

Open Spectrum Submission

Proposal to remake apparatus
and broadcasting licence
condition determinations

JANUARY 2025

January 2025

The Manager, Broadcasting Carriage Policy Section
Australian Communications and Media Authority
PO Box 78
Belconnen ACT 2616

via email to bcp@acma.gov.au

Dear Sir/Madam,

Introduction

Open Spectrum thanks the ACMA for consulting on the proposal to remake the *Radiocommunications Licence Conditions (Broadcasting Licence) Determination 2015* ("the Broadcasting LCD 2015") as the *Radiocommunications Licence Conditions (Broadcasting Licence) Determination 2025* ("the Broadcasting LCD 2025").

Open Spectrum's co-founders and engineers include ACMA-Accredited Persons (APs) who carry out radiofrequency (RF) coordination and assignment for a range of Low Power Open Narrowcasting (LPON) operators. We are also the creators of the online ACMA licence search and RF prediction tool, Maprad.io¹.

Field strength condition is not fit-for-purpose

We are concerned about the **field strength condition** in sections 4.9 and 4.10 of the Broadcasting LCD 2015 being re-made in sections 18 and 19 of the Broadcasting LCD 2025. The field strength condition prohibits signal levels from an LPON transmitter to exceed 48 dBµV/m at a distance of more than 2 km / 10 km² from the transmitter. We believe that the field strength condition is too stringent to allow LPON licensees to provide reasonable stereophonic sound quality up to 2 km / 10 km from a station's antenna.

The main problem with the field strength condition is that, theoretically, a 1-Watt transmitter cannot comply with the 48 dBµV/m field strength limit at 2 kilometres from the station's antenna under line-of-sight (LOS) conditions. Similarly, a 10-Watt transmitter cannot comply with the field strength limit at 10 km from the station's antenna under LOS conditions. This is demonstrated in the equations below. The only way that the field strength limit can be satisfied in practice is if there is terrain obstruction or building clutter over the propagation path.

Furthermore, there is a remarkable disconnect between the field strength condition and the ACMA's stated objective of the LPON planning model—to provide reasonable stereophonic sound quality up to 2 km from a station's antenna, since 48 dBµV/m is less than the minimum field strength required for adequate reception of FM transmissions in the presence of noise in suburban and urban areas (or even for stereo in rural areas), as per the ACMA's own planning documents.

¹ Available here: <https://maprad.io/au>

² Throughout this response, the term "2 km / 10 km" refers to the nominal coverage area radius for LPON transmitters in "residential areas" (i.e. 2 km) and in "non-residential areas" (i.e. 10 km).

Supporting theoretical calculations

The limit of 48 dBµV/m (referred to as “the limit” for simplicity) does not equate to 1 Watt at 2 km.

The derivation of field strength at a particular distance from the transmitter is as follows:

$$\begin{aligned} E \text{ [dB}\mu\text{V/m]} &= \text{EIRP [dBm]} - 20 \cdot \log_{10}(d \text{ [m]}) + 104.8 \\ &= 10 \cdot \log_{10}(1.66) + 30 - 20 \cdot \log_{10}(2000) + 104.8 \end{aligned}$$

E (residential) = 71 dBµV/m

This means that a 1.66 Watt EIRP emission, with line-of-sight (LOS) to a point 2 km away, would fall to a field strength of 71 dBµV/m, which is 23 dB above the ACMA’s limit. This means that, wherever a point 2 km from an LPON transmitter has LOS to that transmitter, the transmitter would automatically be in breach of the current section 4.9 of the the Broadcasting LCD 2015.

Due to the significant margin by which this level exceeds the limit (23 dB), the transmitter would also be in breach even for many locations that are non-LOS (NLOS) from transmitter.

For the current section 4.10 of the Broadcasting LCD, which allows a larger distance of 10 km beyond which the field strength must fall below the limit, but is intended for a transmitter with a higher power level:

$$\begin{aligned} E \text{ [dB}\mu\text{V/m]} &= \text{EIRP [dBm]} - 20 \cdot \log_{10}(d \text{ [m]}) + 104.8 \\ &= 10 \cdot \log_{10}(16.7) + 30 - 20 \cdot \log_{10}(10000) + 104.8 \end{aligned}$$

E (non-residential) = 67 dBµV/m

... the calculated field strength exceeds the limit by 19 dB.

