REGION 43
700 MHz REGIONAL PLANNING COMMITTEE

APPLICATION FILING AND REVIEW PROCEDURE

Version 2.1: July 2018

www.region43.org

Revision History

Revision Date	Revision Number	List of Changes	Author/Approval
January 27, 2006	Original Release		
November 2017	2	1) Updated to match updated Region 43 700 MHz Plan. 2) Clarified submittal requirements. 3) Included checklist as appendix.	Paul Roos – Stantec Tim McDowell – RPC Vice Chair Spencer Bahner – RPC Chair
July 25, 2018	2.1	1) Replaced "The Plan" with "The 700 Plan" for clarity purposes. 2) Added section 2.1.2.3 to clarify contour requirements for adjacent regions submitting applications to Region 43 RPC.	Paul Roos – Stantec Review and approval from RPC during 7/2018 meeting.

Contents

1 PURPOSE

The purpose of this Procedure is to outline the material to be included in an application for frequencies covered by the National Public Safety Planning Advisory Committee (NPSPAC) Region 43 Regional Planning Committee for 700 MHz Band and to explain the Regional Planning Committee's application review process. It is intended as a guide to ensure application packages are completed thoroughly and can receive timely treatment by the Application Review Committee, which is a subcommittee of Region 43 700 MHz Regional Planning Committee ("RPC"). These procedures provide guidance for compliance with the document entitled "Regional Plan for the Public Safety 700 MHz Band in Region 43 (Washington)", which is commonly referred to as "The 700 Plan".

Every submission must include the following items as part of the submission package to the RPC:

1. FCC 601 License Application
2. Contour Showings
    - Contour showings for potential co-channel & adjacent channel usage
    - List of ALL co/adjacent licensees within Region 43
      Note: Licensees within adjacent regions (Region 12 and/or Region 35) may need to be identified as well.
3. Canadian Border showings if required by FCC Rule
4. Implementation Schedule
5. Funding Statement
6. Interop Channel Statement
7. Narrative
8. Application Contact Information
9. Other materials
10. Application Checklist

Each item is fully discussed further below. Once the RPC chair has received this package, he or she will have the Application Review Committee review the application package according to the application review process in section 3.

2 MATERIAL TO BE PROVIDED IN A COMPLETE APPLICATION PACKAGE

It is the practice of the RPC to have all the Application Review Committee members evaluate every application for its technical merit and conformance to The 700 Plan. Applications should be submitted as per section 8.5 of The 700 Plan "Application Filing Window". Applications should be sent to the Chair and Vice-Chair identified on the Region 43 web page (www.region43.org). The Committee Chair will distribute the

material to Committee members for review prior to the next schedule meeting.

Applicants shall have one year from the date that the RPC approves the application to file the application with the appropriate Frequency Coordinator. Applicants who are unable to file their applications within 1 year will require a new coordination letter. If unable to comply, the approval granted by the RPC will be withdrawn and the requested channel(s) will be returned to the pool of available channels.

Applicants are encouraged to read and be familiar with the following documents:

1. FCC 700 MHz public safety band plan (47 C.F.R. Part 90, Subpart R)
2. Regional Plan for the Public Safety 700 MHz Band in Region 43 (Washington)
3. Region 43 Regional Review Committee - 700 MHz Application Review Procedure (this document).
4. Arrangement Q, "*Arrangement Q: Sharing Arrangement Between in Department of Industry of Canada and the Federal Communications Commission of the United States of America Concerning the Use of the Frequency Bands 764 to 776 MHz and 794 to 806 MHz by the Land Mobile Service Along the Canada-United States Border",* if the application involves Canada-primary channels.

2.1 The Application package should include, as a minimum:

2.1.1 FCC License Application(s):

Properly completed license application forms with proposed frequencies clearly identified in the application (FCC Form 601 and any forms required by the Frequency Coordinator used by the Applicant).

2.1.2 Contour Showings:

A system coverage exhibit shall be provided which consists of one or more maps showing the following items for each channel to be considered. Contours are based on desired field strength relative to l µV/m (denoted as dBµ). The FCC defines a 113-km minimum radius for co-channel assignment, and a 32-km radius for adjacent channel assignments in the 800 MHz band (section 90.621b). Co-channel assignments less than 113-km are allowed by exception only. Accordingly, it is recommended to provide interference contours for all co-channel assignments within a 150-km radius of each of the proposed base station locations, and all adjacent-channel assignments within a 60-km radius of each of the proposed base station locations.

2.1.2.1 Application Contour Showings

Applicants shall provide the following FCC contours showing:

- **40 dBu service contour** for each proposed site in the application.
- **5 dBu co-channel interference contour** for each proposed site in the application.
- **60 dBu adjacent channel interference contour** for each proposed site in the application.

2.1.2.2 Applications with co- or adjacent-channel licensees

List all co-channel and adjacent channel licensees within Region 43 along with the call signs and distances to the proposed site(s), and provide the following FCC contours showing:

- **40 dBu service contour** of existing co-channel and adjacent-channel stations within Region 43 boundaries, or within a minimum 150 km radius (for co-channel) or 60-km radius (for adjacent-channel) of each proposed transmit location. Sites with a large HAAT may require a larger contour radius.
- **5 dBu co-channel interference contour** for each proposed site in the application relative to the service contours of existing sites.
- **60 dBu adjacent channel interference contour** for each proposed site in the application relative to the service contours of existing sites.

2.1.2.3 Adjacent Regions:

If co-channel or adjacent channel contours extend into Region 12 – Idaho, or Region 35 – Oregon, the information required in section 2.1.2.1, 2.1.2.2, and 2.1.2.4 needs to be provided for applicable sites in those regions (i.e.- either co-channel or adjacent-channel sites). Applications may need to be submitted to those RPCs for approval as well.

Additionally, applications submitted to Region 43 from adjacent regions requesting concurrence from the RPC shall meet the requirements of sections 2.1.2.1, 2.1.2.2, and 2.1.2.4.

2.1.2.4 Contour Map Requirements

All contour exhibits should clearly show:

- Applicant's geo-political boundaries or the service area, whichever is larger, and
- Any county boundaries within the exhibit, on the same map if possible.
- A scale necessary to depict the overall coverage areas along with details of potential overlapping areas.

All maps shall include a title block or an attached table indicating the following:

- Name of the Applicant agency,
- Name of each site identified on the map and each site's: latitude, longitude, and elevation,
- Height above ground level of the transmit antenna, and the antenna's height above average terrain, and
- Stations Effective Radiated Power.
- Horizontal and vertical plane antenna patterns for each transmitting antenna used in the system or the specification sheet(s) for the proposed antenna(s).

The contour showings shall demonstrate that the proposed 5 dBu F (50,50) contour does not overlap the 40 dBu F (50,50) service contour of any co-channel system, and that the

proposed 60 dBu F (50,50) contour does not overlap the 40 dBu F (50,50) service contour of any adjacent or alternate channel system.

The adjacent channel contour analysis shall be performed for any configuration of channels (e.g. 25 kHz channels, 12.5 kHz channels, or 6.25 kHz channels) in adjacent 25 kHz channel blocks.

A grid-based propagation prediction study based upon TIA/EIA TSB88 (or latest version) may be submitted in addition to the contour overlap study described above. Such a grid-based study shall show the composite predicted 40 dBu F (50,50) coverage, the predicted 60 dBu F (50,50) adjacent/alternate channel interference coverage, and the predicted 5 dBu F (50,50) co-channel interference coverage produced by all sites in the proposed system. Predicted 40 dBu F (50,50) coverage for pertinent co- channel and adjacent/alternate channel systems shall also be shown on each of the two interference maps. In circumstances where the 40 dBu desired coverage of other systems overlaps the interfering 60 dBu (adjacent/alternate channel) or 5 dBu (co-channel) from the proposed system, a separate carrier- to-interference map shall be submitted. This carrier-to-interference map shall demonstrate that the desired-to-undesired signal ratios embodied in the contour showings above are maintained within the service areas of pertinent co-channel and adjacent-channel systems. These desired-to-undesired signal ratios are: +35 dB (based on non-overlap of the 40 dBu service contour and the 5 dBu interference contour) for co-channel systems; and -20 dB (based on the non-overlap of the 40 d Bu service contour and the 60 dBu interfering contour) for adjacent/alternate channel systems.

