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700 MHz Adjacent Channel Allocation Considerations

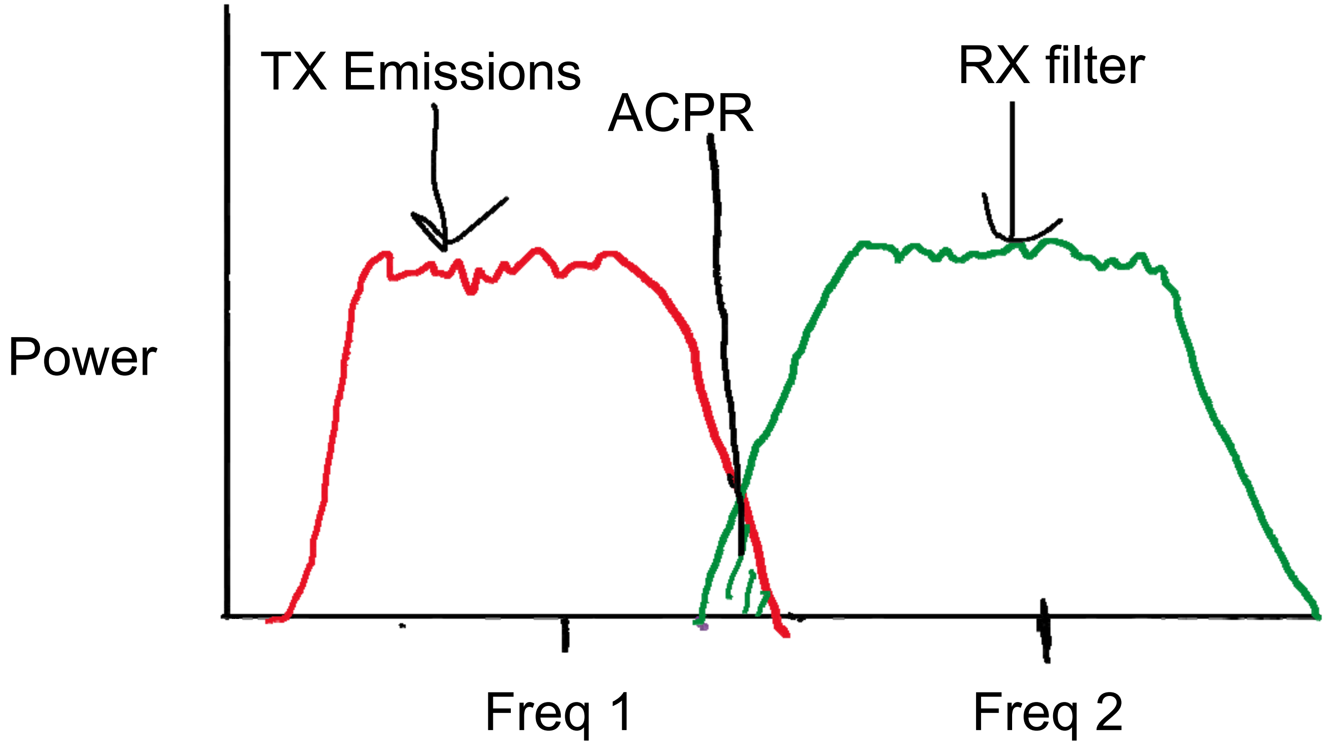
By David Buchanan

Concept of Adjacent Channel Power Ratio

- TIA TSB-88 defines the Adjacent Channel Power Ratio (ACPR) as:

> **ACPR Adjacent Channel Power Ratio**: The ratio of the total power of a transmitter under prescribed conditions and modulation, within its maximum authorized bandwidth to that part of the output power which falls within a prescribed bandwidth centered on the nominal offset frequency of the adjacent channel. ACPR = 1/ACP

What does that mean?



Assumptions:

- Assigning (or accepting) a new location adjacent to an existing allocation or licensed station assumes both systems use 12.5 kHz bandwidth technology
- If one or both systems use wider bandwidth technology such as TETRA or mobile data systems that occupy 25 kHz of bandwidth then different criteria must be used

Criteria for no Harmful Interference

- Determine the desired Delivered Audio Quality (DAQ). This is typically 3.0 but for public safety may be 3.4.
- DAQ 3.0 - Speech understandable with slight effort. Requires occasional repetition due to noise or distortion.
- DAQ 3.4 - Speech understandable without repetition. Some noise or distortion present.

