundary of the transmitter in accordance with the relevant determination made by the ACA under the *Radiocommunications (Unacceptable Levels of Interference – 800 MHz Band) Determination 2000.* This involves establishing the distance, along radials from the transmitter, that is required for the emission level to drop below what the ACA considers to be the typical sensitivity that will be achieved by receivers in adjacent geographic areas. The distance along each radial is based on a mathematical propagation model. The model takes account of the terrain loss of emissions by adjusting the antenna height of a device according to its height above average terrain, called its effective antenna height. Effective antenna heights are calculated every 5 minutes in distance along each radial. The ACA publishes software tools for calculating tables of effective antenna heights for any location in Australia.

The effect of the device boundary procedure is to create 'emission buffer zones' along the geographic boundaries of a licence. It is an important element of the framework because it specifies an exact and direct procedure to determine the maximum radiated power of a transmitter (based on the effective antenna height and distance from the boundary) that cannot be challenged by an adjacent licensee. The direct nature of the limit means that licensees can work closer to the geographic boundary of the licence than otherwise because no reliability margins are required to ensure specified field strengths occurs at a boundary. In addition, licensees can accurately plan for transmitters operated by adjacent spectrum licensees across the area boundary at any time in the future. Also, the device boundary may or may not be based on actual propagation models depending on the outcome required. Additionally, it provides a simple facility for establishing agreements between licensees for sharing spectrum space across area boundaries by employing a single parameter which may be varied to expand or contract the device boundary to provide more or less in-band protection respectively.

If the device boundary falls outside the geographic area of the relevant spectrum licence the ACA will, generally speaking, refuse to register the device because the levels of emission outside the licence that it would cause will be 'unacceptable interference' within the meaning of section 145 of the Act. An exception to this general rule can be made where there is an agreement in the form prescribed in the *Radiocommunications Spectrum Marketing Plan (800 MHz Band) 2000.* In these circumstances, the agreement provides that a device boundary may exceed the licence boundary of a licensee because the adjacent licensee has specifically agreed to that and accepts any interference caused to its use of the spectrum.

Under the section 145 determination, emissions from a mobile transmitter are limited to a horizontally radiated power (measured within a 30 kHz bandwidth) of 46 dBm EIRP. Additionally, a device boundary does not need to be established for mobile or indoor fixed transmitters where the radiated power is less than 38 dBm per 30 kHz.

Deployment Constraints

Whilst the two core conditions aimed at emission levels provide some measure of protection from intermodulation effects, the ACA considers it necessary to provide further means of protection against this interference mechanism. To this end the

licensing framework imposes some constraints on the deployment of transmitters. The ACA does not intend to impose deployment constraints on receivers, and the onus will lie on spectrum licensees to determine the best siting for their receivers, having regard to the overall technical framework.

It is, however, important to note that the technical framework does not provide any protection from intermodulation effects where transmitters are sited within 200 metres of each other. Consequently spectrum licences include a special condition requiring spectrum licensees to come to an arrangement with neighbours in relation to interference in such cases.

The deployment constraints vary from band to band. The constraints are generally expressed in terms of effective antenna height (calculated using the average ground height within approximately 10 kilometres of each device) or through limits on power levels. For a more detailed explanation of effective antenna height, please see the relevant section 145 determination.

Lower 800 MHz Band (825 - 845 MHz)

In this band transmitters must be deployed at less than an effective antenna height of 10 metres. In this case the effect of the framework is to effectively protect high-sited receivers, and the ACA anticipates that spectrum licensees will site their receivers in this way to obtain a reasonable service area. Potential licensees should have regard to this when considering potential sites and the utility of the spectrum.

Upper 800 MHz Band (870 - 890 MHz)

In this part of the 800 MHz band transmitters may be deployed at any effective antenna height. The ACA has adopted this course to provide maximum flexibility for spectrum licensees in country areas where the likelihood of nearby services (receivers) at low sites is low, and consequently the siting of transmitters at low sites may be expected, generally speaking, not to cause any problems. The potential for interference in the 800 MHz band is further limited by the fact that transmitters will be confined below the 10 metre level across the whole of the lower 800 MHz band across the entire country. Consequently, because transmitters in the lower band must be at low sites, and because it is assumed that the spectrum will be used in paired bands (but not necessarily — see below), it can be anticipated that transmitters in the upper band will generally be at high sites. Although the ACA has not required that transmitters in the upper band be placed at high sites, and the receivers at low sites, the ACA considers that this will be the natural result of the combination of the deployment constraint in the lower band plus paired band usage.

If spectrum licensees follow this anticipated siting of transmitters in the upper 800 MHz band, interference from intermodulation effects will normally be a co-siting issue, and fall for resolution between spectrum licensees and others under the special condition requiring negotiation where transmitters are sited within 200 metres of each other.