Systems shall be designed as much as is practical to limit the extension of the 40 dBu F (50,50) contour beyond the proposed service area or geopolitical boundaries. The following extension distances for systems covering different types of areas are provided to serve as guidelines for system design:

Table 1: Service Contour Extension Distances

Type of Area	**Extension (miles)**
Urban (20 dB Buildings)	**5**
Suburban (15 dB Buildings)	**4**
Rural (10 dB Buildings)	**3**

It is understood that the shape and extent of geopolitical boundaries, the availability of specific sites, the nature of the elevated sites typically used within Region 43 and their relationship to surrounding terrain features, and other factors will have an impact on the ability to limit the extension of the 40 dBu contour beyond these boundaries. Also, all three types of areas may be included within the service area of a particular system. Each application shall include a description of the system design techniques employed to limit the extension of the proposed 40 dBu coverage.

Grid-based coverage and interference showings may also be used to demonstrate that the desired-to-undesired signal level ratio implicit in the contour values listed above are maintained within the boundaries of the County in which a co-channel or an adjacent/alternate channel assignment exists, if the channel(s) are not yet used in an existing system.

The contour values shown above are based on the FCC's Public Safety National Coordination Committee (NCC) 700 MHz Pre- Assignment Rules/Recommendations (see appendix A). Applicants may submit a more detailed supplemental interference analysis showing based on the co-channel and adjacent/alternate channel protection assumptions embodied in Appendix A to consider other system design factors that may reduce the levels of predicted interference caused by their particular system design.

When necessary, the local Frequency Advisor associated with the Applicant's Frequency Coordinator will use the Longley-Rice propagation model and the 3 arc-second elevation database, or some other appropriate model and terrain database, to confirm an application's coverage predictions. Propagation will be calculated at the 95% confidence level with radials spaced at l degree intervals and elevations calculated at 0.05-mile increments on each radial. A factor of 12 dB will be included to account for foliage and urban clutter.

2.1.3 Canadian Border Showings:

Any exhibits required to demonstrate compliance with the Canadian border protection requirements shown in §90..533 of the FCC's Rules and in *"Arrangement Q: Sharing Arrangement Between Department of Industry of Canada and the Federal Communications Commission of the United States of America Concerning the Use of the Frequency Bands 764 to 776 MHz and 794 to 806 MHz by the Land Mobile Service Along the Canada-United States Border",* if the proposed system employs sites located within any of the U.S.-Canada Border Zones in the State of Washington.

2.1.4 Implementation Schedule:

A complete implementation schedule for the proposed system.

2.1.5 Funding Statement:

A funding statement or resolution signed by the governing council, agency, executive or appropriate official with authority indicating that sufficient funds are available or will be made available to meet the proposed implementation schedule.

2.1.6 Interop Channel Statement:

A statement describing how the Applicant will implement and support the 700 MHz Interoperability Tactical channels as required by Sections 6.3 and 6.4 of The 700 Plan.

2.1.7 Narrative:

A narrative, based on the applicant's coverage and interference showings (described above), discussing the channel usage, any difference between the Applicant's service area and the predicted system coverage area shown in the applicant's map exhibits, and describing what steps will be taken to eliminate interference to systems in other jurisdictions.

- Proposed channel usage
- Methodology for choosing proposed channels
- Other channels that were considered
- Table showing channels being requested, and Canadian assignment status (Primary, secondary, etc.)
- ERP, Antenna Centerline (above ground level), site coordinates, emission designators
- Antenna type, including manufacturer specification document, noting if electrical or mechanical downtilt or horizontal beamwidth is selected

2.1.8 Applicant Contact Information:

Complete contact information for the person or persons who can answer technical and/or administrative questions about the application.

2.1.9 Other Materials:

Any other material as required by the Regional Planning Committee, by the FCC, or by the Frequency Coordinator selected by the Applicant to make the application complete or provide clarification.

These supporting materials can include:

- Equipment specification sheets
- Additional Engineering studies such as preliminary interference studies
- Letters of concurrence from incumbents

2.1.10 Application Checklist:

To ensure efficient processing of applications, the checklist in Appendix B should be used and submitted along with the application package to ensure all materials for the application package is included as part of the submission.

The Chair of the RPC will review the application package to assure that it is complete. Incomplete applications will be returned to the Applicant. Complete application packages will be date stamped and electronic copies of the complete application package will be forwarded to the full Committee for review.

3 APPLICATION REVIEW PROCESS

The Chair of the RPC may appoint an Application Review Subcommittee to review the application. Upon receipt of an application, each Committee member will begin to evaluate the information. Three members of the Committee will be specifically

designated as an application review sub-committee. These three individuals will begin a detailed review of the application and supporting documents. Specific concerns, questions and comments from Committee members will be directed to the Chair of the Review Sub- committee so these issues can be incorporated into the overall review of the application.

During the review of an application it may be necessary to request further information and clarification from the Applicant and/or from other interested parties. This may be as simple as the exchange of written material or may involve one or more appearances before the Committee to further explain various aspects of the proposed system. The goal of this interactive process is to assure that the committee has all the information it needs to render a fair decision on the application.

After there has been adequate time for the full Committee to consider all applications on hand and, if necessary, for subsequent meetings to be held with the Applicant and/or other interested parties to collect information to better evaluate the applications, the Chair of the RPC will convene a meeting of the full Committee to consider and act on all applications on hand. This meeting will be set on or before the action deadline established in The 700 Plan for the particular Filing Window. The Applicant and any other interested parties will be encouraged to attend this meeting to be able to answer further questions or to provide additional information.

The Application Review Sub-committee will report on its findings. This report will include a recommendation for either Approval as submitted, Approval if certain modifications are made to the application, or Disapproval. Any recommendation for Disapproval must be accompanied with an explanation of the specific aspects of The 700 Plan that were not conformed to and any other reasons for the disapproval recommendation. In situations where there is no competition for available channels, the Committee will base its decision for approval or disapproval on the conformance of the application to The 700 Plan.

In situations where there are applications for more than the available number of channels, the Committee will still base its decisions on conformance to The 700 Plan, but the Committee will also use the weighted criteria outlined in Section 9 of The 700 Plan, "Explanation of How Needs Were Assigned Priorities in Areas Where Not All Eligibles Could Receive Licenses" Points will be assigned in the following manner:

All competing applications will be evaluated for their demonstration of merit in relation to each of the criteria and point values will be assigned based on the comparative information for each criterion. For example, the application that exhibits the highest demonstrated immediate need to protect life and property under the Service category in Section 9 of The 700 Plan will be assigned 6 points. The application with the next highest demonstrated need will be assigned 5 points and this process will continue with descending point assignments as needed. In the event that the Committee feels there is

an equal demonstration of need more than one application may be assigned the same value.

The same approach will be used for each of the other criteria until each application has been evaluated against all the criteria. An accumulated total point value will be determined for all applications and the applications will then be rank ordered based on these point totals.

Once the applications are ordered by rank, the Committee will attempt to assign as much of the requested channel capacity to the highest ranked application while still attempting to meet at least a portion of the needs of lower ranked applications. During this process, the Committee will continue to work with all competing Applicants to attempt to find system implementation approaches that will allow all Applicants to meet their needs.

In either of the above situations, the quorum of the Region 43 700 MHz Regional Planning Committee ("RPC") attending the meeting will be polled by its Chair and the results of the poll will be documented. If the application is approved, the Chair will inform the Applicant of the results and the Applicant will forward the original application package, along with the letter of approval from the RPC, to the appropriate Frequency Coordinator for further processing.

If the Committee agrees with a recommendation to approve an application if certain modifications are made, the Chair of the RPC will write a letter to the Applicant outlining the changes required and a deadline for return of the revised application to the Committee. When the Application Review Sub-committee is satisfied that the appropriate changes have been made, it will inform the Chair of the RPC who will document the results and advise the Applicant, who will forward the corrected original application package to the appropriate Frequency Coordinator for further processing.

Any application that is disapproved will be returned to the Applicant with a letter from the Chair of the RPC explaining why the application was disapproved and explaining the Applicant's right to re-apply in the next Filing Window or to appeal the decision, as described in Section 13.3 of The 700 Plan.