Therefore, it is almost certain that a significant proportion of LPON services cannot comply with the limits of sections 4.9 and 4.10 (whichever is applicable to the transmitter’s location) since compliance would necessitate either terrain obstruction or building clutter along the path between the transmitter and a point 2 km / 10 km away, *for every azimuth/bearing around the transmitter*, and that the associated diffraction losses and/or clutter losses are at least as large as the exceedance margins calculated above (23 dB and 19 dB, whichever is applicable to the transmitter’s location).

The following extract from the ACMA’s audit³ reveals exactly that: *“The average measured field strength for transmitters was found to be significantly more than the permitted level of 48 decibels microvolt per metre squared (dBµV/m²)⁵. The ACMA is concerned that only 30% of licences measured during field audits were operating at a compliant field strength, with a number of licensees operating at 20 times [i.e. 13 dB higher than] the permitted level.”*

⁵ The average found was 51.33 dBµV/m². [i.e. 3.33dB higher than the permitted level, on average]

We are aware that the ACMA considers that the appropriate solution to address the field strength condition being exceeded is for licensees to reduce their transmitter power. Along azimuths where there is LOS to a point 2 km / 10 km from the station’s antenna, the 1W / 10W

³ ACMA, October 2024, Compliance priority 2023-24 report: LPON audit, available here: <https://www.acma.gov.au/publications/2024-09/report/compliance-priority-2023-24-report-lpon-audit>

transmitter power output would need to be reduced to 1/200th (-23 dB) or 1/80th (-19 dB), respectively.

In light of the above, we disagree with such exceedance of the limit resulting in the transmitter being labelled an “overpowered transmitter”; if the transmitter complies with the EIRP of 1.66 Watts is being satisfied (or 16.6 Watts in non-residential areas), then the transmitter is not overpowered⁴. In its audits, the ACMA should endeavour to separate cases of non-compliance with the field strength condition, and cases where the transmitter is actually overpowered (i.e. exceeding the applicable 1W / 10W transmitter power limit).

We believe, given the above, it is established that (according to the theory), it is highly impractical for all LPON licensees to comply with the 48 dB μ V/m limit.

Consideration of alternative paths/propagation models

Noting that the assessment above focuses on free space loss to points with LOS from the transmitter, we used our RF Tools in Maprad.io to investigate both (a) whether LOS from a low-site transmitter is reasonable to expect beyond 2 km and (b) use of other propagation models. We used our local neighbourhood of Yarralumla ACT as an arbitrary LPON transmitter site. Canberra is a reasonably hilly city with plenty of terrain to present obstructions to signals over distances of a few kilometres, but Yarralumla is not a particularly elevated location of Canberra and therefore serves as a “low-sited” location.

As a sanity check, we also performed these checks in Cobar NSW; arbitrarily selected as a town in a relatively flat area.

As can be seen in Figures 1 and 3, the assumption that there can be LOS, between two antennas at 10 metres above ground level, well beyond 2 km, is entirely reasonable. For Yarralumla, this is limited to a set of northerly and southerly azimuth ranges, however for Cobar, there is LOS at distances > 2 km for *most* azimuths/bearings.

As can be seen in Figures 2(a) and 4(a), using Recommendation ITU-R P.526, the field strength can exceed 48 dB μ V/m even for NLOS paths well beyond 2 km, due to diffraction over terrain.

The only coverage plot for which containing the coverage to 2 km appears even close to being achieved, is when the propagation model used is Recommendation ITU-R P.1546—see Figures 2(b) and 4(b). However, P.1546 is an empirical model where path loss curves were generated from empirical data measured over a range of many propagation paths. It therefore makes assumptions about the path between the transmitter and receiver point which may not necessarily exist, although that “on average” may be expected to give a reasonable answer.