Criteria for no Harmful Interference

- Decide on DAQ to use – for this presentation we will use 3.4
- Determine the CPC (or VCPC – voice) value for the technology used. In this case P25.
- Channel Performance Criterion (CPC): The CPC is the specified design performance level in a faded channel.
- For P25 this is 18 dB. So as long as the interfering signal is 18 dB lower than the desired signal there will **NOT** be harmful interference

Criteria for no Harmful Interference

- The ACPR ratio for P25 C4FM is 71 dB for a 12.5 kHz channel
- TSB-88 methodology states the interfering TX ERP can be reduced by the ACPR value and then used as a co-channel ERP to determine interference. So, a 100 WERP TX reduced by 71 dB would result in -21 dBm (.00000794 Watts or 111.8 dBu) as TX power of the adjacent channel TX

Criteria for no Harmful Interference

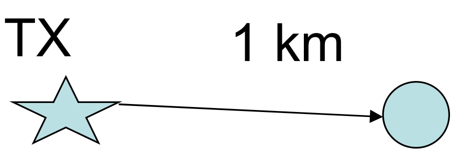
- Assume coverage signal strength – Almost all regions specify 40dBu for coverage, therefore interference signals can not be greater than 40-18 = 22 dBu

Example 1 – Worst Case

- Let's assume free space loss for a new station assumed to be 12.5 kHz adjacent to another station. The station has a TX ERP of 100 Watts. So, with the ACPR of 71 dB, the ERP is reduced to -21 dBm or 111.8 dBu
- Using free space loss formula, at 1 km (90.16 dB loss) from the new station the field strength is 21.64 dBu. This is just lower than the 22 dBu value that will not cause interference to an existing system that has a 40 dBu field strength.

Example 1 – Worst Case

This example is the worst case for adjacent channel use. It implies that as long as the incumbent mobile service area is more than 1 km away from the new There will not be interference.

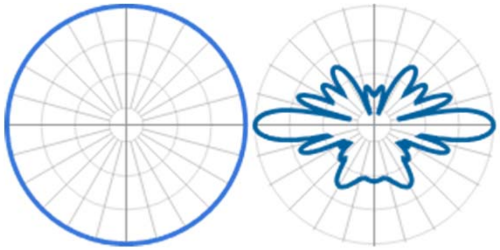


Example 2 – Best case

- Best case is when the two adjacent channel frequencies are used at the same location. That results in the interference from either TX to the adjacent mobile RX is always -71 dB lower than the desired signal.

Real World example

The Free Space Loss assumed an antenna gain of 0dB. As can be seen by the antenna pattern to the right, close distances to the antenna have negative antenna gain. This will have some positive impact on the free space loss to adjacent mobiles operating closer than 1 km to an adjacent station service area