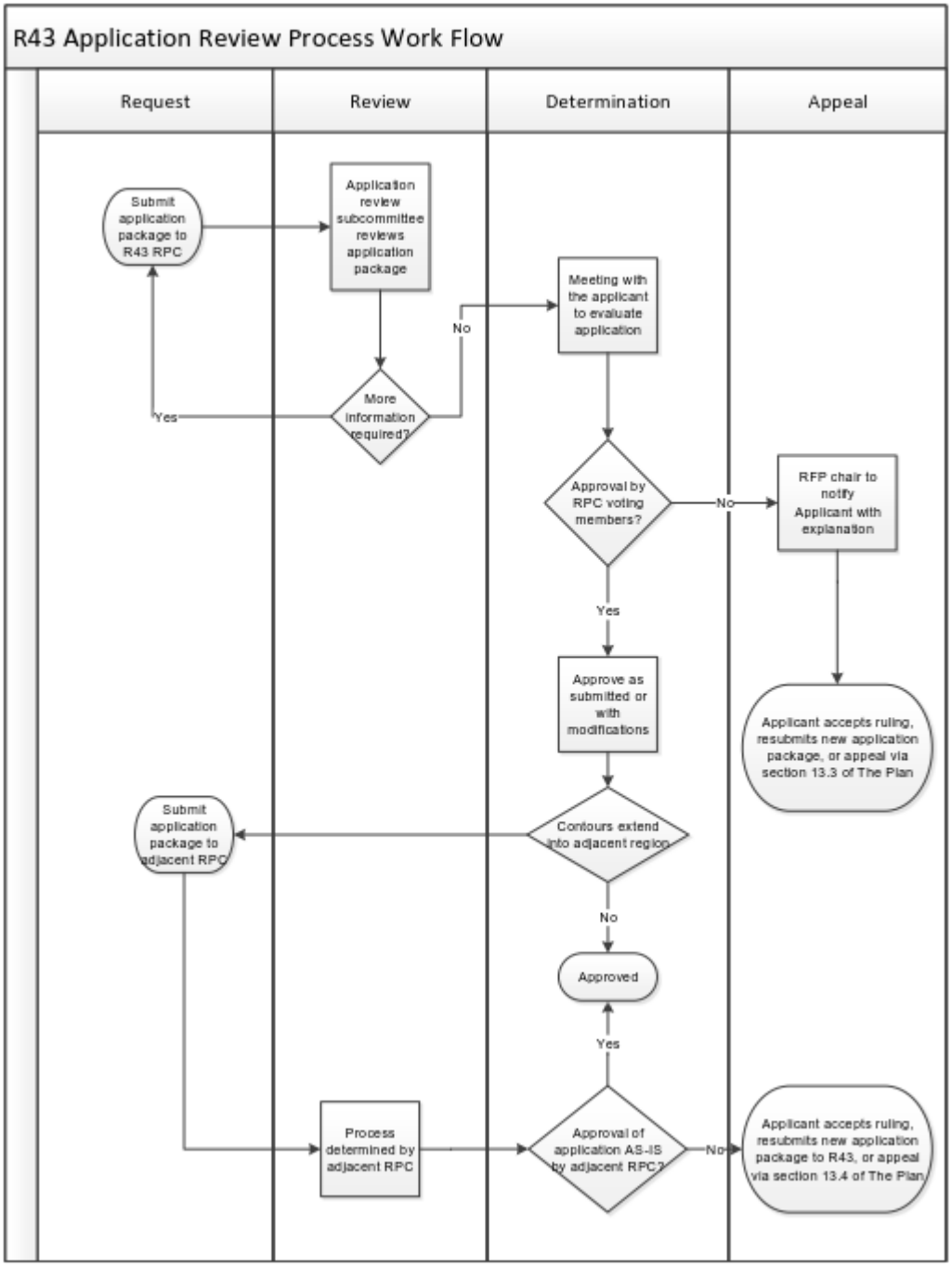


Figure 1: Application review work flow

Appendix A - Simplified 700 MHz Pre-Assignment Rules/Recommendations

The following document is included in its entirety without edits to facilitate Region 43 applicants with analysis, and to support the conclusions and recommendations of this process. This is for informational purposes only. Future revisions of the document included in this appendix are not intended to supersede R43 application process itself.

This was originally included as Appendix O of the "700 MHz Regional Planning Guidebook" and was produced by The National Public Safety Telecommunications Council (NPSTC) for the Federal Communications Commission based on recommendations of the Public Safety National Coordination Committee (NCC) July 15, 2002 (Revision 2.01).

Simplified 700 MHz Pre-assignment Rules

Introduction

This paper describes a process for coordinating the initial block assignments of 700 MHz channels before details of actual system deployments is available. In this initial phase, there is little actual knowledge of the specific equipment to be deployed and the exact antenna sites locations. As a result, a simple, high-level method is proposed to establish guidelines for frequency coordination. When actual systems are deployed, additional details will be known and the system designers will be required to select specific sites and supporting hardware to control interference.

Overview

Assignments will be based on a defined service area for each applicant. This will normally be an area defined by geographical or political boundaries such as city, county or by a data file consisting of line segments creating a polygon that encloses the defined area. The service contour is normally allowed to extend slightly beyond the geo/political boundaries such that systems can be designed for maximum signal levels within the boundaries, or coverage area. Systems must also be designed to minimize signal levels outside their geo/political boundaries to avoid interference into the coverage area of other co-channel users.

For co-channel assignments, the 40 dBμ service contour will be allowed to extend beyond the defined service area by 3 to 5 miles, depending on the type of environment: urban, suburban or rural. The co-channel 5 dBμ interfering contour will be allowed to touch but not overlap the 40 dBμ service contour of the system being evaluated. All contours are (50,50).

For adjacent and alternate channels, the 60 dBμ interfering contour will be allowed to touch but not overlap the 40 dBμ service contour of the system being evaluated. All contours are (50,50).

Discussion

Based upon the ERP/HAAT limitations referenced in 47CFR ¶ 90.541(a), the maximum field strength will be limited to 40 dB relative to 1μV/m (customarily denoted as 40 dBμ). It is assumed that this limitation will be applied similar to the way it is applied in the 821-824/866-869 MHz band. That is, a 40 dBμ field strength can be deployed up to a defined distance beyond the edge of the service area, based on the size of the service area or type of applicant, i.e. city, county or statewide system. This is important that public safety systems have adequate margins for reliability within their service area in the presence of interference, including the potential for interference from CMRS infrastructure in adjacent bands.

The value of 40 dBμ in the 700 MHz band corresponds to a signal of -92.7 dBm, received by a half-wavelength dipole (λ/2) antenna. The thermal noise floor for a 6.25 kHz bandwidth receiver would be in the range of -126 dBm, so there is a margin of approximately 33 dB available for "noise limited" reliability. Figure 1 shows show the various interfering sources and how they accumulate to form a composite noise floor that can be used to determine the "reliability" or probability of achieving the desired performance in the presence of various interfering sources with differing characteristics.

If CMRS out-of-band emissions (OOBE) noise is allowed to be equal to the original thermal noise floor, there is a 3 dB reduction[1] in the available margin. This lowers the reliability and/or the channel performance of Public Safety systems. The left side of Figure 1 shows that the original 33 dB margin is reduced by 3 dB to only 30 dB available to determine "noise + CMRS OOBE limited" performance and reliability.

There are also different technologies with various channel bandwidths and different performance criteria. C/N in the range of 17 – 20 dB is required to achieve channel performance.

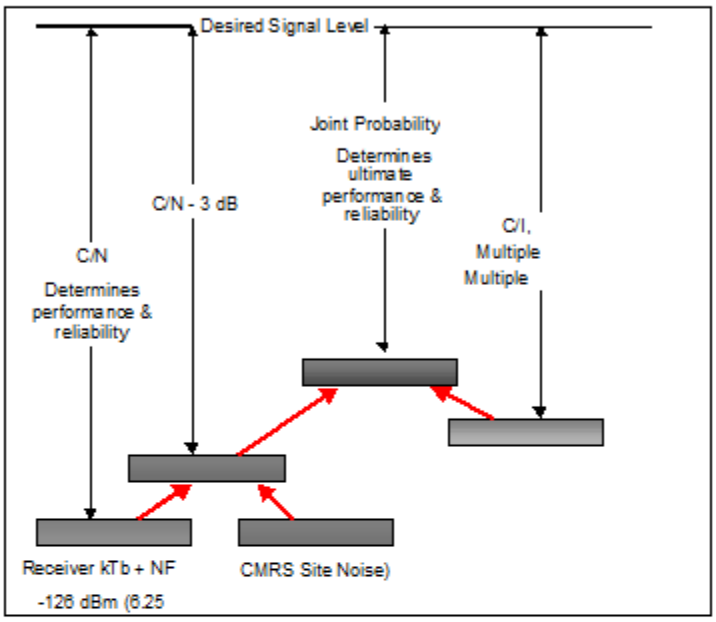


Figure 1 - Interfering Sources Create A "Noise" Level Influencing Reliability

In addition, unknown adjacent and alternate channel assignments need to be accounted for. The co-channel and adjacent/alternate sources are shown in the right hand side of Figure 1. At the edge of the service area, there would normally be only a single co-channel source, but there could potentially be several adjacent or alternate channel sources involved. It is recommended that co-channel assignments limit interference to <1% at the edge of the service area (worst case mile). A C/I ratio of 26.4 dB plus the required capture value (~10 dB) is required to achieve this goal.[2].

