REGION 21

700 MHz
PUBLIC SAFETY BAND
REGIONAL PLAN

700 MHz PLANNING COMMITTEE OFFICERS

Chairman: Joe Turner
Secretary: Keith M. Bradshaw
Treasurer: Patricia Coates
Convener: Richard DeMello

Note: Combined Files - Submitted April 10, 2006 as one Adobe Document

The Region Twenty-One 700 MHz Plan

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The Region 21 700 MHz Plan

SCOPE

Introduction

This is the second major planning thrust for Region 21. The first was to meet the Federal Communications Commission (FCC) requirements for the NPSPAC spectrum. This planning thrust was precipitated by the establishment of the 700 MHz public safety band.

The FCC announced the allocation of 24 MHz in the 700 MHz radio spectrum subsequent to the Public Safety Wireless Advisory Committee (PSWAC) report that established need requirements throughout the country. Interoperability within and among public safety and public service providers was identified in the PSWAC report as a basic minimum essential requirement.

Subsequent to the PSWAC the FCC established a Federal Advisory Committee called the National Coordination Committee (NCC). The NCC was created to address interoperability, technology, and implementation issues to be considered for the 700 MHz spectrum. The FCC required that a Regional Plan outlining the use of public safety radio frequencies be complete and approved of by the FCC before any agency within a region would receive channels from this new allocation. The Regional 21 Plan conforms to the NCC planning guidelines. The Region 21 committee's membership represents a cross-section of public safety and public service users. A Region Planning Committee membership list is contained in Appendix A.

Purpose

The purpose of the Regional Plan is to insure that maximum public benefit is derived from use of the 700 MHz spectrum by eligible agencies. Further, the plan was developed to guide eligibles through the application process and provide an equitable means of settling disputes concerning frequency allocations should they arise.

Plan Summary

First, Region 21 is defined as the entire State of Michigan. The broad classifications of entities eligible to apply for spectrum are defined in accord with NCC definitions. Next, to garner their participation in and support of the planning process, an attempt was made to contact all eligible agencies. These attempts are documented. The authority by which the Regional Planning Committee undertook these planning efforts is reviewed. A discussion follows of the process by which the initial spectrum allocation was made. Finally, a detailed discussion of the application process is given. This includes guidelines for spectrum use, application requirements, the application review process and dispute resolution. Also included is a discussion of the future planning process.

The Region 21 Committee accepts the Computer Assisted Pre-Coordination Resource and Database (CAPRAD) database initial allocation based on population density and call volume by county. It has been noted by the committee that this allocation closely matches the description of Designated Statistical Areas by the US Department of Management and Budget Bulletin 03-04 of June 6, 2003. See Appendix L. The Committee will use the CAPRAD database when allocating frequency resources in Region 21. Use of allocated frequencies in counties “north of Line A” are subject to international treaty obligations. Please see Title 47 Code of Federal Regulations Part 90.7 for the definition of Line A.

Interoperability guidelines and usage must be in accordance with the requirements of the State Interoperability Executive Committee (SIEC). Any conflict between the I/O rules for National Calling and Tactical channels in this plan and SIEC guidelines, the SIEC guidelines will prevail.

Television broadcasting activity is currently limited to approximately the southern half of the Region. Therefore, until February 18, 2009, assignments in certain aras of the state on channels where interference issues are anticipated will be made on the basis of the guidelines laid out in National Coordinating Committee (NCC) planning documents (see Appendix T). Frequency assignments which are secondary to Public Safety operations, such as television translator, Low Power TV stations, or other secondary assignments will not be granted interference protection. Licensees of transmitters located within the state of Michigan were notified of the last Public Hearing prior to finalization of the Plan. They will be notified again when the FCC has approved the Region 21 Plan, and a final time when applications for frequency assignment within the station's coverage area are received by the Region.

Region 21 Defined

Region 21 consists of the entire state of Michigan[1]. The total area is 56,809 square miles. The value of all taxable property in Region 21 in the year 2003 was estimated as Seven Hundred Thirty Nine Billion, Fifty Million, Ninety Four Thousand, Six Hundred Fifty Four dollars ($739,050,594,654). The population of this region is 9,938,444 based upon the 2000 US Census (Appendix L), a 6.9% increase since 1990. This Regional plan will consider the communication needs of all agencies currently eligible in the FCC Public Safety pool (PW). No other agencies within Region 21 that we are aware of have developed 700 MHz band plans.

[1] At the April 15,2001 planning committee meeting pursuant to FCC notice DA 01-58 of January 10,2001, the committee discussed modification of the region 21 boundaries. After consultation with region 54, the planning committee informed the FCC of its desire to modify region 21 boundaries to include the entire state of Michigan.

Definition of Eligible Entities

Eligible agency users are defined by the Public Safety Wireless Advisory Committee (PSWAC) and NCC as follows: Public safety – the public's right, exercised through Federal, State or Local government as prescribed by law, to protect and preserve life, property, and natural resources and to serve the public welfare. Public safety services – those services rendered by or through Federal, State or Local government entities in support of Public Safety duties. Public safety services provider – governmental and public entities or those non-government, private organizations, which are properly authorized by the appropriate governmental authority whose primary mission is providing Public Safety duties. Public services – those services provided by non-Public Safety entities that furnish, maintain, and protect the nation's basic infrastructures which are required to promote the public's safety and welfare.

Meetings, Public Notices and Meeting Attendance

A diverse group of individuals and agencies were invited to participate in the development of the Regional Plan. Notification was accomplished by LEIN, US mail, web page postings and e-mail sent to public safety and public service organizations and to organizations representing eligible agencies. In addition, Federal, State, Local, and Tribal government agencies concerned with National Security and Emergency Preparedness were contacted. Appendix B contains the notification list, Appendix E contains the initial convening information and Appendix F contains the minutes of the meetings. All Region 21 RPC meetings are open to the general public, as certified in Appendix W.

AUTHORITY

Regional Planning Committee Authority

Authority for the Regional Planning Committee to carry out its assigned tasks is derived from the Federal Communications Commission (FCC) Report and Order, Docket 96-86. The by-laws for Region 21 are contained in Appendix D of this plan.

National Interrelationships

The Region 21 700 MHz Plan conforms to the NCC planning documents. If there is a conflict between this plan, the NCC documents, or the FCC rules, the FCC rules will prevail. It is expected that Regional Plans for other areas in the country may differ from this plan due to their local needs. By officially sanctioning this Plan, the FCC agrees that it conforms to the NCC and FCC planning requirements. This Plan is not intended to conflict with the proper functions and duties of the frequency coordination entities in the Private Land Mobile Service. The Region 21 Plan provides procedures that are the consensus of the group of individuals involved in its development over several years. If there is a perceived conflict, the judgment of the FCC will prevail.

SPECTRUM ALLOCATION

Usage Guidelines

Systems operating in the Region must comply with all applicable FCC rules and regulations and the requirements of this Plan. Applications for the purpose of expanding exisiting systems will NOT be given consideration unless the applicant can demonstrate that the existing system is loaded to the criteria contained in this Plan.

Adjacent Region Coordination

Any applicant requesting frequency allocation(s) within 113 km (70 miles) of the border between Region 21 and the adjoining regions (including Region 54) must be coordinated with the effected adjoining Region. Applicants will be required to file identical applications with the Region 21 committee and the committee of the region or regions adjoining the proposed stations.

Application Requirements

This portion of the plan provides a basis for proper spectrum utilization. Its purpose is to evaluate the implementation of 700 MHz radio communication systems within the Region. Any applications for spectrum must be submitted after the date this plan is approved by the FCC and will be processed in the order they are received.