As demonstrated with these coverage plots, one may form the conclusion that *“a 1-Watt transmitter into a unity-gain dipole can provide mono coverage in rural areas (i.e. field strength of at least 48 dB μ V/m) up to approximately 2 km from the transmitter”*. It is therefore reasonable to apply as a “rule of thumb” or first-pass target for planning purposes; however this observation is obviously completely different to the statement that *“the 1-Watt transmitter into a unity-gain dipole will not exceed 48 dB μ V/m anywhere beyond 2 km from the transmitter”*.

⁴ The additional factor of 1.66 is due to the antenna gain of 2.2 dBi (the gain of a standard, omnidirectional dipole antenna).

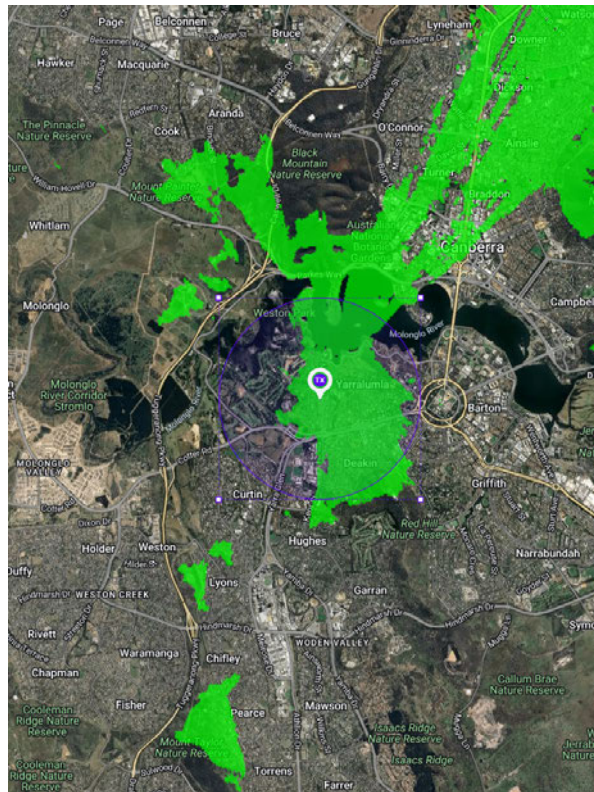


Figure 1—Area with line-of-sight (LOS) from a notional LPON transmitter at Yarralumla