The ultimate performance and reliability has to take into consideration both the noise sources (thermal & CMRS OOBE) and all the interference sources. The center of Figure 1 shows that the joint probability that the both performance criteria and interference criteria are met must be determined.

Table 1 shows estimated performance considering the 3 dB rise in the noise floor at the 40 dBμ signal level. Performance varies due to the different Cf/N requirements and noise floors of the different modulations and channel bandwidths.

[1] TIA TR8 made this 3 dB allowance for CMRS OOBE noise during the meetings in Mesa, AZ, January 2001.
[2] See Appendix A for an explanation of how the 1% interference value is defined and derived.

Note that since little is known about the affects of terrain, an initial lognormal standard deviation of 8 dB is used.

Comparison of Joint Reliability for various				
Channel Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz	25.0 kHz
Receiver ENBW (kHz)	6	6	9	18
Noise Figure(10 dB)	10	10	10	10
Receiver Noise Floor (dBm)	-126.22	-126.22	-124.46	-121.45
Rise in Noise Floor (dB)	3.00	3.00	3.00	3.00
New Receiver Noise Floor (dB)	-123.22	-123.22	-121.46	-118.45
40 dBu = -92.7 dBm	-92.7	-92.7	-92.7	-92.7
Receiver Capture (dB)	10.0	10.0	10.0	10.0
Noise Margin (dB)	30.52	30.52	28.76	25.75
C/N Required for DAQ = 3	17.0	17.0	18.0	20.0
C/N Margin (dB)	**13.52**	**13.52**	**10.76**	**5.75**
Standard deviation (8 dB)	8.0	8.0	8.0	8.0
Z	1.690	1.690	1.345	0.718
Noise Reliability (%)	**95.45%**	**95.45%**	**91.06%**	**76.37%**
C/I for <1% prob of capture	36.4	36.4	36.4	36.4
I (dBu)	3.7	3.7	3.7	3.7
I (dBm)	-129.0	-129.0	-129.0	-129.0
Joint Probability (C & I)	**94.7%**	**94.7%**	**90.4%**	**76.1%**
40 dBu = -92.7 dBm @ 770 MHz				

Table 1 Joint Probability For Project 25, 700 MHz Equipment Configurations.

These values are appropriate for a mobile on the street, but are considerably short to provide reliable communications to portables inside buildings.

Portable In-Building Coverage

Most Public Safety communications systems, today, are designed for portable in-building[3] coverage and the requirement for >95 % reliable coverage. To analyze the impact of requiring portable in building coverage and designing to a 40 dBμ service contour, several scenarios are presented. The different scenarios involve a given separation from the desired sites. Whether simulcast or multi-cast is used in wide-area systems, the antenna sites must be placed near the service area boundary and directional antennas, directed into the service area, must be used. The impact of simulcast is included to show that the 40 dBμ service contour must be able to fall outside the edge of the service area in order to meet coverage requirements at the edge of the service area. From the analysis, recommendations are made on how far the 40 dBμ service contour should extend beyond the service area.

Table 2 estimates urban coverage where simulcast is required to achieve the desired portable in building coverage. Several assumptions are required to use this estimate.

- Distance from the location to each site. Equal distance is assumed.
- CMRS noise is reduced when entering buildings. This is not a guarantee as the type of deployments is unknown. It is possible that CMRS units may have transmitters inside buildings. This could be potentially a large contributor unless the CMRS OOBE is

[3] Building penetration losses typically required for urban = 20 dB, suburban = 15 dB, rural = 10 dB.

suppressed to TIA's most recent recommendation and the "site isolation" is maintained at 65 dB minimum.

- The 40 dBμ service contour is allowed to extend beyond the edge of the service area boundary.
- Other configurations may be deployed utilizing additional sites, lower tower heights, lower ERP and shorter site separations.

Estimated Performance at 2.5 miles from each site				
Channel Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz	25.0 kHz
Receiver Noise Floor (dBm)	-126.20	-126.20	-124.50	-118.50
Signal at 2.5 miles (dBm)	-72.7	-72.7	-72.7	-72.7
Margin (dB)	53.50	53.50	51.80	45.80
C/N Required for DAQ = 3	17.0	17.0	18.0	20.0
Building Loss (dB)	20	20	20	20
Antenna Loss (dBd)	8	8	8	8
Reliability Margin	8.50	8.50	5.80	-2.20
Z	1.0625	1.0625	0.725	-0.275
Single Site Noise Reliability (%)	**85.60%**	**85.60%**	**76.58%**	**39.17%**
Simulcast with 2 sites	97.93%	97.93%	94.51%	62.99%
Simulcast with 3 sites	99.70%	99.70%	98.71%	77.49%
Simulcast with 4 sites	99.96%	99.96%	99.70%	86.30%

Table 2, Estimated Performance From Site(s) 2.5 Miles From Typical Urban Buildings.

Table 2 shows for the example case of 2.5 miles a single site cannot provide >95% reliability. Either more sites must be used to reduce the distance or other system design techniques must be used to improve the reliability. For example, the table shows that simulcast can be used to achieve public safety levels of reliability at this distance. Table 2 also shows that the difference in performance margin requirements for wider bandwidth channels requires more sites and closer site-to-site separation.

Figures 2 and 3 show how the configurations would potentially be deployed for a typical site with 240 Watts ERP. This is based on:

- 75 Watt transmitter, 18.75 dBW
- 200 foot tower
- 10 dBd 180 degree sector antenna +10.0 dBd
- 5 dB of cable/filter loss. - 5.0 dB

23.75 dBW ≈ 240 Watts (ERPd)

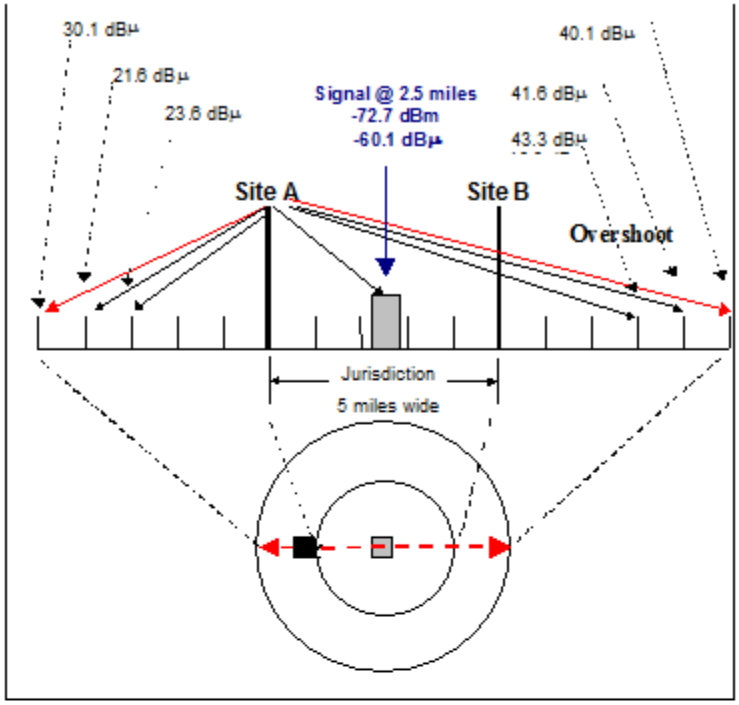


Figure 2 - Field Strength From Left Most Site.