Agencies that desire spectrum must submit a complete application containing various documents as listed in Appendix G. The applicant may need to include a system design that incorporates base stations for use on the interoperability channels. This will be dependent upon the hierarchy of levels of government as listed on page 11, the geographic coverage of the proposed system, or the pre-existence of any other 700 MHz applications or systems in the same geographic area. Evaluation of applications for available spectrum is accomplished during the regularly scheduled MPSFAC meetings.

Applicants are encouraged to join larger existing systems whenever possible, or to form consortiums with neighboring agencies to create spectrum efficient new systems. As the 700 MHz spectrum is allocated, applicants for new systems surrounded by or adjacent to existing systems may be required to document as part of the application process the technical, functional, financial, or political reasons joining the existing system does not meet their requirements.

Interoperability

Interoperability between Federal, State and Local Governments during both daily and emergency and disaster operations will primarily take place on the interoperability channels. These channels are identified in this and the National Plan. Additionally, through the use of an S-160 or the MOU (see Appendix P) or equivalent agreements, a licensee may permit Federal use of non-Federal communications system spectrum.

Interoperability Requirements

All applicants shall submit an Interoperability Plan with their application. In this plan, the applicant shall:

A) identify the organizations with whom interoperable communications are to be achieved, and

B) stipulate how they will accomplish interoperable communications in their proposed system (for example, via gateway, switch, cross-band repeater, console cross patch, software defined radio, or other means.) with the agencies listed in A as well as for each of the following priorities:

1. Disaster and extreme emergency operation for mutual aid and interagency communications.
2. Emergency or urgent operation involving imminent danger to life or property.
3. Special event control. (Generally of a preplanned nature and including task force operations.)

Through proper consideration, design, and implementation, the best possible interoperability will be achieved.

Interoperability Responsibilities

Responsibility for the implementation of operation on the interoperability frequencies rests with:

1. The highest level of government submitting an application within or encompassing a given geographical area, or

2. The applicant whose proposed system coverage encompasses the largest geographical area, or

3. The first or "lead" agency in a multi-agency environment using 700 MHz frequencies in a given geographic area.

The hierarchy of levels of government shall be as follows:

1. The State of Michigan
2. Regional Consortiums or Multi-county systems
3. County systems
4. Multiple city, village or township Consortium systems
5. Single city, village, township or other eligible system

For Region 21, the largest geographic area and the highest level of government is the State of Michigan. Should the State of Michigan apply for a statewide 700 MHz system on channels outside the state channel block, their application must show the inclusion of interoperability frequencies according to state and regional area requirements. Otherwise, the next largest jurisdiction to apply must include provisions for wide area operation on the interoperability frequencies throughout their coverage area and so forth. System implementations must provide interoperability between area wide agencies as mandated by this plan. Such implementation must be reviewed and approved by the State Interoperability Executive Committee (SIEC) and Region 21.

Incident Command System Standard

Region 21 supports NCC recommendations regarding the National Incident Management System (NIMS) and ICS.

Coverage and Interference

Systems are to be designed and protected in accordance with the methods given in TIA/EIA Telecommunications Systems Bulletin TSB-88A and its addendums. Required engineering submittals are listed in Appendix G. Applicants which demonstrate compliance with 40 dB curve standards shall be deemed to have complied with the coverage requirements of this plan. Where a question of compliance arises, applicants shall demonstrate to the committee that they are in compliance with the applicable portions of TSB-88A and its addendums.

Those systems that are designed to provide "wide area" coverage must demonstrate their need to require such coverage. Communication coverage beyond the bounds of a jurisdictional area cannot be tolerated unless it is critical to the protection of life and property. Otherwise, strict criteria for limiting area of coverage to the boundaries of the applicant's jurisdiction must be observed. Overlapping or extended coverage must be minimized, even where "intermixed" systems are proposed for cooperative and/or mutual aid purposes.

Antenna heights are to be limited to provide only the necessary coverage for a system. When antenna locations are placed on the "high ground," reduced transmitter output ERP limits and special antenna patterns must be employed to produce the necessary coverage within and confined to the protected service area.

Interference complaints will be addressed in cooperation with the appropriate FCC certified frequency coordinators. In the event that the Committee determines adjacent channel interference is likely, the applicant will be required to provide the appropriate technical data in accord with the NCC Implementation Sub-Committee Simplified 700 MHz Pre-Assignment Rules Recommendation pp 132 - 134 (see Appendix Q). The Committee may require additional technical exhibits and documentation in order to conduct a full and proper evaluation of the complaints.

TV/DTV Protection

Analog television operations exist on some of the NTSC channels 60 through 69 in Region 21. Two areas of the region, Detroit (WWJ-TV 62) and Kalamazoo (WLLA -TV 64) are currently entitled to protection as primary TV operations until February 18, 2009. All other stations within the Region are televison translators or Low Power (LP) stations and are secondary to Public Safety operations. Some primary television assignments in IL, IN, OH, and WI may also be entitled to receive protection until February 18, 2009.

Applicants desiring to utilize channels prior to February 18, 2009 which are presently affected by incumbent Primary TV stations are required to protect these incumbents by:

a) utilizing geographic separation specified in the 40 dB Tables of 90.309, or

b) submitting an engineering study justifying other distance separations which the FCC approves, or

c) obtaining concurrence from the applicable TV station (see Appendix T).

Loading

Per-channel block loading requirements are given in Appendix G.

Channel Reuse

All necessary precautions will be taken to gain maximum reuse of the limited 700 MHz spectrum. The distance between transmitters for co-channel reuse will be determined through the use of TR 8.8 standards. Consideration will be given to the coverage needs of the applicant, natural barriers for separation, antenna patterning, and limiting ERP where possible. System tests and/or propagation studies should be provided to establish minimum distances for separation.

The Regional Committee shall be responsible for reviewing the engineering submittals on an application. Applicants will submit additional relevant documents to the FCC certified coordinators as the MPSFAC deems necessary.

Reassignment of Existing Frequencies

Applicants shall furnish the committee with a list of agencies transitioning to the 700 MHz system. At the time of application, the applicant must provide a Letter of Intent listing all frequencies per agency to be relinquished if 700 MHz allocations are granted and an anticipated date the frequencies will be relinquished. This document will be submitted as a condition of license grant by the FCC. At the time the applicant files a Construction Completion Notification and /or final Slow Growth Imp[lementation Report with the FCC, a copy of these documents shall immediately be provided to the Michigan Public Safety Frequency Advisory Committee. When the transition to the 700 MHz band has been completed, the VHF and UHF frequencies presently licensed to an applicant and listed for relinquishment shall be returned to the frequency pool for reassignment.

However, the Committee recognizes that it may be necessary for an applicant to maintain certain operations on legacy systems. Therefore, applicants desiring to maintain such legacy operations must submit a request to retain each existing frequency in writing. This request must specify the current as well as the future use of the requested legacy frequency.

Frequencies not approved for retention will be returned to the pool by cancellation of those frequencies from the appropriate FCC license(s). It shall be the responsibility of the licensee to cancel all frequencies not approved for retention from their FCC Licenses. Normal application and coordination procedures will be followed with returned channels.

It is not consistent with the goals and objectives of this Region to permit the direct reassignment of radio frequencies between agencies. Similarly, agencies shall not "farm down" or otherwise make frequencies available to other radio services within their political structure.

Channel Assignment

The applicant evaluation criteria established in the NCC process and further defined in this Regional plan are to be complied with. In cases where more than one applicant requires a specific allotment, the Competing Application Evaluation Matrix will be utilized to determine the successful applicant. In all cases, area of coverage criteria, technical requirements, and channel loading criteria will be applied, except upon unique circumstances after review and approval from the MPSFAC. No deviation from FCC rules is to be approved unless a fully justifiable waiver has been presented to the MPSFAC.