If, however, spectrum licensees take advantage of the flexibility to site transmitters operating in the upper 800 MHz Band at less than 10 metres above effective ground level, and intermodulation interference arises within 200 metres of a receiver, the spectrum licensee will bear the responsibility for managing the interference.

Registration of Devices

The ACA will, generally speaking, refuse to register a device whenever it would give rise to levels of emission outside the licence that would be 'unacceptable interference' within the meaning of section 145 of the Act.

The ACA has provided for exceptions to this general rule (under the *Radiocommunications Advisory Guidelines (Registration of Devices under Spectrum Licences without an Interference Impact Certificate) 1998*). The exception can be made where it is shown that there is sufficient internal spectrum guard space or where there is an agreement, in the form prescribed in the *Radiocommunications Spectrum Marketing Plan (800 MHz Band) 2000*. In these circumstances, the agreement provides that emissions of a device may exceed the core conditions of a licence because the adjacent licensee has specifically agreed to that, and accepts any interference caused to its use of the spectrum space. Spectrum licensees should take such expert technical and other advice they consider necessary to inform themselves of this aspect of the technical framework.

The corollary of this aspect of interference management is that spectrum licensees must expect that certain levels of emission will legitimately cross their geographic (and spectrum) boundaries from points within other spectrum licensed areas. Accordingly, when considering what services they might establish within their own geographic areas, spectrum licensees should take into account the fact that transmitters may be located at certain points within other spectrum licensed areas. Furthermore, those transmitters may radiate power into the spectrum licensee's area at any level up to that allowed under the relevant section 145 determination of unacceptable interference, or levels otherwise negotiated with the relevant spectrum licensees.

The ACA recommends that radiocommunications devices are registered at the system design stage. This will enable other licensees, if they wish, to re-check the coordination and if an obvious error is detected, negotiate directly with the spectrum licensee before further costs are incurred when transmitters cannot be operated due to interference. The registration of devices never intended for operation is not recommended because this has the potential to inhibit unnecessarily the operation of adjacent licensees' devices.

Registering Groups of Transmitters and Receivers

The Determination also sets out the definition of a group of transmitters and a group of receivers for the purpose of simplifying registration of those devices. The Determination specifies how the registration details for a group of transmitters and receivers must be calculated.

Unless exempted, transmitters must always be registered as either an individual transmitter or as part of a group of transmitters. If two or more transmitters are operated for the purpose of communicating with the same receiver or same group of receivers

and they have identical emission characteristics, then those transmitters may be treated as a group in order to simplify the registration process. A transmitter may belong to more than one group. Groups are defined to help minimise the work associated with the registration process of similar transmitters, for example, subscriber transmitters and multiple transmitters at a hub. Subscriber transmitters may be registered as a group. A group of devices may have location details consisting of a centre and an associated effective radius that can take into account the distribution of subscriber transmitters. Mobile and indoor transmitters are exempted from device registration requirements. Licensees may decide whether to register receivers based on a risk assessment of the benefits achieved through coordination to manage out-of-band interference.

Radiocommunications Advisory Guidelines

There are three Radiocommunications Advisory Guidelines made under section 262 of the Act issued by the ACA associated with spectrum licensing of the 800 MHz band. They are:

- *Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed Transmitters—800 MHz Band) 1998* (**Attachment 9**);
- *Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed Receivers—800 MHz Band) 1998* (**Attachment 10**); and
- *Radiocommunications Advisory Guidelines (Protection of Molonglo Observatory Synthesis Telescope) 1998* (**Attachment 11**).

These guidelines do not bind licensees or the ACA. This approach has been adopted in order to provide the maximum flexibility for both spectrum and apparatus licensees in how they arrange their affairs so as to avoid interference between services. The ACA is prepared to consider alternative interference management arrangements agreed between spectrum licensees and, where relevant, apparatus licensees. Spectrum licensees should note, however, that the ACA would not give effect to alternative arrangements unless all affected and potentially affected licensees have agreed (subsequent trading of spectrum will affect any agreements made previously).

Licensees who are unable to resolve interference issues between themselves may expect the ACA to have regard to the guidelines in dealing with such disputes.

Managing Interference from Apparatus-licensed Transmitters

The *Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed Transmitters-800 MHz Band) 1998* contains information for spectrum licensees on managing interference from non-spectrum-licensed services.

Only registered receivers will receive protection in the planning of services by the ACA. For the management of interference from out-of-band services, the ACA in this guideline has set out a minimum performance level for receivers in the 800 MHz band and a compatibility requirement for transmitters of apparatus-licensed services. These criteria provide a basis upon which spectrum and apparatus licensees are able to develop procedures for the management of interference between services, using good engineering practice.

Receiver performance. As mentioned previously, licensees will need to take account of the emission limits permitted under the technical framework when deciding the level of performance they require for their receivers. Receivers will cope with emission levels with differing degrees of success, depending on their interference susceptibility. A receiver with poor performance would normally deny large amounts of spectrum space for transmitters in order to protect it from interference. The ACA does not intend to enforce receiver standards. It is for licensees to balance the cost of receiver performance against the cost of spectrum space denied to their transmitters.