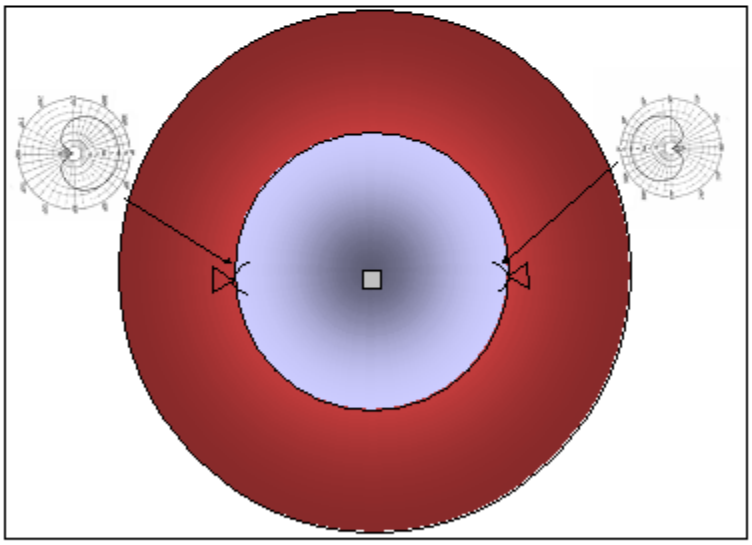


Figure 3 - Antenna Configuration Required To Limit Field Strength Off "Backside"

Figure 2 is for an urbanized area with a jurisdiction defined as a 5 mile circle. To provide the necessary coverage to portables in buildings at the center of the jurisdiction requires that the sites be placed along the edge of the service area and utilize directional antennas oriented toward the

center of the service area (Figure 3). In this case, at 5 miles beyond the edge of the service area, the sites would produce a composite field strength of approximately 40 dBμ. Since one site is over 10 dB dominant, the contribution from the other site is not considered. The control of the field strength behind the site relies on a 20 dB antenna with a Front to Back Ratio (F/B) specification as shown in Figure 3. This performance may be optomistic due to back scatter off local obstructions in urbanized areas. However, use of antennas on the sides of buildings can assist in achieving better F/B ratios and the initial planning is not precise enough to prohibit using the full 20 dB.

The use of a single site at the center of the service area is not normally practical. To provide the necessary signal strength at the edge of the service area would produce a field strength 5 miles beyond in excess of 44 dBμ. However, if the high loss buildings were concentrated at the service area's center, then potentially a single site could be deployed, assuming that the building loss sufficiently decreases near the edge of the service area allowing a reduction in ERP to achieve the desired reliability.

Downtilting of antennas, instead of directional antennas, to control the 40 dBμ is not practical, in this scenario. For a 200 foot tall tower, the center of radiation from a 3 dB down-tilt antenna hits the ground at ~ 0.75 miles[4]. The difference in angular discrimination from a 200 foot tall tower at service area boundary at 5 miles and service contour at 10 miles is approximately 0.6 degrees, so ERP is basically the same as ERP toward the horizon. It would not be possible to achieve necessary signal strength at service area boundary and have 40 dBμ service contour be less than 5 miles away.

Tables 3 and 4 represent the same configuration, but for less dense buildings. In these cases, the distance to extend the 40 dBμ service contour can be determined from Table 5.

Estimated Performance at 3.5 miles from each site				
Channel Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz	25.0 kHz
Receiver Noise Floor (dBm)	-126.20	-126.20	-124.50	-118.50
Signal at 3.5 miles (dBm)	-77.7	-77.7	-77.7	-77.7
Margin (dB)	48.50	48.50	46.80	40.80
C/N Required for DAQ = 3	17.0	17.0	18.0	20.0
Building Loss (dB)	15	15	15	15
Antenna Loss (dBd)	8	8	8	8
Reliability Margin	8.50	8.50	5.80	-2.20
Z	1.0625	1.0625	0.725	-0.275
Single Site Noise Reliability (%)	**85.60%**	**85.60%**	**76.58%**	**39.17%**
Simulcast with 2 sites	97.93%	97.93%	94.51%	62.99%
Simulcast with 3 sites	99.70%	99.70%	98.71%	77.49%
Simulcast with 4 sites	99.96%	99.96%	99.70%	86.30%

Table 3 - Lower Loss Buildings, 3.5 Mile From Site(s)

[4] Use of high gain antennas with down-tilt on low-level sites is one of the causes of far-near interference experienced in the 800 MHz band.

Estimated Performance at 5.0 miles from each site				
Channel Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz	25.0 kHz
Receiver Noise Floor (dBm)	-126.20	-126.20	-124.50	-118.50
Signal at 5.0 miles (dBm)	-82.7	-82.7	-82.7	-82.7
Margin (dB)	43.50	43.50	41.80	35.80
C/N Required for DAQ = 3	17.0	17.0	18.0	20.0
Building Loss (dB)	10	10	10	10
Antenna Loss (dBd)	8	8	8	8
Reliability Margin	8.50	8.50	5.80	-2.20
Z	1.0625	1.0625	0.725	-0.275
Single Site Noise Reliability (%)	**85.60%**	**85.60%**	**76.58%**	**39.17%**
Simulcast with 2 sites	97.93%	97.93%	94.51%	62.99%
Simulcast with 3 sites	99.70%	99.70%	98.71%	77.49%
Simulcast with 4 sites	99.96%	99.96%	99.70%	86.30%

Table 4 - Low Loss Buildings, 5.0 Miles From Site(s)

Note that the receive signals were adjusted to offset the lowered building penetration loss. This produces the same numerical reliability results, but allows increasing the site to building separation and this in turn lowers the magnitude of the "overshoot" across the service area.

Table 5 shows the field strength for a direct path and for a path reduced by a 20 dB F/B antenna. This allows the analysis to be simplified for the specific example being discussed.

	Site A Direct Path	Site B Back Side of 20 dB F/B Antenna
Overshoot Distance (mi)	Field Strength (dBµ)	Field Strength (dBµ)
1	73.3	53.3
2	63.3	43.3
2.5	60.1	40.1
3	57.5	37.5
4	53.3	**33.5**
5	50.1	30.1
...	**...**	
10	40.1	
11	**38.4**	
12	37.5	
13	36.0	
14	34.5	
15	33.0	

Table 5 - Field Strength Vs. Distance From Site

For the scenarios above, the composite level at the Service Contour is the sum of the signals from the two sites. The sum can not exceed 40 dBµ. Table 5 allows you to calculate the distance to Service Contour given the distance from one of the sites.

Scenario 1: Refer to Figure 3a. Site B is just inside the Service Area boundary and Service Contour must be <5 Miles outside Service Area boundary. Signal level at Service Contour from Site B is 30.1 dBµ. Signal level for Site A can be up to 40 dBµ, since when summing two signals with >10 dB delta, the lower signal level has little effect (less than 0.4 dB in this case). Therefore, Site A can be 10 miles from the Service Contour, or 5 miles inside the Service Area boundary. The coverage perfomance for this scenario is shown in Table 2, above, for 20 dB building loss typical of urban areas.

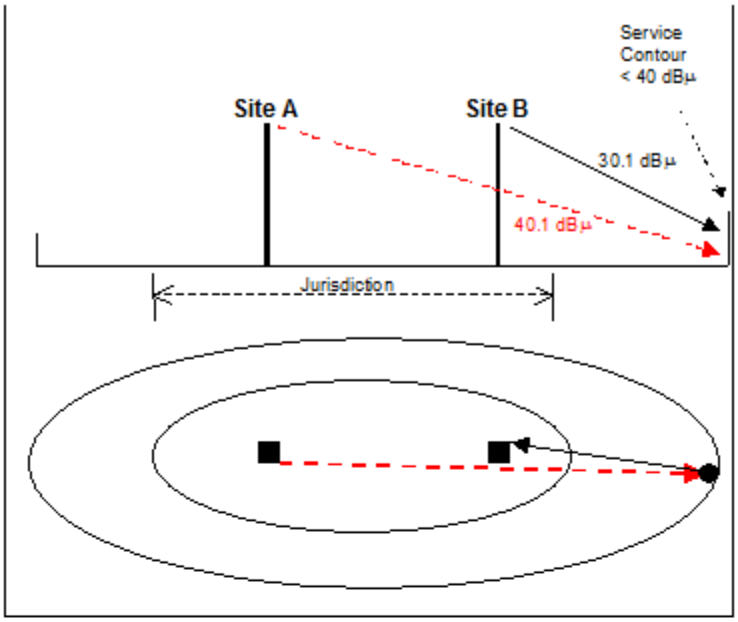


Figure 3a. Scenario 1 on of Use of Table 5

Scenario 2: Refer to bold data in Table 5. Site B is just inside the Service Area boundary and Service Contour must be <4 Miles outside Service Area boundary. Signal level at Service Contour from Site B is 33.5 dBμ. Signal level for Site A can be up to 38.4 dBμ. (See Appendix B for simple method to sum the powers of signals expressed in decibels.) The composite power level is 39.7 dBμ. Therefore, Site A can be slightly less than 11 miles from the Service Contour, or ~7 miles inside the Service Area boundary. The coverage perfomance for this example is shown in Table 3, above, for 15 dB building loss typical of suburban areas.