Expansion of Existing NPSPAC Systems

Existing NPSPAC systems that are to be expanded to include the frequency bands of 700 MHz will have to separately meet the requirements of the Region 21 plans on each band. They must maintain compliance with the NPSPAC plan and the 700 MHz plan also.

FREQUENCY ALLOTMENT METHODOLOGY

Allotment Process

The Region 21 700 MHZ Planning Committee accepts the NLECTC database as the official allotment for Region 21. See Appendix O for explanation. The sorted channel assignments by county are given in Appendix N.

Application Review

The flow chart entitled "Application Review Matrix" presents the sequence of events that will be followed in the allocation of the 700 MHz spectrum. The flow chart may be found in Appendix M.

Applications are received and reviewed by the MPSFAC (Block #I & II). If the application is not in compliance with SIEC requirements (Block #III) and Regional Plan requirements, the application will be rejected at this point and returned to the applicant with an explanation of the reason(s) for rejection. If there are no competing applications to be considered, the application will be populated with channels and be forwarded to the frequency coordinating body of choice (Block #V and beyond). The Competing Application Evaluation Matrix will be used when competition for spectrum arises.

Competing Application Dispute Resolution

The implementation of the Competing Application Evaluation Matrix (see Appendix M) will result in the award of a score for each application. The application score is the total number of the points awarded in eight categories. The applicant with the highest total score will have their application processed and supported for frequency coordination. Others will be returned to the applicant if no spectrum is available. The eight categories are as follows:

1. Service and Use (Block #1) – maximum score 360 points. Each of the eligible services, and each use, has a predetermined point value. Total points for this block will be the sum of the point assignments for each service and use the system is to support.

SERVICE	Points
Federal	24
Tribal Nation	24
State	24
Local Gov	24
Police	24
Special Emerg./EMS	24
Emergency Management	24
Fire	24
Forestry Consv.	24
Highway Maint.	24
USE	
Rescue	40
Safety of Life and Property	40
Environmental Protection	40
Maximum Total	360

Environmental protection shall be considered tasks that directly reduce any contamination to the air, water or ground by chemicals or waste materials.

2. Interoperability Diversity (Block #2) – maximum score 100 points.

The application is scored on the degree of interoperability that is demonstrated, with range of points from 0 to 100. This category does not rate the application on the inclusion of the mandated interoperability channels. This category does rate the application on its proposed ability to communicate with different levels of government and services during times of emergency.

Each applicant is encouraged to have direct mobile-to-mobile communications among the Federal, State, and Local Government, Tribal Nations, police, special emergency-EMS, fire, forestry conservation and highway maintenance radio services. All applications start with 100 points and points are deducted based upon their lack of intersystem communications.

Deducts

Deduct 10 points for each radio service type function in which the applicant lacks communication at the operator position via console patch or other means, when direct mobile-to-mobile communication does not exist. Radio services type functions are stated above.

Deduct five points for each radio service that the applicant lacks direct mobile-to-mobile communications with. Radio services type functions are stated above.

3. Cooperative Use (Block #3) – maximum score 150 points. Those applications that have demonstrated that they are part of cooperative, multi-organization systems will be scored depending upon the extent of the cooperative system.

System Points

Multi agency trunked system fully loaded	150
Trunked system fully loaded/channel	100
Conventional system fully loaded/channel	75

Expansion of Existing Systems

As it is the intent of this plan to promote cooperative use of the spectrum, expansion of an existing system will be given greater competitive weight than a competing new system. Therefore, the point award from the aforementioned category will be doubled as,

System Points (from previous category) X 2 = Score.

4. Spectrum Efficient Technology (Block #4) maximum score 125 points.

This category scores the applicant on the degree of spectrum efficient technology that the system demonstrates. A point value range of 0 to 100 points can be awarded for this category. Technologies that are designed to provide for more efficient spectrum use shall be awarded twenty-five (25) additional points.

Spectrum Efficiency Points.

Description	Points
Trunked System, voice only on narrow channels	50
Trunked System, voice and data or equally efficient Technology	100
Conventional System using MDT on wide channels	50
Technologies that result in increased system throughput	add 25

5. This section (Block #5) gives municipalities consideration for the impact of urban sprawl. If they have recently established or plan to establish a public safety agency with approved funding and they do not yet have any radio frequencies allocated, they will receive 150 points.

Applicants requesting initial radio frequency(ies) for the purpose of communicating vital voice messages.	150

6. Systems Implementation Factors (Block #6) – maximum score 100 points.

This category scores the applicant on two factors, budgetary commitment and planning completeness. The degree of budgetary commitment is scored on a range of 0 to 50 points. An applicant who demonstrates a high degree of commitment in funding the proposed system will receive the higher score. Each applicant will be scored on the degree of planning completeness with a range of scoring from 0 to 50 points. Applicants will be required to submit a timetable for the implementation of the communications system or systems.

Description	Points
Multi Phase Project with the applicant committing funds to all phases.	50
Multi phase project plan completed for all phases	50

Applicants with less than a complete funding commitment and/or incomplete plan will have their point score reduced accordingly. Resolutions shall be included in each plan stating the applicants governing boards (or equal) financial commitment.

7. System Density (Block #7)

Each applicant will be scored on the ratio of subscriber units to the area covered.

System Density Points

(Total number of subscriber units) / (Area in square miles) x 100 = score.

8. Givebacks or relinquished Frequency(ies) (Block #8) – maximum score 200 points. The applicant is scored on the number of channels given back. The greater the number of channels given back, the higher the score.

Scoring: Number frequencies to be Relinquished x 10 = Score

Points are totaled for each competing application (Block #SUM).

The competing applications are prioritized based on the total number of points each has received in the evaluation process. The application with the higher score will then proceed with the approval process. The application with the lower score will be returned to the applicant. The applications (Block #VI) are sent to the PW coordinated requested by the applicant. Subsequent to coordination approval (Block #VII) the FCC would grant the license(s) to the applicant (Block #VIII).

This plan has been prepared to enable consistent evaluation of competing applications. Variation within the parameters of this plan and submitted application and/or plans may require extensive evaluation. Therefore the MPSFAC shall evaluate each plan or situation on its own merit, as well as on a relative basis to other competing applications.

REGIONAL COMMITTEE

The Michigan Public Safety Frequency Advisory Committee shall be responsible for the frequency coordination of the application. This shall include making a determination about the engineering of the system, ERP, coverage, and compliance with FCC requirements.

System Implementation

Should system implementation not begin (award of contract) within a two-year period or if projected channel loading is not attained within four years after the granting of license(s), the channel(s) will be returned for reassignment to others. A one-year extension may be supported by the MPSFAC depending upon circumstances that are beyond the control of the applicant. The applicant will be responsible to contact the FCC to request an extension from the Commission. Any applicant must be doing all in their power to implement the project within their authority.

The MPSFAC will determine if progress is being made on the implementation of the system (Block #IX & X). Monitoring of systems implementation by the MPSFAC will take place at intervals not longer than one-year. If progress is made, the system is implemented (Block #XI). If progress is not made, the licensee is advised of the consequences and the MPSFAC informs the PW frequency coordinator of the situation (Block #XII). The MPSFAC continues to monitor progress on the implementation of the system (Block #IX). If progress is still not being made in the next evaluation period, the licensee is notified of the pending action of the MPSFAC to advise FCC of lack of progress (Block #XIII).

The notified licensee can appeal this action (Block #XIV) or can allow the license to be cancelled or withdrawn. If the authorized frequencies are withdrawn they are added back to the frequency allotment pool (Block #XVI).