Poor receiver performance is only an issue when a licensee attempts to use spectrum space belonging to an adjacent licensee as part of the receiver protection requirement. The framework provides for the operation of receivers that have interference susceptibility commensurate with that achieved by current technology and intends for this level of performance to guide the interference settlement process. Receivers with poor interference susceptibility performance can be used, but in those cases licensees may have to use more of their own spectrum space as guard space. For example, interference that results from a receiver having a RF or IF bandwidth that is larger than the frequency band of the licence will be the licensee's responsibility. It is the licensee's responsibility to use receivers in a manner that is both consistent with good engineering practice and effectively copes with the levels of emissions permitted under the technical framework.

Protecting Apparatus-licensed Receivers

The *Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed Receivers—800 MHz Band) 1998* contains information for spectrum licensees regarding protection they should provide to non-spectrum-licensed receivers.

These guidelines apply to the protection of receivers of trunked land mobile services, narrowband point to point services, wide-band point-to-point services, studio transmitter links, GSM base receivers and AMPS receivers, which operate in various parts of the 800 MHz band.

Radiocommunications Advisory Guidelines (Protection of Molonglo Observatory Synthesis Telescope) 1998

The *Radiocommunications Advisory Guidelines (Protection of Molonglo Observatory Synthesis Telescope) 1998* provides information for spectrum licensees regarding protection to be provided to the Molonglo Observatory Synthesis Telescope (MOST). The MOST is a radio telescope located approximately 30 km to the east of Canberra that monitors radio signals from weak celestial radio sources in a frequency band centred on 843 MHz. These advisory guidelines set out the compatibility requirement to provide the MOST with a reasonable level of interference protection from transmitters operating in this band. A suggested approach to assessing the compatibility is also provided. The compatibility requirement will cease at the end of 2008.

Interference that the technical framework does not prevent

No matter how rigorous the engineering analysis of a device, there is always a possibility of actual interference when devices are deployed in the field. This is because

the technical framework is designed according to certain levels of acceptable interference probability. Under the framework described in this Chapter, it is anticipated that interference between spectrum licensed devices will occur at about the same rate as between apparatus licensed devices, that is, interference will arise in fewer than one percent of cases. Such interference may be caused by emissions at frequencies either inside or outside licensees' spectrum space.

Licensees are strongly advised before making an interference complaint to attempt to locate the source of any interference by checking the Register of Radiocommunications Licences (http://www.aca.gov.au/database/radcomm/index.htm). This investigation may indicate the likely cause of the interference and it may be possible to settle the problem without the ACA's intervention. If the ACA becomes involved, licensees may be charged for any work undertaken.

International co-ordination

The ITU Radio Regulations have international treaty status and are binding on Australia. Transmitters operated under a spectrum licence, other than in accordance with ITU Radio Regulations, must not cause interference to any services of any other country (for example, Papua New Guinea or Indonesia) which are operating in accordance with ITU Radio Regulations. If operation of a transmitter does cause harmful interference to overseas services operating in accordance with ITU Radio Regulations, the transmission must cease. Spectrum licensees must also accept interference from any overseas service operating in accordance with ITU regulations. Spectrum licensees should note that the ACA will impose such additional licence conditions on spectrum licences as may be necessary from time to time to meet Australia's international obligations.

Health and safety

Every spectrum licensee will need to take into account occupational health and safety requirements for radiofrequency devices. Occupational health and safety requirements that concern use of radiofrequency devices are currently the responsibility of State and Territory Governments.

In addition, licensees will be required to comply with any health exposure standards that may be made by the ACA for the health and safety of persons who operate, work on or use radiocommunications transmitters and receivers.

Environmental and other considerations

A spectrum licence only authorises the operation of devices, and does not confer any rights on the licensee to erect infrastructure. Antenna siting, height and construction may be regulated by State, Territory or local government legislation. Licensees should investigate the local rules pertaining to the erection of towers and antennas before planning for a device to operate in a certain location. However, the holders of carrier licences under the *Telecommunications Act 1997* may, in some circumstances, obtain limited immunity from such legislation for the erection of certain infrastructure. The ACA recommends that applicants seek legal and other specialist advice on this issue.

Obtaining a permit to operate non-standard devices

A licensee who wishes to operate standard devices under a spectrum licence (that is, equipment that conforms to mandatory ACA standards) does not need to apply to the ACA for permission to do so. However, a permit will be required to supply or operate any non-standard devices. These permits may be issued by the ACA under section 167 of the *Radiocommunications Act 1992*, and will only be issued during the term of the licence.

Permits to supply non-standard devices for operation under a spectrum licence may also be issued by the ACA under section 174 of the Act.