Scenario 3: Site B is just inside the Service Area boundary and Service Contour must be <3 Miles outside Service Area boundary. Signal level at Service Contour from Site B is 37.5 dBμ. Signal level for Site A can be up to 36.4 dBμ. (See Appendix B simple method to sum signals expressed in decibels.) The composite power level is 40.0 dBμ. Therefore, Site A can be ~13 miles from the Service Contour, or ~10 miles inside the Service Area boundary. The coverage perfomance for this example is shown in Table 4, above, for 10 dB building loss typical of rural areas.

Service Contour Extension Recommendation

The resulting recommendation for extending the 40 dBμ service contour beyond the service area boundary is:

Type of Area	Extension (mi.)
Urban (20 dB Buildings)	5
Suburban (15 dB Buildings)	4
Rural (10 dB Buildings)	3

Table 6 - Recommended Extension Distance Of 40 dBμ Field Strength

Using this recommendation the 40 dBμ service contour can then be constructed based on the defined service area without having to perform an actual prediction.

Interfering Contour

Table 1 above shows that 36.4 dB of margin is required to provide 10 dB of co-channel capture and <1% probability of interference. Since the 40 dBμ service contour is beyond the edge of the service area, some relaxation in the level of interference is reasonable. Therefore, a 35 dB co-channel C/I ratio is recommended and is consistent with what is currently being licensed in the 821-824/866-869 MHz Public Safety band.

Co-Channel Interfering Contour Recommendation

- Allow the constructed 40 dBμ (50,50) service contour to extend beyond the edge of the defined service area by the distance indicated in Table 6.
- Allow the 5 dBμ (50,50) interfering contour to intercept but not overlap the 40 dBμ service contour.

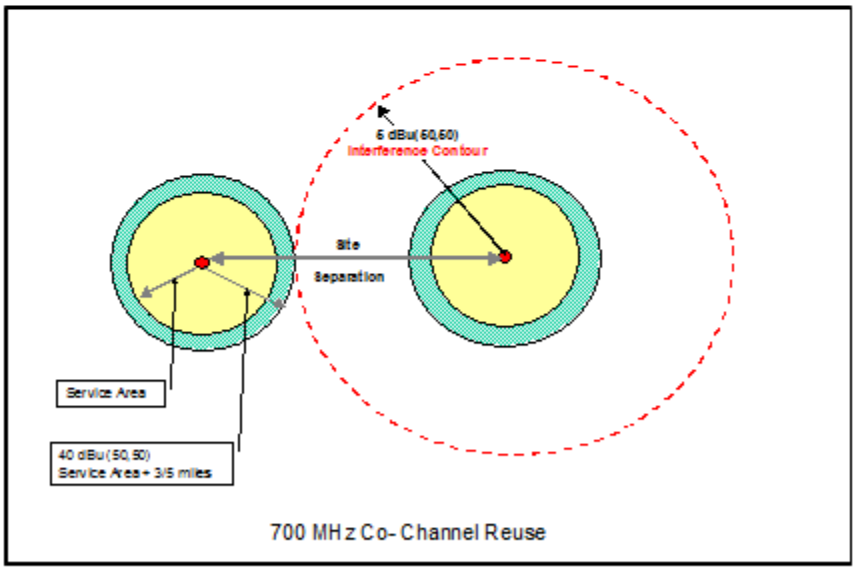


Figure 4 - Co-Channel Reuse Criterion

Adjacent and Alternate Channel Considerations

Adjacent and alternate channels are treated as being noise sources that alter the composite noise floor of a victim receiver. Using the 47 CFR § 90.543 values of ACCP can facilitate the coordination of adjacent and alternate channels. The C/I requirements for <1% interference can be reduced by the value of ACCPR. For example to achieve an X dB C/I for the adjacent channel that is -40 dBc a C/I of [X-40] dB is required. Where the alternate channel ACP value is -60 dBc, then the C/I = [X-60] dB is the goal for assignment(s). There is a compounding of interference energy, as there are numerous sources, i.e. co channel, adjacent channels and alternate channels plus the noise from CMRS OOBE.

There is insufficient information in 47 CFR § 90.543 to include the actual receiver performance. Receivers typically have "skirts" that allow energy outside the bandwidth of interest to be received. In addition, the FCC defines ACCP differently than does the TIA. The term used by the FCC is the same as the TIA definition of ACP. The subtle difference is that ACCP defines the energy intercepted by a defined receiver filter (e.g., 6 kHz ENBW). ACP defines the energy in a measured bandwidth that is typically wider than the receiver (e.g., 6.25 kHz channel bandwidth). As a result, the FCC values are optimistic at very close spacing and somewhat pessimistic at wider spacings, as the typical receiver filter is less than the channel bandwidth.

In addition, as channel bandwidth is increased, the total amount of noise intercepted rises compared to the level initially defined in a 6.25 kHz channel bandwidth. However, the effect is diminished at very close spacings as the slope of the noise curve falls off rapidly. At greater spacings, the slope of the noise curve is essentially flat and the receiver's filter limits the noise to a rise in the thermal noise floor.

Digital receivers tend to be less tolerant to interference than analog. Therefore, a 3 dB reduction in the C/(I+N) can reduce a DAQ = 3 to a DAQ = 2, which is threshold to complete muting in digital receivers. Therefore to maintain a DAQ = 3, at least 17 dB of fading margin plus the 26.4 dB margin for keeping the interference below 1% probability is required, for a total margin of 43.4 dB. However, this margin would be at the edge of the service area and the 40 dBμ service contour is allowed to extend past the edge of the service area.

Frequency drift is controlled by the FCC requirement for 0.4-ppm stability when locked. This equates to approximately a 1 dB standard deviation, which is negligible when associated with the recommended initial lognormal standard deviation of 8 dB and can be ignored.

Project 25 requires that a transceiver receiver have an ACIPR of 60 dB. This implies that an ACCPR ≥ 65 dB will exist for a "companion receiver". A companion receiver is one that is designed for the specific modulation. At this time the highest likelihood is that receivers will be deploying the following receiver bandwidths at the following channel bandwidths.

Estimated Receiver Parameters	
Channel Bandwidth	Receiver Bandwidth
6.25 kHz	5.5 kHz
12.5 kHz	5.5 or 9 kHz
25 kHz	18.0 kHz

Table 7 - Estimated Receiver Parameters

Based on 47 CFR ¶ 90.543 and the P25 requirement for an ACCPR ≥ 65 dB into a 6.0 kHz channel bandwidth and leaving room for a migration from Phase 1 to Phase 2, allows for making the simplifying assumption that 65 dB ACCPR is available for both adjacent 25 kHz spectrum blocks.

The assumption is that initial spectrum coordination sorts are based on 25 kHz bandwidth channels. This provides the maximum flexibility by using 65 dB ACCPR for all but one possible combination of 6.25 kHz channels within the 25 kHz allotment.

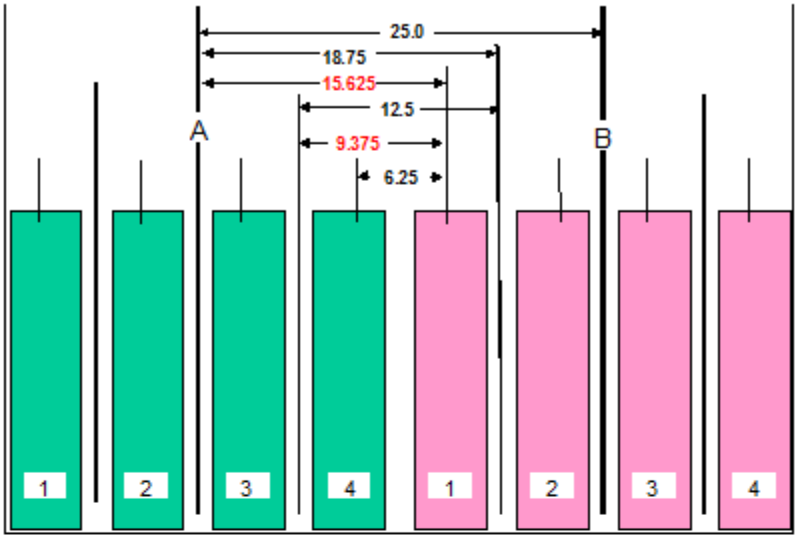


Figure 5, Potential Frequency Separations

Case	Spacing	ACCPR
25 kHz to 25 kHz	25 kHz	65 dB
25 kHz to 12.5 kHz	18.750 kHz	65 dB
25 kHz to 6.25 kHz	15.625 kHz	>40 dB
12.5 kHz to 12.5 kHz	12.5 kHz	65 dB
12.5 kHz to 6.25 kHz	9.375 kHz	>40 dB
6.25 kHz to 6.25 kHz	6.25 kHz	65 dB

Table 8 - ACCPR Values For Potential Frequency Separations

All cases meet or exceed the FCC requirement. The most troublesome cases occur where the wider bandwidths are working against a Project 25 Phase 2 narrowband 6.25 kHz channel. This pre-coordination based upon 25 kHz spectrum blocks still works if system designers and frequency coordinators keep this consideration in mind and move the edge 6.25 kHz channels inward away from the edge of the system. This approach allows a constant value of 65 dB ACCPR to be applied across all 25 kHz spectrum blocks regardless of what channel bandwidth is eventually deployed. There will also be additional coordination adjustments when exact system design details and antenna sites are known.