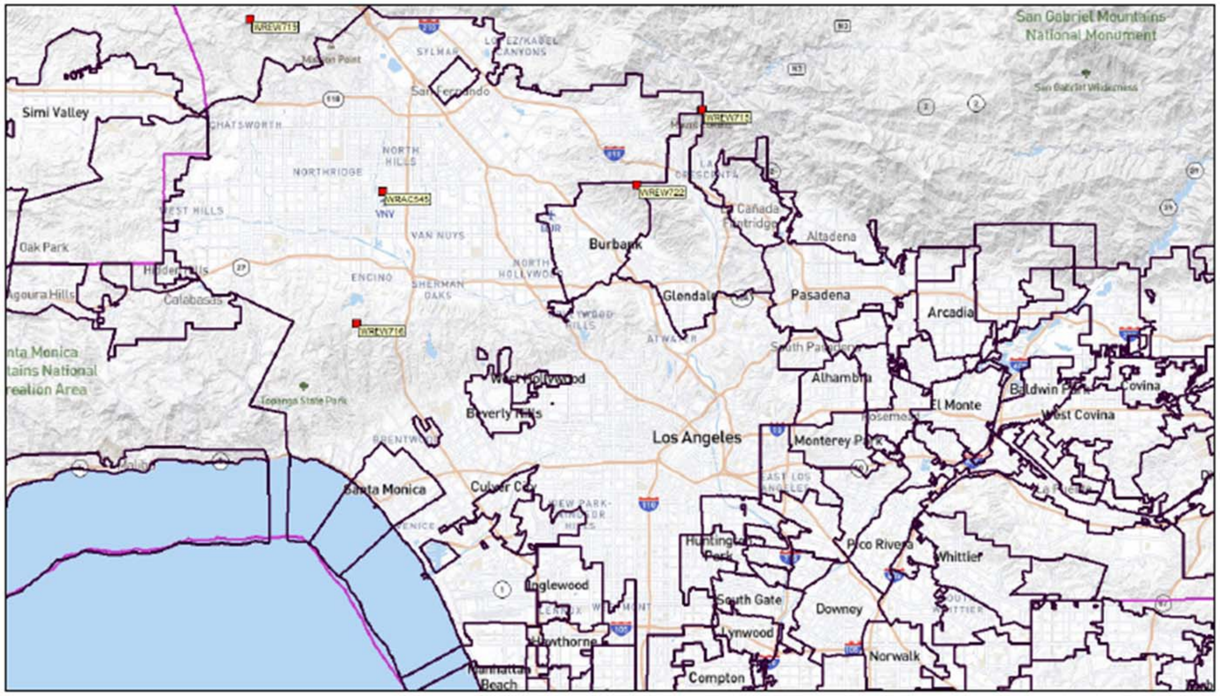
Real World example

- In many cases with two sites close spaced using adjacent frequencies, the actual signal strength will be greater than 40 dBu. Therefore, the chance of interference is less than if the signal strength was only 40 dBu
- If we look at other bands such as UHF, the frequency coordinators do not consider the 12.5 kHz adjacent channels when coordinating those channels. The ACPR for analog 2.5 kHz deviation is approximately 61 dB.

So, I’m still worried about using adjacent channels.

- Example of existing use cases:
  - LAWA to City of Los Angeles
  - Riverside County to itself
  - San Bernardino to itself Valley and Mountain sites
  - LA T-Band Example

Adjacent channel use in Region 5 - site locations



Callsign	Latitude	Longitude	Freq (MHz)	Antenna Height (m)	ERP (W)	Emission
WRAC545	34° 12' 56.0" N	118° 29' 34.0" W	772.13125000	21	50	8K10F1D
WREW716	34° 07' 43.0" N	118° 30' 47.3" W	772.11875000	6	66	8K10F1D
WREW719	34° 19' 44.0" N	118° 35' 55.3" W	772.11875000	24	63	8K10F1D
WREW722	34° 13' 11.2" N	118° 17' 25.5" W	772.11875000	34	50	8K10F1D
WQPJ604	34° 16' 08.0" N	118° 14' 20.3" W	772.11875000	30	450	8K10F1D
WREW715	34° 16' 09.0" N	118° 14' 16.0" W	772.11875000	18	66	8K10F1D
WRNR203	33° 51' 29.0" N	118° 13' 27.0" W	772.14375000	37	100	8K10F1D
WQYI592	33° 44' 51.7" N	118° 20' 13.5" W	772.14375000	30	50	9K80F1D

Notes on Region 5 Allotments

- Region 5 Southern California allotted channel in 25 kHz blocks directly to agencies rather than the County pool allotments.
- This meant Region 5 agencies had to use channels at 12.5 kHz adjacent within their operations area and systems.
- The benefit of this approach is better spectrum use efficiencies. There are no “orphan” channels.
- The next two slides show examples of how two agencies used the channels in their systems.

Adj ch example -WQMZ239 and WQNA504

Blue is 50 dBu and green is 40 dBu.

Distance between the sites is 40 km

Callsign	Latitude	Longitude	Freq (MHz)	Antenna Height (m)	ERP (W)	Emission
WQMZ239	33° 39' 17.8" N	115° 27' 14.7" W	769.08125000	21	100	8K10F1E
WQNA504	33° 36' 49.8" N	115° 54' 46.5" W	769.09375000	22	324	8K10F1E