Appeal Process

Throughout the application review and frequency allotment process, applicants are given opportunities to appeal decisions that have caused the rejection of their application. The appeal process has two levels: the MPSFAC and the FCC. An applicant who decides to appeal a rejection should initiate that appeal within ten (10) business days after receiving the decision. In the event that an appeal reaches the second level, the FCC, the FCC decision will be final and binding upon all parties. The Region 21 appeal process is contained in Appendix H.

Future Planning Process

The Michigan Public Safety Frequency Advisory Committee (MPSFAC) shall serve as the Plan Update Committee. This committee's responsibility is to recommend changes in the Plan and resolve interregional problems that may arise. The MPSFAC shall also be responsible for receiving, reviewing, considering, and acting on applications as well as updating the database for spectrum in the 700 MHz band. The CAPRAD Administrator and Alternate Administrator will each be members of the MPSFAC committee with voting privileges. MPSFAC committee structure and routine duties are contained in Appendix U.

700 MHz Membership List

Name	Agency	Address	Phone	Fax	E-mail	
Alger, Dean A.	Alger Communications, Inc	4290 Cascade Road SE Grand Rapids, MI 49546	(616) 954-9000 pager (616) 564-3322	Office fax (616) 954-9001 Home fax (616) 897-3179	algercomm@aol.com	Gov agency
Altland, Thomas	Mason Oceana-911	PO Box 27 Hart, MI 49420	(231) 873-8868	(231) 873-0095	mo911@voyager.net	Gov agency
Andrus, Robert	City of Dearborn	16087 Michigan Ave Dearborn, MI 48126	(313) 943-2082	(313) 943-3055	bandrus@ci.dearborn.mi.us	Gov agency
Betz, Dennis	Washtenaw Central Dispatch	2201 Hogback Rd Ann Arbor, MI 48105	(734) 971-8400 ext. 1298	(734) 971-7296	betzd@co.washtenaw.mi.us	Gov agency
Bradshaw, Keith	Macomb County	21930 Dunham Mount Clemens, MI 48048	(810) 469-6433	(810) 783-0957	macrad@libcoop.net	Gov agency
Coates, Patricia	Oakland County	1200 N Telegraph, 49W Pontiac, MI 48341-0421	(248) 452-9947	(248) 452-9128	coatesp@co.oakland.mi.us	Gov agency
DeMello, Richard	Retired DNR	536 Lyons Rd Portland, MI 48875	(517) 647-4630	(517) 373-8048	demellor@power-net.net	Gov agency
Folske, William	APCO Frequecy Adv	1235 S Maple #102 Ann Arbor, MI 48103	(734) 741-1346	(734) 741-1846	wfolske@worldnet.att.net	Co. that provides public safety
Grant, John H.	Lansing School District	Dept. of Public Safety 519 W Kalamazoo St Lansing, MI 48933	(517) 325-6125	(517) 325-6129	jgrant@lsd.k12.mi.us	Gov agency
Ogden, Bob	DNR	7th Floor Mason Bldg PO Box 30711 Lansing, MI 48909	(517) 373-2172	(517) 373-8048	ogdenr@state.mi.us	Gov agency
Rutare, Louis	DNR	7th Floor Mason Bldg PO Box 30711 Lansing, MI 48909	(517) 335-4597	(517) 373-8048	rutarel@state.mi.us	Gov agency
Swenson, Craig	Washtenaw Central Dispatch	2201 Hogback Rd Ann Arbor, MI 48105	(734) 971-8400 ext. 1297	(734) 971-7296	swensonc@co.washtenaw.mi.us	Gov agency

Thomas, Erica	DNR	7th Floor Mason Bldg PO Box 30711 Lansing, MI 48909	(517) 373-8048	(517) 373-8048	thomasem@state.mi.us	Gov agency
Turner, Joe	Retired	520 Jameson St Saginaw, MI	(517) 797-3816		turnerj@juno.com	Non-public safety
Uslan, Rick	Motorola	925 Alexandria Dr Lansing, MI 48917	(517) 323-9770	(517) 321-2382	R.Uslan@motorola.com	Co. that provides public safety
Warner, Harry	MSP	Communications Division 4000 Collins RD PO Box 30631 Lansing, MI 48909-8131	(517) 336-6623		warnerh@state.mi.us	Gov agency

REGION 21 700 MHZ PLANNING COMMITTEE OFFICERS

CHAIRPERSON	Joseph M. Turner 520 Jameson St. Saginaw, MI 48602 jturner@michiganpropertytax.com
VICE-CHAIRPERSON	William Folske 1235 S. Maple 102 Ann Arbor, MI 48103 wfolske@worldnet.att.net
TREASURER	Patricia Coates Oakland County Clemis 1200 N. Telegraph Road Pontiac, MI 48341 coatesp@co.oaklnad.mi.us
SECRETARY	Keith M. Bradshaw Macomb County Technical Services 21930 Dunham Mount Clemens, MI 48043 macrad@libcoop.net

NEW REGIONAL PLANNING THRUST

March 1, 2000

TO: Public Safety/Service Agencies

FROM: Richard S. DeMello, Convener for 746-806 MHz Region 21 Plan

SUBJECT: First Planning Meeting

Where: Masonic Temple
2875 W. Liberty Road
Ann Arbor, MI

When: Wednesday, May 3, 2000

Time: 10:00 a.m. - 3:00 p.m.

Why: Discuss:

1. History, how we got to where we are.
2. Interoperability.
3. National planning requirements.
4. New planning thrust and discussion of needs and or uses of the spectrum.

Bill Folske is planning to have an inexpensive lunch available.

Please RSVP via the internet to thomasem@state.mi.us.

If you have any questions, you can contact Bill Folske at (734) 741-1346, Erica Thomas at (517) 373-8048 or Richard DeMello at (517) 335-3266.

March 1, 2000

p:\admin\telecom\700MHz\1stplanmeeting

Michigan Cities, Villages and Townships

Acme, Ada, Addison, Adrian, Afton, Ahmeek, Akron, Alanson, Alba, Albion, Alden, Alger, Algoma, Allegan, Allen, Allen Park, Allendale, Allenton, Allouez, Alma, Almont, Alpena, Alpha, Alpine Twp, Alto, Amasa, Anchorville, Ann Arbor, Applegate, Arcadia, Argyle, Armada, Arnold, Ashley, Athens, Atlanta, Atlantic Mine, Atlas, Attica, Au Gres, Au Train, Auburn, Auburn Hills, Augusta, Avoca, Azalia

Bad Axe, Bailey, Baldwin, Bancroft, Bangor, Bannister, Baraga, Barbeau, Bark River, Baroda, Barryton, Barton City, Bath, Battle Creek, Bay City, Bay Port, Bay Shore, Bay View, Bear Lake, Beaver Island, Beaverton, Bedford, Belding, Bellaire, Belleville, Bellevue, Belmont, Benton Harbor, Benzonia, Bergland, Berkley, Berrien Center, Berrien Springs, Bessemer, Beulah, Beverly Hills, Big Bay, Big Rapids, Bingham Farms, Birch Run, Birmingham, Bitely, Black River, Blanchard, Blissfield, Bloomfield Hills, Bloomfield Township, Bloomingdale, Boon, Boyne City, Boyne Falls, Bradley, Branch, Brant, Breckenridge, Breedsville, Brethren, Bridgeport, Bridgewater, Bridgman, Brighton, Brimley, Britton, Brohman, Bronson, Brooklyn, Brown City, Brownstown Township Bruce Crossing, Brutus, Buchanan, Buckley, Burlington, Burnips, Burr Oak, Burt, Burt Lake, Burton, Byron, Byron Center