For spectrum blocks spaced farther away, it must be assumed that transmitter filtering, in addition to transmitter performance improvements due to greater frequency separation, will further reduce the ACCPR.

Therefore it is recommended that a consistent value of 65 dB ACCPR be used for the initial coordination of adjacent 25 kHz channel blocks. Rounding to be conservative due to the possibility of multiple sources allows the Adjacent Channel Interfering Contour to be approximately 20 dB above the 40 dBμ service contour, at 60 dBμ.

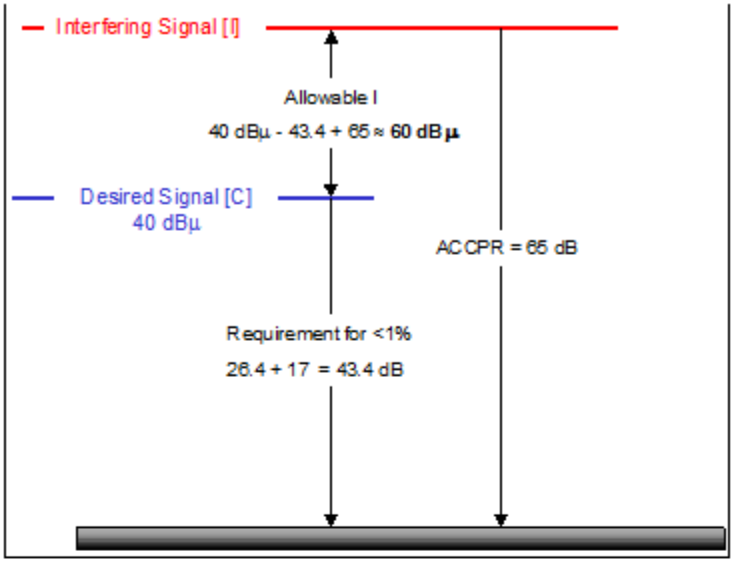


Figure 6 - Adjusted Adjacent 25 kHz Channel Interfering Contour Value

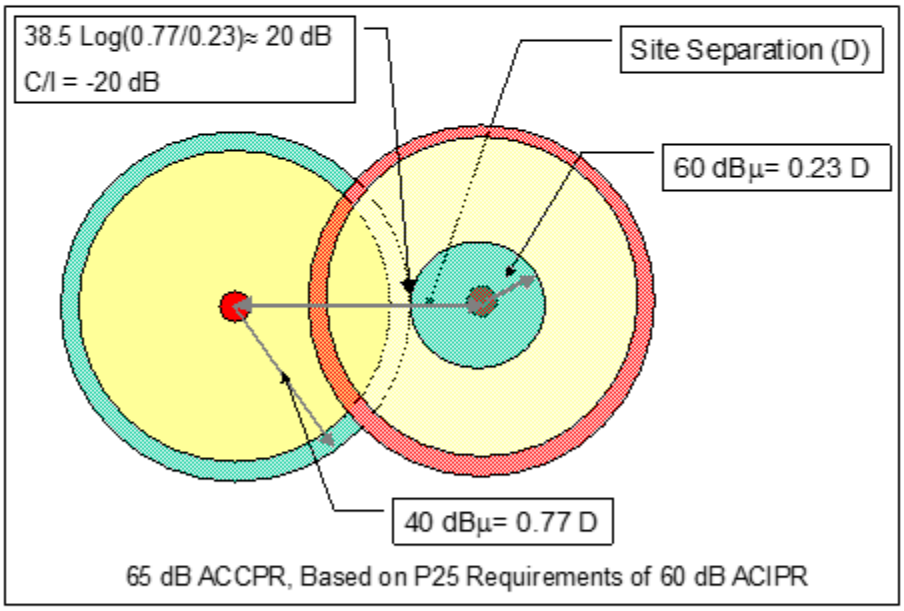


Figure 7 - Example Of Adjacent/Alternate Overlap Criterion

Adjacent Channel Interfering Contour Recommendation

An adjacent (25 kHz) channel shall be allowed to have its 60 dBµ (50,50) interfering contour touch but not overlap the 40 dBµ (50,50) service contour of a system being evaluated. Evaluations should be made in both directions.

Final Detailed Coordination

This simple method is only adequate for presorting large blocks of spectrum to potential entities. A more detailed analysis should be executed in the actual design phase to take all the issues into consideration.

Additional factors that should be considered include:

- Degree of Service Area Overlap
- Different size of Service Areas
- Different ERPs and HAATs
- Actual Terrain and Land Usage
- Differing User Reliability Requirements
- Migration from Project 25 Phase 1 to Phase 2
- Actual ACCP
- Balanced Systems
- Mobiles vs. Portables
- Use of voting
- Use of simulcast
- Radio specifications
- Simplex Operation
- Future unidentified requirements.

Special attention needs to be paid to the use of simplex operation. In this case, an interferer can be on an offset adjacent channel and in extremely close proximity to the victim receiver. This is especially critical in public safety where simplex operations are frequently used at a fire scene or during police operation. This type operation is also quite common in the lower frequency bands. In those cases, evaluation of base-to-base as well as mobile-to-mobile interference should be considered and evaluated.

Appendix A

Carrier to Interference Requirements

There are two different ways that Interference is considered.

- Co Channel
- Adjacent and Alternate Channels

Both involve using a C/I ratio. The C/I ratio requires a probability be assigned. For example, if 10% Interference is specified, the C/I implies 90% probability of successfully achieving the desired ratio. 1% interference means that there is a 99% probability of achieving the desired C/I.

$$\frac{C}{I}\% = \frac{1}{2} \bullet erfc\left(\frac{\frac{C}{I}\text{margin}}{2\sigma}\right) \quad (1)$$

This can also be written in a form using the standard deviate unit (Z). In this case the Z for the desired probability of achieving the C/I is entered. For example, for a 90% probability of achieving the necessary C/I, $Z = 1.28$.

$$\frac{C}{I}\% = Z \cdot \sqrt{2} \cdot \sigma \quad (2)$$

The most common requirements for several typical lognormal standard deviations (σ) are included in the following table based on Equation (2).

Location Standard Deviation (σ) dB	5.6	6.5	8	10
Probability %				
10%	10.14 dB	11.77 dB	14.48 dB	18.10 dB
5%	13.07 dB	15.17 dB	18.67 dB	23.33 dB
4%	13.86 dB	16.09 dB	19.81 dB	24.76 dB
3%	14.90 dB	17.29 dB	21.28 dB	26.20 dB
2%	16.27 dB	18.88 dB	23.24 dB	29.04 dB
1%	18.45 dB	21.42 dB	**26.36 dB**	32.95 dB

Table A1 - Probability Of Not Achieving C/I For Various Location Lognormal Standard Deviations

These various relationships are shown in Figure A1, a continuous plot of equation(s) 1 and 2.