Riverside County Adjacent Channel Sites 90 dBu

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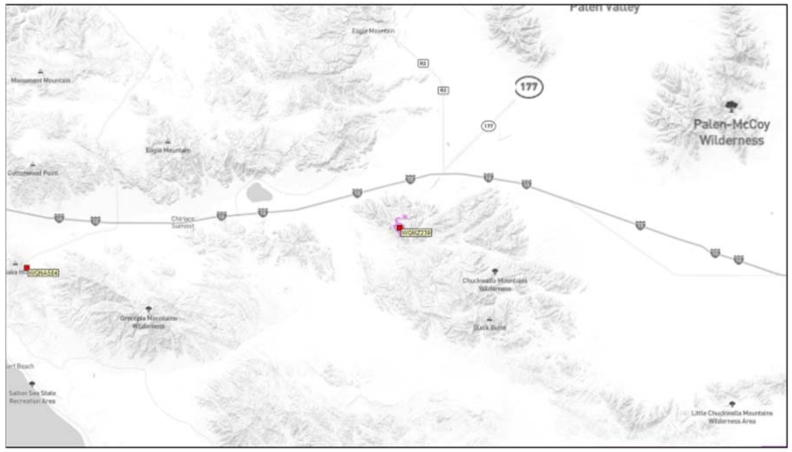
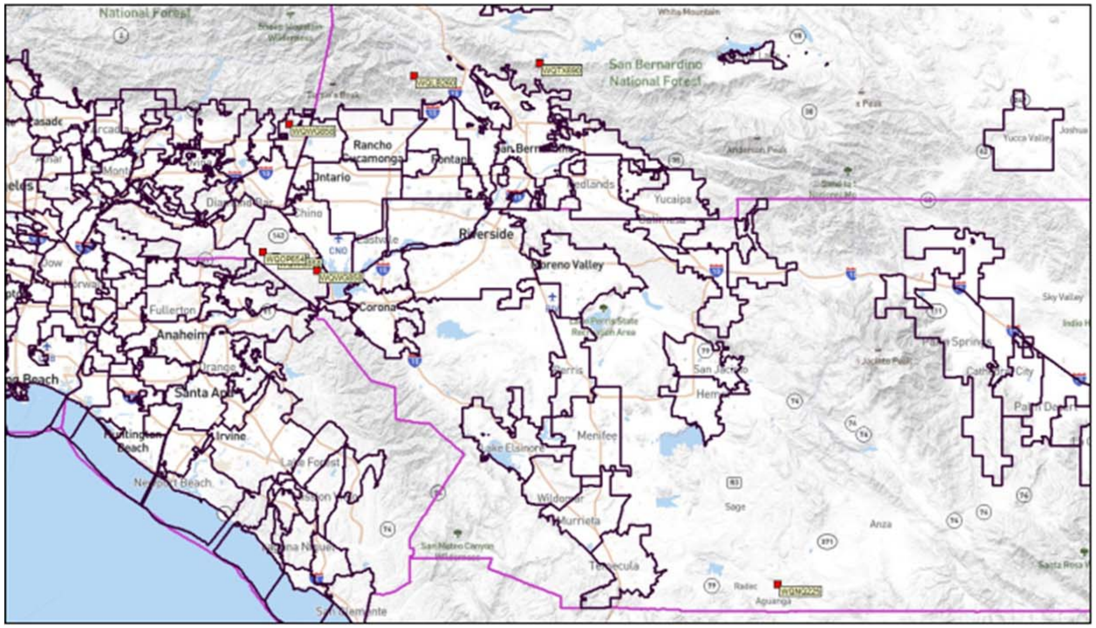


Callsign	Latitude	Longitude	Freq (MHz)	Antenna Height (m)	ERP (W)	Emission
WQMZ239	33° 39' 17.8" N	115° 27' 14.7" W	769.08125000	21	100	8K10F1E
WQNA504	33° 36' 49.8" N	115° 54' 46.5" W	769.09375000	22	324	8K10F1E