Cadilac, Caledonia, Calumet, Camden, Cannonsburg, Canton, Capac, Carleton, Carney, Caro, Carp Lake, Carrollton, Carson City, Carsonville, Casco, Caseville, Casnovia, Caspian, Cass City, Cassopolis, Cedar, Cedar Lake, Cedar River, Cedar Springs, Cedarville, Cement City, Center Line, Central Lake, Centreville, Ceresco, Champion, Channing, Charlevoix, Charlotte, Chase, Chassell, Chatham, Cheboygan, Chelsea, Chesaning, Chesterfield, Chippewa Lake, Chocolay, Christmas, Clare, Clark Twp, Clarklake, Clarkston, Clarksville, Clawson, Clayton, Clifford, Climax, Clinton, Clinton Twp, Clio, Cloverdale, Cohoctah, Coldwater, Coleman, Coloma, Colon, Columbiaville, Columbus, Comins, Commerce, Comstock, Comstock Park, Concord, Conklin, Constantine, Conway, Cooks, Coopersville, Copemish, Copper City, Copper Harbor, Coral, Cornell,,Corunna, Covert, Covington, Cross Village, Croswell, Crystal, Crystal Falls, Curran, Curtis, Custer, Cutlerville

Dafter, Daggett, Dansville, Davisburg, Davison, De Tour Village, Dearborn, Dearborn Heights, Decatur, Decker, Deckerville, Deerfield, Deerton, Deford, Delhi, Delta Township, Delton, Detroit, DeWitt, Dexter, Dimondale, Dollar Bay, Dorr, Douglas, Dowagiac, Dowling, Drayton Plains, Drummond Island, Dryden, Dundee, Durand

Eagle, Eagle River, East China, East Grand Rapids, East Jordan, East Lansing, East Leroy, East Tawas, Eastlake, Eastpointe, Eastport, Eaton Rapids, Eau Claire, Eben Junction, Eckerman, Ecorse, Edenville, Edmore, Edwardsburg, Elberta, Elk Rapids, Elkton, Ellsworth, Elm Hall ,Elmira, Elsie, Elwell,,Emmett, Empire, Engadine, Erie, Escanaba, Essexville, Eureka, Evart, Ewen

Fair Haven, Fairgrove, Fairview, Falmouth, Farmington, Farmington Hills, Farwell, Felch, Fennville, Fenton, Fenwick, Ferndale, Ferrysburg, Fife Lake, Filer City, Filion, Flat Rock, Flint, Flushing, Forestville, Fort Gratiot, Foster City, Fostoria, Fountain, Fowler, Fowlerville, Frankenmuth, Frankfort, Franklin, Fraser, Frederic, Free Soil, Freeland, Freeport, Fremont, Frontier, Fruitport, Fulton

Gaastra, Gagetown, Gaines, Galesburg, Galien, Garden, Garden City, Gaylord, Genesee, Genoa, Georgetown, Germfask, Gibraltar, Gilford, Gladstone, Gladwin, Glen Arbor, Glenn, Glennie, Gobles, Goetzville, Good Harbor, Good Hart, Goodells, Goodland, Goodrich, Gould City, Gowen, Grand Beach, Grand Blanc, Grand Haven, Grand Junction, Grand Ledge, Grand Marais, Grand Rapids, Grandville, Grant, Grass Lake, Grawn, Grayling, Greenbush, Greenland, Greenville, Gregory, Grosse Ile, Grosse Pointe, Grosse Pointe Farms, Grosse Pointe Shores, Grosse Pointe Woods, Gulliver, Gun Lake, Gwinn

Hadley, Hagar Shores, Hale, Hamburg, Hamilton, Hamlin, Hampton, Hamtramck, Hancock, Hanover, Harbert, Harbor Beach, Harbor Point, Harbor Springs, Harper Woods, Harrietta, Harris, Harrison, Harrisville, Harsens Island, Hart, Hartford, Hartland, Harvey, Haslett, Hastings, Hawks, Hazel Park, Hell, Hemlock, Henderson, Hermansville, Herron, Hersey, Hesperia, Hessel, Hickory Corners, Higgins Lake, Highland, Highland Park, Hillman, Hillsdale, Holland, Holly, Holt, Holton, Homer, Honor, Hope, Hopkins, Horton, Houghton, Houghton Lake, Houghton Lake Heights, Howard City, Howell, Hubbard Lake, Hubbardston, Hubbell, Hudson, Hudsonville, Hulbert, Huntington Woods

Ida, Idlewild, Imlay City, Indian River, Ingalls, Inkster, Interlochen, Ionia, Irish Hills, Iron Mountain, Iron River, Irons, Ironwood, Ishpeming, Ithaca

Jackson, Jamestown, Jasper, Jeddo, Jenison, Jerome, Johannesburg, Jones, Jonesville

Kalamazoo, Kaleva, Kalkaska, Kawkawlin, Kearsarge, Keego Harbor, Kendall, Kent City, Kenton, Kentwood, Kewadin, Keweenaw, Kimball, Kincheloe, Kinde, Kingsford, Kingsley, Kingston, Kinross

L'Anse, La Salle, Lachine, Lacota, Laingsburg, Lake, Lake Ann, Lake City, Lake George, Lake Gogebic, Lake Leelanau, Lake Linden, Lake Odessa, Lake Orion, Lakeland, Lakeside, Lakeview, Lakeville, Lambertville, Lamont, Lansing, Lansing Township, Lapeer, Lathrup Village, Laurium, Lawrence, Lawton, Leelanau, Leland, Lennon, Leonard, Leonidas, LeRoy, Leslie, Levering, Lewiston, Lexington, Lincoln, Lincoln Park, Linden, Linwood, Litchfield, Little Lake, Livonia, Long Lake, Loretto, Lowell, Ludington, Luna Pier, Lupton, Luther, Luzerne, Lyons

Macatawa, Mackinac Island, Mackinaw City, Macomb Twp, Madison Heights, Mancelona, Manchester, Manistee, Manistique, Manitou Beach, Manton, Maple City, Maple Rapids, Marcellus, Marenisco, Marine City, Marion, Marlette, Marne, Marquette, Marshall, Martin, Marysville, Mason, Mass City, Mattawan, Maybee, Mayfield, Mayville, Mc Bain, McBrides, McMillan, Mears, Mecosta, Melvin, Melvindale, Memphis, Mendon, Menominee, Meridian, Merrill, Merritt, Mesick, Metamora, Michigamme, Michigan Center, Middleton, Middleville, Midland, Mikado, Milan, Milford, Millersburg, Millington, Milton Twp, Minden City, Mio, Mohawk, Moline, Monroe, Montague, Montgomery, Montrose, Moorestown, Moran, Morenci, Morley, Morrice, Moscow, Mosherville, Mount Clemens, Mount Morris, Mount Pleasant, Muir, Mullett Lake, Mulliken, Munger, Munising, Munith, Muskegon, Muskegon Heights

Nadeau, Nahma, Napoleon, Nashville, National City, National Mine, Naubinway, Nazareth, Negaunee, New Baltimore, New Boston, New Buffalo, New Era, New Haven, New Hudson, New Lothrop, New Troy, Newaygo, Newberry, Newport, Niles, Nisula, North Adams, North Branch, North Lake, North Muskegon, North Star, North Street, Northeast, Northland, Northport, Northville, Northwest, Norton Shores, Norvell, Norway, Nottawa, Novi, Nunica