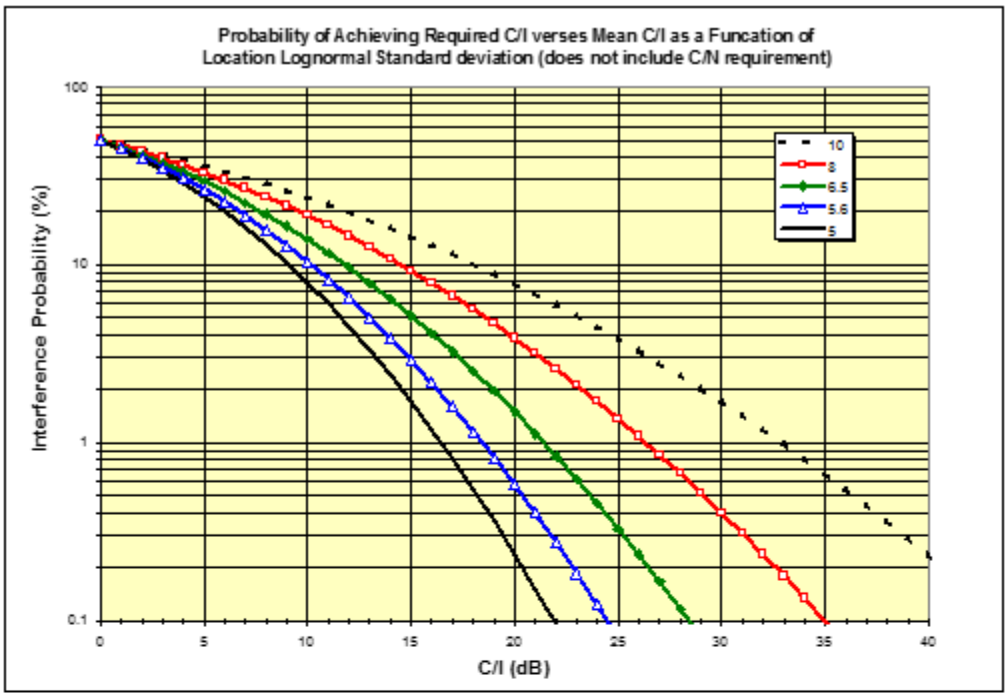


Figure A1, Probability Of Achieving Required C/I As A Function Of Location Standard Deviation

For co-channel the margin needs to include the "capture" requirement. When this is done, then a 1% probability of co channel interference can be rephrased to mean, there is a 99% probability that the "capture ratio" will be achieved. The capture ratio varies with the type of modulation. Older analog equipment has a capture ratio of approximately 7 dB. Project 25 FDMA is specified at 9 dB. Figure A1 shows the C/I requirement without including the capture requirement.

The 8 dB value for lognormal location standard deviation is reasonable when little information is available. Later when a detailed design is required, additional details and high-resolution terrain and land usage databases will allow a lower value to be used. The TIA recommended value is 5.6 dB. Using 8 dB initially and changing to 5.6 dB provides additional flexibility necessary to complete the final system design.

To determine the desired probability that both the C/N and C/I will be achieved requires that a joint probability be determined. Figure A2 shows the effects of a family of various levels of C/N reliability and the joint probability (Y-axis) in the presence of various probabilities of Interference. Note that at 99% reliability with 1% interference (X-axis) that the reduction is nearly the difference. This is because the very high noise reliability is degraded by the interference, as there is little probability that the noise criterion will not be satisfied. At 90%, the 1% interference has a greater likelihood that it will occur simultaneously when the noise criterion not being met, resulting in less degradation of the 90%.

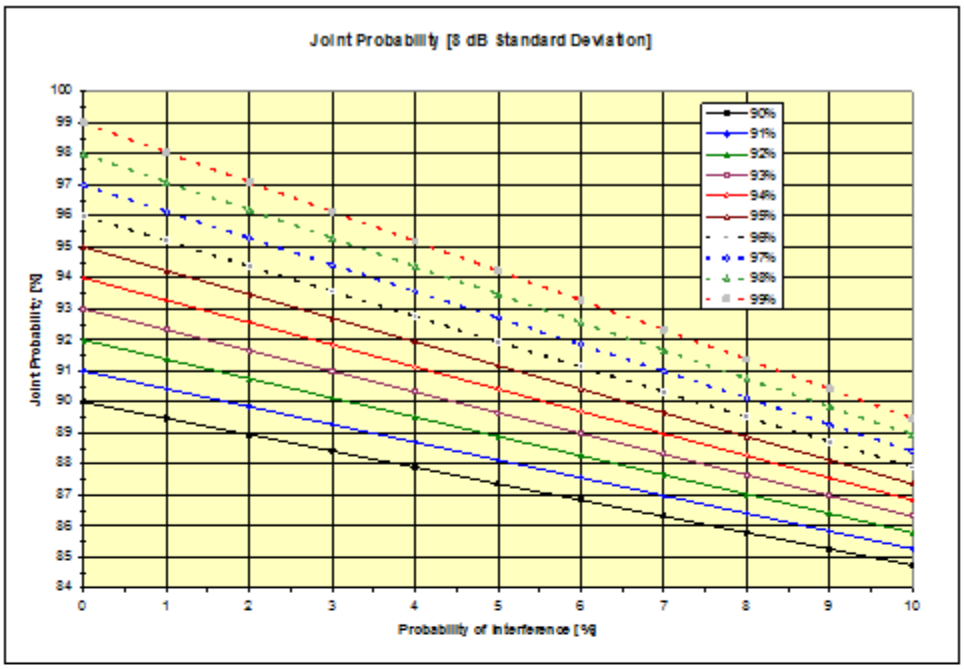
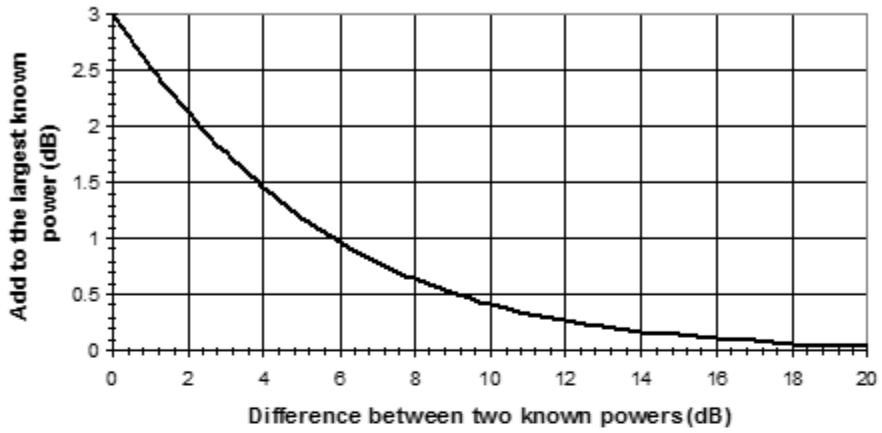


Figure A2 - Effect Of Joint Probability On The Composite Probability

For adjacent and alternate channels, the channel performance requirement must be added to the C/I ratio. When this is applied, then a 1% probability of adjacent/alternate channel interference can be rephrased to mean, there is a 99% probability that the "channel performance ratio" will be achieved.

Appendix B

Adding Two Known Non-Coherent Powers



In order to sum the power of two or more signals expressed in dBm or dBμ, they level should be converted to a voltage level or a power level, summed (root of the sum of the squares), and then converted back to dBm or dBμ.

The chart above provides simple method to sum two power levels expressed in dBm or dBμ. First find the difference between the two signals on the horizontal axis. Go up to the curve and across to the vertical axis to find the power delta. Add the power delta to the larger of the two original signal levels.

Example 1: Signal A is 36.4 dBμ. Signal B is 37.5 dBμ. Difference is 1.1 dB. Power delta is about 2.5 dB. Composite signal level is 37.5 dBμ + 2.5 dB = 40 dBμ.

Example 2: Signal is –96.3 dBm. Signal B is –95.2 dBm. Difference is 1.1 dB. Power delta is about 2.5 dB. Composite signal level is –95.2 dBm + 2.5 dB = -92.7 dBm.

Appendix B – R43 Application Checklist

The following checklist is provided as a tool to assist applicants with preparing a thorough application package. It provides a list of items to be submitted as part of the Region 43 application package. Refer to each section of the "Application Filing and Review Procedure" for more details.

R43 Application Checklist

Section	Description	Details	Included
2.1.1	FCC License Application(s)	601 FCC application forms filled	☐
2.1.2	Contour Showing for Proposed, and/or Existing Transmitter Sites	• 40 dBu service contour for each proposed new site(s), as well as contours of existing station if applicable • 5 dBu interference contour for each proposed new site(s), as well as contours of existing station if applicable • 60 dBu adjacent channel interference contours for each proposed new site(s), as well as contours of existing station if applicable	☐
2.1.3	Canadian Border showings	Any exhibits required to demonstrate compliance with the Canadian Border protection requirements shown in §90.533 of the FCC's Rules	☐
2.1.4	Implementation Schedule	A complete implementation schedule for the proposed system.	☐
2.1.5	Funding Statement	A funding statement or resolution indicating that sufficient funds are available to support implementation	☐
2.1.6	Interop Channel Statement	A statement describing how the applicant will implement and support the 700 MHz Interoperability channels.	☐
2.1.7	Narrative	A narrative to explain the reason for the request and additional steps required to adhere to the requirements.	☐
2.1.8	Applicant Contact Information	Complete contact information for the person who can answer and provide technical questions	☐
2.1.9	Other materials	Additional supporting materials as required to clarify or support request	☐