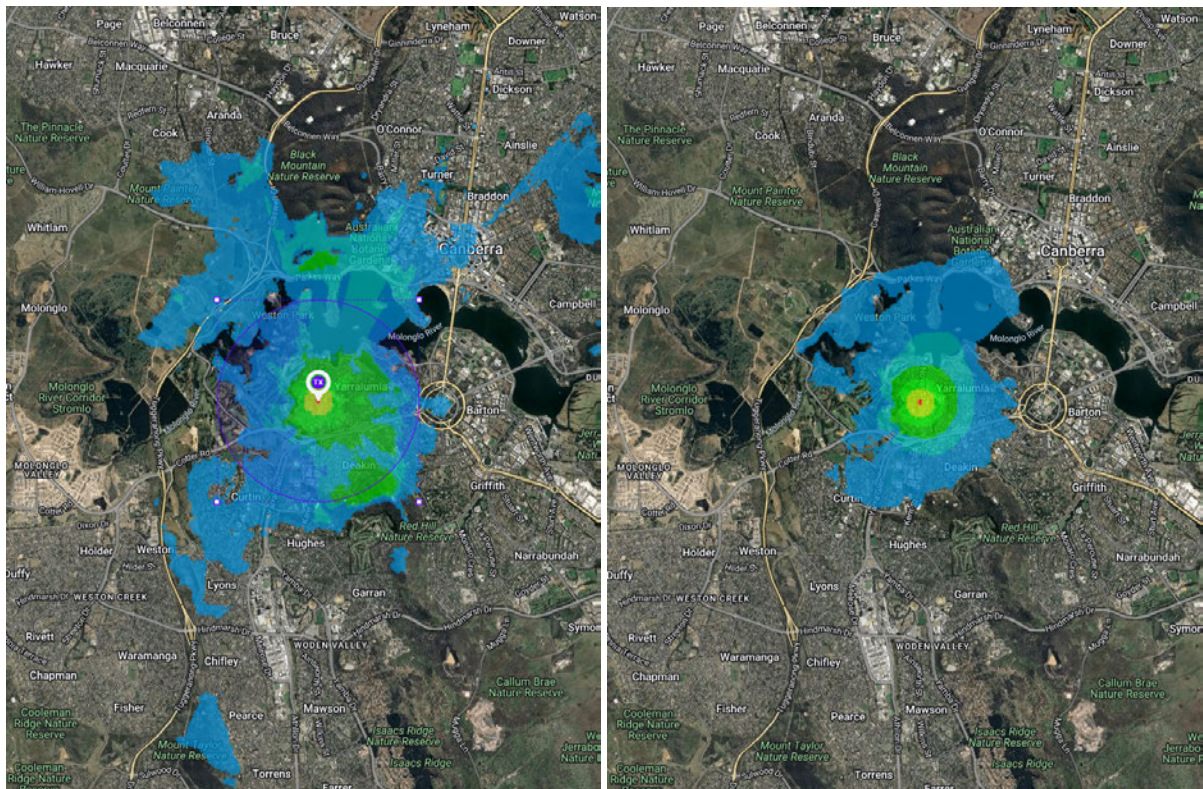


Figure 2—Area for which 48 dBμV/m is exceeded from a notional LPON transmitter at Yarralumla using (a) Rec. ITU-R P.526 and (b) Rec. ITU-R P.1546.