Oak Grove. Oak Park. Oakland. Oakley. Oden. Okemos. Old Mission. Olivet. Omena. Omer. Onaway. Onekama. Onondaga. Onsted. Ontonagon. Orchard Lake. Orion. Orleans. Ortonville. Oscoda. Oshtemo. Osseo. Ossineke. Otisville. Otsego. Ottawa Lake. Otter Lake. Ovid. Owendale. Owosso. Oxford

Painesdale, Palmer, Palmyra, Palo, Paradise, Parchment, Paris, Parma, Paw Paw, Pearl Beach, Peck, Pelkie, Pellston, Peninsula, Pentwater, Perkins, Perrinton, Perronville, Perry, Petersburg, Petoskey, Pewamo, Pickford, Pierson, Pigeon, Pinckney, Pinconning, Pittsfield, Plainfield, Plainwell, Pleasant Lake, Pleasant Ridge, Plymouth, Pointe Aux Pins, Pompeii, Pontiac, Port Austin, Port Hope, Port Huron, Port Sanilac, Portage, Posen, Potterville, Powers, Prescott, Presque Isle, Prudenville, Pullman

Quincy, Quinnesec, Quinicassee,

Ralph, Ramsay, Rapid City, Rapid River, Ravenna, Ray, Reading, Redford, Reed City, Reese, Remus, Republic, Rhodes, Richland, Richmond, Richville, Ridgeway, Riga, River Rouge, Riverdale, Riverside, Riverview, Rives Junction, Rochester, Rochester Hills, Rock, Rockford, Rockland, Rockwood, Rodney, Rogers City, Rollin, Romeo, Romulus, Roosevelt Park, Roscommon, Rose City, Rosebush, Roseville, Ross, Rothbury, Royal Oak, Ruby, Rudyard, Rumely, Ruth

Saginaw, Saginaw Township, Sagola, Saint Charles, Saint Clair, Saint Clair Shores, Saint Helen, Saint Ignace, Saint Johns, Saint Joseph, Saint Louis, Salem, Saline, Samaria, Sand Creek, Sand Lake, Sandusky, Sanford, Saranac, Saugatuck, Sault Sainte Marie, Sawyer, Schoolcraft, Scotts, Scottville, Sears, Sebewaing, Seneca, Seney, Shaftsburg, Shelby, Shelby Township, Shelbyville, Shepherd, Sheridan, Sherwood, Shingleton, Sidnaw, Sidney, Silverwood, Six Lakes, Skandia, Skanee, Skidway Lake, Smiths Creek, Smyrna, Snover, Sodus, Somerset, Somerset Center, South Boardman, South Branch, South Haven, South Lyon, South Range, South Rockwood, Southeast, Southfield, Southgate, Spalding, Sparta, Spring Arbor, Spring Lake, Springfield, Springport, Spruce, Stambaugh, Standish, Stanton, Stanwood, Stephenson, Sterling, Sterling Heights, Stevensville, Stockbridge, Strongs, Sturgis, Summit Twp, Sumner, Sunfield, Suttons Bay,

Swartz Creek, Sylvan Lake

Tawas City, Tallmadge, Taylor, Tecumseh, Tekonsha, Temperance, Texas Twp, Thomas, Thompsonville, Three Oaks, Three Rivers, Tipton, Toivola, Topinabee, Tower, Traverse City, Trenary, Trenton, Trout Creek, Trout Lake, Troy, Trufant, Turner, Tuscola, Tustin, Twin Lake, Twining

Ubly, Union, Union City, Union Lake, Union Pier, Unionville, University Center, Utica

Vandalia, Vanderbilt, Vasser, Vermontville, Vernon, Vestaburg, Vicksburg, Vulcan

Wabaningo, Wakefield, Waldron, Walhalla, Walker, Wallace, Walled Lake, Walloon Lake, Warren, Washington, Waterford, Waters, Watersmeet, Watervliet, Watton, Wayland, Wayne, Webberville, Weidman, Wells, Wellston, Wequetonsing, West Bloomfield, West Branch, West Olive, Westland, Weston, Westphalia, Westwood, Wetmore, Wheeler, White Cloud, White Lake, White Pigeon, White Pine, Whitehall, Whitmore Lake, Whittaker, Whittemore, Williamsburg, Williamston, Willis, Wilson, Winn, Wixom, Wolverine, Wolverine Lake, Woodhaven, Woodland, Wyandotte, Wyoming

Yale, Ypsilanti

Zeeland

<layer src="http://ad2.doubleclick.net/adl/www.50states.com/;ord=999999?" width="468" height="60" visibility="hide" onload="moveToAbsolute(ph1.pageX, ph1.pageY); visibility='show';" clip="468,60"></layer><layer src="http://ad2.doubleclick.net/adl/www.50states.com/;ord=999999?" width="468" height="60" visibility="hide" onload="moveToAbsolute(ph2.pageX, ph2.pageY); visibility='show';" clip="468,60"></layer>

BY LAWS OF THE REGION 21 700 MHZ PLANNING COMMITTEE

ARTICLE 1

NAME AND PURPOSE

1.1 The name of this Regional Planning Committee shall be Region 21 700 MHZ Planning Committee. Its primary purpose is to foster cooperation, planning, and development of regional plans and to expedite the implementation in the 700 MHz Public Safety Band.

ARTICLE II

MEMBERSHIP AND OPERATING RULES

2.1 Region 21 shall have two classes of members, 'voting members' and 'non-voting members'. New members may be added as needed. Voting members shall consist of one representative or designate from any agency engaged in public safety eligible to hold a license under 47 CFR 90.20, 47 CFR 90.523 or 47 CFR 2.103. An agency shall be allowed no more than one vote for each distinct eligibility category within the agency's organization or political jurisdiction. Non-voting members are all others interested in furthering the goals of public safety communications.

2.2 Membership shall be from the date of acceptance until resignation or removal.

2.3 In addition to such powers and rights as are vested in them by law, or these bylaws, the members shall have such other powers and rights as the membership may determine.

2.4 A member may be suspended or removed by a majority vote of members after reasonable notice and opportunity to be heard. Failure to attend *50%* of meetings held in a calendar year shall be cause for removal.

2.5 A member may resign by written notice to the chairperson.

2.6 The annual meeting of Region 21 shall be held in conjunction with the annual meeting of the Michigan Chapter of the Association of Public Safety Communications Officials.

2.7 Special meetings of Region 21 may be called by the chairperson or by the vice-chairperson, or upon written application of two or more members. If an annual meeting is not held as herein provided, a special meeting of the members may be held.

2.8 Reasonable notice of the time and place of Region 21 meetings shall be given to each member. Such notice need not specify the purposes of a meeting unless there is to be considered at the meeting (i) amendments to these bylaws, or (ii) removal or suspension of an officer. It shall be reasonable and sufficient to notify the members at least seven days before the meeting.

2.9 At any meeting of Region 21 twenty (20) per cent of the voting members shall constitute a quorum. At no time shall a quorum be fewer than ten (10) voting members.

2.10 Each voting member shall have one vote. A majority of the votes cast shall decide any question, unless otherwise specified in these bylaws.

ARTICLE III

OFFICERS AND AGENTS

3.1 Officers of Region 21 shall be a chairperson, vice-chairperson, treasurer, secretary and other officers as deemed necessary.

3.2 Officers shall be elected by the voting members at the first meeting and thereafter at the annual meeting.

3.3 An officer may be removed by a majority vote.

3.4 An officer may resign by written notice to the chairperson.

ARTICLE IV

AMENDMENTS

These bylaws may be altered, amended or repealed in whole or in part at a meeting by two-thirds vote.

ARTICLE V

DISSOLUTION

Region 21 may be dissolved upon completion of its stated purpose and a two-thirds plus one majority vote of the members. The FCC shall be notified.