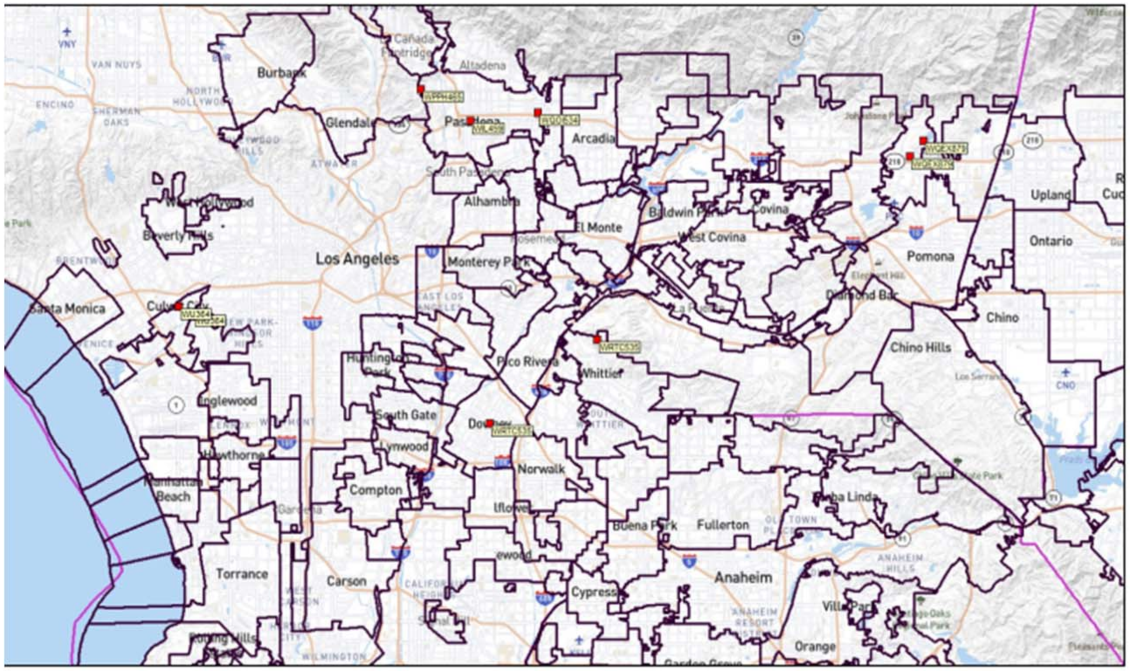
Shows the 90 dBu signal areas for one site. This would be equvilant to 20 dBu co-channel (70 dB ACPR)

San Bernardino County adjacent channel use



Callsign	Latitude	Longitude	Freq (MHz)	Antenna Height (m)	ERP (W)	Emission
WQWG858	33° 56' 54.1" N	117° 44' 40.9" W	769.33125000	24	357	8K10F1D
WQWG858	33° 57' 18.2" N	117° 46' 06.8" W	769.33125000	18	140	8K10F1D
WQWG858	33° 55' 40.0" N	117° 40' 20.0" W	769.33125000	8	25	8K10F1D
WQLF625	34° 08' 33.0" N	117° 43' 20.0" W	769.33125000	18	100	8K10F1E
WQTX700	34° 12' 49.9" N	117° 30' 03.7" W	769.33125000	41	140	8K10F1D
WQTX700	34° 13' 57.4" N	117° 16' 41.8" W	769.33125000	9	101	8K10F1D
WQWG858	33° 56' 54.1" N	117° 44' 40.9" W	769.34375000	24	357	8K10F1D
WQOP654	33° 57' 18.2" N	117° 46' 06.8" W	769.34375000	21	140	8K10F1E
WQWG858	33° 55' 40.0" N	117° 40' 20.0" W	769.34375000	8	25	8K10F1D
WQWG858	34° 08' 33.0" N	117° 43' 20.0" W	769.34375000	15	357	8K10F1D
WQLB260	34° 12' 49.9" N	117° 30' 03.7" W	769.34375000	41	140	8K10F1E
WQTX690	34° 13' 56.0" N	117° 16' 41.2" W	769.34375000	21	92	8K10F1E
WQNQ225	33° 27' 58.0" N	116° 51' 26.0" W	769.31875000	22	30	8K10F1D

Adjacent channel T-Band



Callsign	Latitude	Longitude	Freq (MHz)	Antenna Height (m)	ERP (W)	Emission
WRTC535	33° 56' 24.7" N	118° 07' 42.4" W	482.25000000	18	200	11K2F3D
WRTC535	33° 59' 52.0" N	118° 02' 12.2" W	482.25000000	18	200	11K2F3D
WIL459	34° 08' 52.0" N	118° 08' 43.3" W	482.23750000	27	100	10K0F1D
WQOI534	34° 09' 12.9" N	118° 05' 15.1" W	482.23750000	29	100	10K0F1D
WPPH465	34° 10' 11.0" N	118° 11' 16.3" W	482.23750000	11	1000	10K0F1D
WPPH465	34° 10' 11.0" N	118° 11' 16.3" W	482.23750000	11	1000	10K0F1E
WIJ364	34° 00' 57.0" N	118° 22' 59.3" W	482.26250000		40	10K0F1D
WQEX879	34° 07' 25.0" N	117° 46' 07.2" W	482.25000000	12	357	20K0F9W
WQEX879	34° 08' 03.7" N	117° 45' 25.5" W	482.25000000	11	20	20K0F9W
WIJ364	34° 01' 14.0" N	118° 23' 42.3" W	482.26250000	37	90	10K0F1D