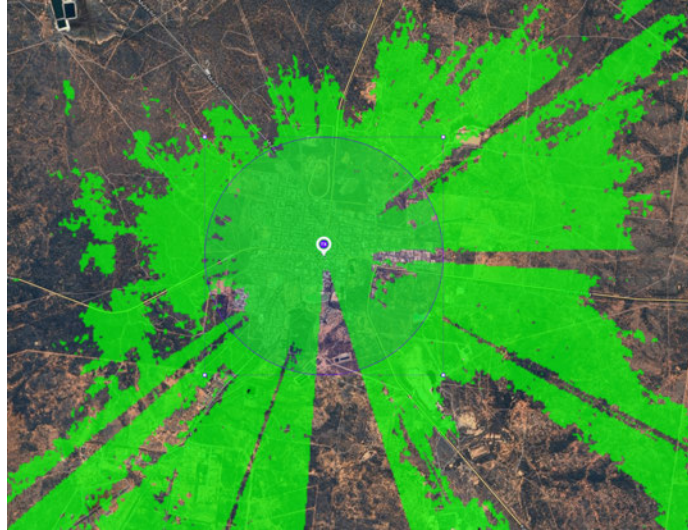


Figure 3—Area with line-of-sight (LOS) from a notional LPON transmitter at Cobar

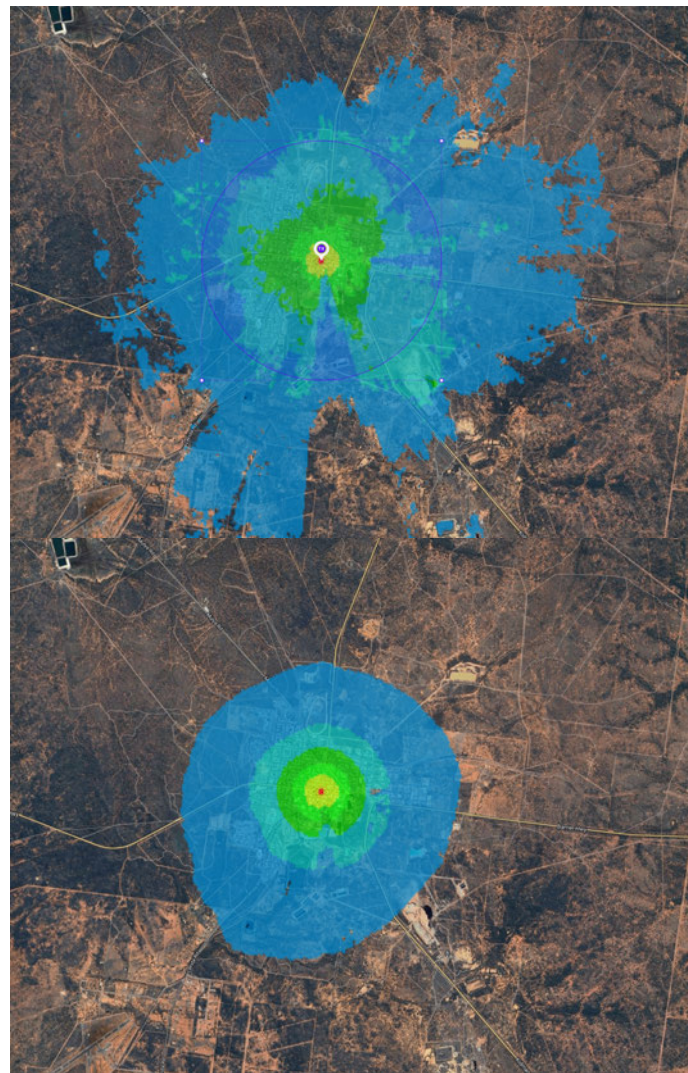


Figure 4—Area for which 48 dB μ V/m is exceeded from a notional LPON transmitter at Cobar using (a) Rec. ITU-R P.526 and (b) Rec. ITU-R P.1546.

Tension between field strength condition and planning model

The ACMA's audit report acknowledges that *"the planning model anticipated...for LPON stations to have reasonable stereophonic sound quality up to 2 km from a station's antenna"*. In the ABA's planning documents⁵, the minimum field strength for this is 48 dB μ V/m.

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 dB μ V/m (0.25 mV/m)	54 dB μ V/m (0.5 mV/m)
Suburban	60 dB μ V/m (1.00 mV/m)	66 dB μ V/m (2.0 mV/m)
Urban	70 dB μ V/m (3.00 mV/m)	74 dB μ V/m (5.0 mV/m)

In urban/built-up areas, the building clutter means that the actual receive antennas closer to the ground will receive even lower wanted signal at the same distance from the transmitter, as compared to a service in a rural environment. As such, the difference between the signal level required to be received by the receiver on the ground, and the planning field strength at 10m, needs to be even greater (to account for said building clutter, and also the higher man-made noise). As per the planning document, in Urban areas, stereo sound requires a signal with a field strength (at 10 metres) of 74 dB μ V/m...and all the way up to 2 km from the transmitter (as per the planning objective noted above). How is the signal supposed to be both (a) at least 74 dB μ V/m within 2 km, and (b) no more than 48 dB μ V/m beyond 2 km?

The field strength condition creates a hard discontinuity at the 2 km / 10 km boundary: within the boundary an operator can have a decent coverage up to 2km / 10km distance and beyond the boundary the operator of the service must not exceed this level beyond this distance. Such discontinuities do not exist in the real world and RF propagation does not play by such rules. The limit in question cannot go hand-in-hand with the planning model objective of reasonable coverage up to 2 km; they are contradictory. If the ACMA wishes to continue supporting LPON services that can reasonably be expected to provide coverage up to 2km, then the hard limit must be reviewed.

Furthermore, the 48 dB μ V/m value is for *mono* sound; for *stereo* it is 6 dB higher (at 54 dB μ V/m)! So, from the outset, the LPON licensee is being short-changed on the expectation to be able to provide stereo sound within 2 km.

⁵ Australian Broadcasting Authority, April 2004, *Technical Planning Parameters and Methods for Terrestrial Broadcasting*, available here: <https://www.acma.gov.au/sites/default/files/2019-11/Technical%20Planning%20Parameters%20and%20Methods%20for%20Terrestrial%20Broadcasting.pdf>

Examination of potential solutions

Above, it is established that (according to the theory), it is highly impractical for LPON licensees to comply with the limit. It follows that either:

1. the level of the limit is far too low (stringent); or
2. the imposition of a hard limit on field strength beyond a certain distance is not fit-for-purpose.

With respect to point #1 above, the solution would be to increase the field strength limit.