ARTICLE VI

RULES OF ORDER

The Conduct of Region 21 Meetings shall be governed by Robert's Rules of Order newly revised 1990 edition, ninth edition, Sarah Corbin Robert, Henry M. Robert III, and William J. Evans.

ARTICLE VII

DEFINITIONS

Region 21 has adopted the following definitions of *Public Safety* and *Public Services.*

Public Safety: *The public's right, exercised through Federal, State or Local government as prescribed by law, to protect and preserve life, property, and natural resources and to serve the public welfare.*

Public Services: *Those services provided by non-Public Safety entities that furnish, maintain, and protect the nation's basic infrastructures which are required to promote the public's safety and welfare.*

APPENDIX E

A LEIN 58194 03/28/00 1049 GBDC1.
A ELOP GBDC.

ADMINISTRATIVE MESSAGE FROM MSP SPEC OPERATIONS DIV

GBDC #43

ATTN: ALL PUBLIC SAFETY AGENCIES

NEW REGIONAL PLANNING THRUST
FIRST PLANNING MEETING
RICHARD S. DEMELLO, CONVENER FOR 746-806 MHZ REGION 21 PLAN

MASONIC TEMPLE 2875 W. LIBERTY ROAD, ANN ARBOR, MI
WEDNESDAY, MAY 3, 2000 10:00 A.M. - 3:00 P.M.

MEETING IS FOR SPECTRUM ALLOCATION OF THE 700 MHZ FREQUENCIES.

THE FCC HAS ESTABLISHED THE PUBLIC SAFETY NATIONAL COORDINATION COMMITTEE (NCC), PURSUANT TO THE PROVISION OF THE FEDERAL ADVISORY COMMITTEE ACT, TO ADVISE THE COMMISSION ON A VARIETY OF ISSUES RELATING TO THE USE OF THE 24 MHZ OF SPECTRUM IN THE 764-776/794-806 MHZ FREQUENCY BANDS.

IT IS VERY IMPORTANT THAT THE PUBLIC, PARTICULARLY THE PUBLIC SAFETY COMMUNITY, PARTICIPATE IN THE NCC. THE 24 MHZ OF SPECTRUM IN THE 700 MHZ BAND REPRESENTS THE LARGEST ALLOCATION OF SPECTRUM FOR PUBLIC SAFETY USE THE FCC HAS EVER MADE. IT PRESENTS A ONCE-IN-A-LIFETIME OPPORTUNITY FOR BIG PICTURE THINKING ABOUT HOW THIS SPECTRUM RESOURCE CAN BEST SERVE THE NATION'S PUBLIC SAFETY AND EMERGENCY RESPONSE NEEDS.

DISCUSS:

1. HISTORY, HOW WE GOT TO WHERE WE ARE.
2. INTEROPERABILITY.
3. NATIONAL PLANNING REQUIREMENTS.
4. NEW PLANNING THRUST AND DISCUSSION OF NEEDS AND OR USES OF THE SPECTRUM.

QUESTIONS, CONTACT BILL FOLSKE (734)741-1346, ERICA THOMAS (517)373-8048 OR RICHARD DEMELLO (517)335-3266.

PLEASE RSVP VIA THE INTERNET TO THOMASEM@STATE.MI.US.

AUTH: HARRY WARNER,MICHIGAN STATE POLICE., COMMUNICATIONS DIVISION

MSP OPERATIONS
LT ALLAIRE
OPR OLGER

31 January, 2001
Regular Meeting of the Region 21 700 MHZ Public Safety Band
Regional Planning Committee
Lansing School District Hill Center
5815 Wise Road
Lansing, MI 48911

Present are: Stephen Todd,Acting Chairperson, Ottawa County 911; Mac Dashney,Lansing School District; John Grant,Lansing School District; Keith Bradshaw,Secretary, Macomb County Technical Services; Dean Alger,MDCIS-EMS; Robert Andrus,City of Dearborn; Joe Turner; Dennis Betz,Washtenaw County; Bill Folske, Apco Frequency Advisor; Richard DeMello, Convener; Paul Mayer, State of Ohio; Pat Coates,Treasurer, OaklandCounty; Rick Uslan, Motorola

The Interoperability and Bylaws sub-committee working groups meet from 10:00am to 12:40pm.

The regular meeting is called to order at 12:40pm by the acting chairperson S. Todd.

Minutes of 10-12-2000 meeting: **Motion D. Alger, Support D. Betz to approve minutes as presented. Motion carried by voice vote.**

We adjourn for lunch at 12:50. The acting chair reconvenes the meeting at 1:15pm.

Approval of Bylaws: The chair presents the revised by-laws for approval. The bylaws are read to the members present. **Motion D. Betz, Support D. Alger to approve revised by-laws as presented by the Bylaws Committee. Motion carried by voice vote.**

Discussion follows. Proposal to amend paragraph 1.1 to read "The name of this Regional Planning Committee shall be Region 21 700 MHZ Planning Committee." The eligibility of persons engaged in frequency coordination to be voting members of the committee is questioned. By consensus, such persons are eligible. **Motion D. Betz to approve by-laws with the above amendment to paragraph 1.1. Support, D. Alger. Motion carried by voice vote.**

Mr. R. DeMello discusses his work with the National Coordinating Committee. A $2500.00 grant is available from the National Public Safety Telecommunications Council (NPSTC) to fund the operating expenses of the Region 21 700 MHZ committee. 700 MHZ equipment should be designed for superior performance to minimize interference from commercial operations. **Motion D. Betz, Support J. Turner to accept the report of Mr. DeMello as information. Motion carried by voice vote.**

Motion Betz, Support Andrus, to instruct Mr. R. DeMello to apply for the NPSTC grant of $2500.00. Motion carried by voice vote.

Interoperability Subcommittee Report: Mr. J. Turner. **Motion Grant, Support, Betz to accept the report of the Interoperability Subcommittee. Motion carried.**

The next meeting is to be held on April 25, 2001 in Saginaw, Michigan.

Motion Betz, Support Alger to adjourn at 2:20pm. Motion carried.

Mr. DeMello requests the following be included in the minutes for information: The 800 MHZ "Best Practices Guide" can be found at http://www.fcc.gov/eb/interfernce/plmic.html.

Respectfully submitted by Keith M. Bradshaw.

25 April, 2001

Regular Meeting of the Region 21 700 MHZ Public Safety Band Regional Planning Committee
Saginaw County 911 Center
618 Cass Street
Saginaw, Michigan

Present are: Stephen Todd, Chairperson, Ottawa County 911; Pat Coates, Treasurer, Oakland County; Keith Bradshaw, Secretary, Macomb County Technical Services; Bill Folske, APCO Frequency Advisor; Richard DeMello, Convener; Lloyd Fayling, Genesee County; Joe Turner, Dennis Betz Washtenaw County; Dean Alger, MDCIS-EMS; Rick Uslan, Motorola

Also Present are: Paul M. Mayer, Ohio Department of Administrative Services; Ray Smith, Region 33 (Ohio) Chairman.

Mr. DeMello reviews decisions of NIJ frequency pre-coordination database committee.

The Interoperability and Writing sub-committee working groups meet from 11:00am to 12:15pm.

The regular meeting is called to order at 12:30pm by the chair.

Minutes of the 31 January meeting: **Motion Folske, support Betz, to accept the minutes of the meeting held on 31 January, 2001 as presented. Motion carried by voice vote.**

Vacant Positions: **Motion Alger, support Coates, to nominate J. Turner as Vice-chair, Stephen Todd to assume duties of chair. Motion carried unanimously.**

Addition of Counties to Region 21: Mr. DeMello wishes the committee consider moving some region 54 counties into region 21.