- Increasing the field strength limit to the levels derived above (i.e. 71 and 67 dBuV/m for the residential and non-residential cases, respectively) would obviate the need for the field strength limits in the first place, since it would be physically impossible to exceed them provided that the EIRP limits were being respected (i.e. you cannot have less than free-space loss, except for anomalous 'enhancement' effects for low percentages of time not relevant to the short distances discussed here).
- Increasing the field strength limit to some other level(s) between 48 and 71/67 dBuV/m might improve the situation and reduce the level of non-compliance to some degree. However, it will still mean that for any paths between the transmitter and a point 2/10 km away for which there is LOS, the transmitter would still be non-compliant. This may even apply in scenarios where deeming the transmitter as non-compliant makes no sense whatsoever.
 - For example, if a low-sited transmitter were in a valley, and more than 2 km / 10 km away (and within a particular range of azimuth angles) there is a terrain feature (e.g. mountain range), from which there is LOS to the low-sited transmitter, the transmitter would be non-compliant. In this case, basing non-compliance on the elevated part of the mountain range facing the transmitter is especially nonsensical, because the mountain range would actually provide considerable protection to any other services on the other side.

As such, simply addressing point #1 above by increasing the limit does not address the issues with these legislative provisions.

The 2 km and 10 km distances are meant to be nominal service area radii, while minimum separation distances for co-channel sharing—and at which the unwanted signal levels must be sufficiently below the wanted signals levels of the other service such that harmful interference is not caused—are much greater than this: 8 km⁶ and 20 km⁷, respectively. To have the boundary of a (wanted signal) service area and the boundary of the (unwanted signal) “interference area” at the same distance is not part of radiocommunications planning best practice. Wanted signal coverage areas are typically planned to levels well above the minimum (with margins included to account for, e.g. location variability), for high percentages of time. The consideration of unwanted signals would not include such margins and perhaps for low percentages of time. Different propagation models or model parameters are often used for both cases.

As such, we move to point #2 above, and recognise that the field strength condition is not fit-for-purpose, and **the solution is to review the meaning and intent of these provisions themselves.**

⁶ 10 km minimum separation distance minus 2 km to the edge of the 'victim' service's coverage area.

⁷ 30 km minimum separation distance minus 10 km to the edge of the 'victim' service's coverage area.

We recommend that, instead of being a hard limit, the 48 dBµV/m limit at 2 km / 10 km be revised to be stated as:

- a) a planning target as part of an LPON model which will minimise the risk of interference between adjacent services (particularly co-channel, adjacent-area services), and
- b) a threshold to which the ACMA will have regard to in determining which service would be the 'at fault' offending service in the case that interference occurs between two services and cannot be resolved between the respective licensees.

Note: point (b) is similar to the intent of the Radiocommunications Advisory Guidelines made under section 262 of the Radiocommunications Act 1992 ("the Act").

Even if the 48 dBµV/m limit at 2 km / 10 km could reasonably be implemented by LPON licensees, the current nature of the hard limit also unnecessarily restricts services where the adjacent area is served by the same licensee. Noting that the LPON planning models have "dead zones" of 6 km and 10 km in residential and non-residential areas (respectively), we cannot see why the dead zones could not be allowed to benefit from fortuitous coverage, if co-channel interference were not being caused in practice.

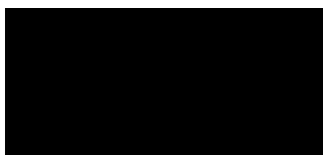
We believe that the legislated imposition of these dead zones between two services, without any regard to the terrain in between those services, or potential for agreements between the relevant licensees (including if the licensee is the same entity), is not in the public interest.

Conclusion

Open Spectrum supports the ACMA's proposal to remake the Broadcasting LCD, but we believe that the field strength condition needs to undergo significant changes such that it aligns with proper spectrum management practices by removing the hard discontinuity at the boundary of the nominal coverage area—where on one side reasonable coverage can be expected to be provided by the licensee and on the other side the field strength is expected to drop below the minimum threshold.

Open Spectrum looks forward to continue working with the ACMA and the wider radiocommunications industry.

Yours sincerely



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