Motion Fayling, support Turner, to add the counties of Muskegon, Kent, Ottawa, Kalamazoo, St. Joe, and Alleghan into Region 21 for the purposes of 700 MHZ planning. Discussion.

Motion Fayling, support Turner, to amended the previous motion to include the county of Van Buren. Motion carried by voice vote.

Adoption of Incident Command System standards: Chairman Todd discusses changes made to the draft document entitled 'Public Safety National Coordination Committee (NCC) Interoperability Subcommittee, Operational Standards Working Group #2, Recommendations Concerning use of the Incident Command System (ICS)'. Discussion follows. Changes incorporated into the document; under Part XI, paragraph 7, "…or other clearly defined position." to read "…or other clearly defined position, as may be appropriate

within the jurisdiction." Under Part XII, paragraph 1, "It is this subcommittees recommendation that the NCC advise the FCC to mandate the use of ICS on the 700 MHz interoperability spectrum." to read "It is this Subcommittee's Recommendation that use of ICS on the 700 MHz interoperability spectrum be implemented when appropriate." Part XII, paragraph 3, strike all of Paragraph 3.

Motion Fayling, support Betz, to accept the amended Incident Command System Document as part of the Region 21 Plan. Motion carried by voice vote.

We adjourn for lunch at 1:10pm. We reconvene at 1:15pm.

Interoperability sub-committee: Mr. Turner presents the interoperability subcommittee report. **Motion Turner, support Folske, to adopt recommendations of the sub-committee.** Discussion follows. **Motion carried by voice vote.**

Memorandum of Understanding (MOU): Mr. Todd discusses changes to the draft document entitled, 'Appendix C, Memorandum of understanding for Operating the 700 MHz Interoperability Channels". Under paragraph "The APPLICANT…" "To monitor the calling channel(s) and coordinate the use of the Tactical Channels." to read "To monitor the Calling Channel(s)." Add as a separate sentence, "To coordinate the use of the Tactical Channels". "To identify inappropriate use and mitigate the same from occurring in the future" to read "To identify and eliminate inappropriate use." "To relinquish secondary Trunked operation of approved interoperability channels to requests for primary conventional access with the same or higher priority" To read "To relinquish secondary Trunked operation of interoperability channels to requests for primary conventional access." "To mitigate contention for channels by exercising the Priority Levels identified in this MOU" to read "To grant access to channels according to the Priority Levels identified in this MOU." Paragraph beginning with "To resolve contention within the same priority…" to read "To resolve contention within agencies with the same priority shall be determined by the highest level of on scene authority, or the State Interoperability Executive Committee, or RPC.

Motion Betz, support Turner to adopt the proposed changes. Motion carried by voice vote.

Presentation of the MATRIX sub-committee: Ms. Coates discusses application matrix. Original regional 21 point matrix language to be kept, except for channel loading…every mobile data unit to be considered as one-half a mobile unit. Appeals procedure with extensive changes to be presented later. MPSFAC to remain the regional plan update committee.

Motion Coates, support DeMello, to accept the report of this subcommittee. Discussion. **Motion carried by voice vote.**

We adjourn at 2:10pm.

Next meeting 9/26/2001 at 1:00pm, location in Kettenun Center in Tustin, Michigan.

Respectfully submitted by Keith M. Bradshaw, Secretary.

September 19, 2001

Regular Meeting of the Region 21 700 MHZ Public Safety Band Regional Planning Committee
Oakland County MIS
1200 N. Telegraph Road, 49 W
Pontiac, Michigan 48341

The meeting is called to order by Patricia Coates (acting chair) at 10:10 am.

Present are: Patricia Coates, Treasurer, Oakland County Clemis; Keith M. Bradshaw, Secretary, Macomb County; Richard S. DeMello, FCCA, Convener; Michael Whately, CSI; Rick Uslan, Motorola; Robert Andrus, City of Dearborn; Dean A. Alger, MDCIS-EMS; Karl Beckman, Motorola

Also Present are: Paul Mayer and Ray Smith, State of Ohio

NCC Report: Mr. DeMello relates that the NCC did not meet. Our plan is ready to be proof read for grammar, logic, etc. we should form a plan review committee.

Minutes of 25 April Meeting: **Motion Betz, support Folske to approve minutes as presented. Motion approved by voice vote.**

Treasurers report: **Motion DeMello, support Betz to approve. Motion approved by voice vote.**

We divide into Process and Writing sub-committees for Plan review at 10:40 am.

We break for Lunch from 11:45am to 12:40pm. Reconvene sub-committees at 12:45 pm.

Next meeting scheduled for 1:00 pm, October 18, 2001 in conjunction with the Michigan Apco meeting in Frankenmuth Michigan.

We adjourn at 2:55 pm.

Respectfully submitted by
Keith M. Bradshaw

October 1, 2004

700 MHz Regional Planning Committee
Public Hearing held at APCO Fall Conference,
Tustin, MI

Mr. Turner opens the meeting at 10:31AM.

Members Present: Keith Bradshaw, County of Macomb; Joe Turner, MML; Pat Coates, Oakland County; Bob Andrus, City of Dearborn; Michael Whately, CSI; Al Eichenberg, State of Michigan

Approval of Agenda.
Motion Bradshaw, support Eichenberg. Motion carried by voice vote.

Approval of Minutes of September 14, 2004.
Motion Eichenberg, support Bradshaw. Motion carried by voice vote.

Comments by Andrus as to Motorola wireless accessories in band.

Review of 700 plan.

Public comments.

Comment; In lieu of SIEC adopting I/O language, we should move I/O section of plan to appendix. RPC discussion. We decide that plan language vis SIEC is sufficient.

Comment; Multiple users - counties that share common borders, can they use all the freqs in each county? answ: will probably be decided on a case by case basis by committee.

Next meeting date November 16, 2004. To be held at Ann Arbor or Oakland County.

Motion to adjourn Bradshaw, support Whately. Motion carried by voice vote.

We close the meeting at 11:50.

Respectfully Submitted by
Keith M. Bradshaw

12 October, 2000

Regular meeting of the Region 21 700 MHZ Public Safety Band
Regional Planning Committee
Masonic Temple, 2875 W. Liberty, Ann Arbor, MI

Mr. Richard S. DeMello convenes the meeting at 10:20 am.

Chairman Andre' T. Brooks asks for a volunteer to be temporary Secretary. Keith M. Bradshaw volunteers and is appointed temporary Secretary.

By Laws: The Chair directs members refer to the "Bylaws Template". **Chair asks for a voice vote to approve name of "BYLAWS FOR REGION 21". Name approved with one (1) dissenting vote, S. Todd.**

The Chair directs members attention to ARTICLE I, and asks that '21' be inserted in paragraph 1.1. Paragraph 1.1 to read in part, "…The name of this region shall be Region 21…." Approved by consensus.

The Chair directs members review Article II, paragraphs 2.1 through 2.6. Discussion concerning definition of membership and voting rights follows. The Chair directs members review paragraphs 2.1 through 2.12. Further discussion.

Motion R. DeMello, to include the definitions of PUBLIC SAFETY and PUBLIC SERVICE as defined by the FCC on a separate page of the bylaws. Support Joe Turner. Motion approved by voice vote.

Motion S. Todd to approve bylaws as previously amended. Discussion. **Motion withdrawn.**

Discussion of paragraph 2.6 follows.

Motion R. DeMello, to amend paragraph 2.6 Annual Meetings to read "The annual meeting of the members shall be held in conjunction with the annual meeting of the Michigan Chapter of the Association of Public Safety Communication Officials held in October of each year. If an annual meeting is not held as herein provided…". Motion approved by consensus.

Motion R. DeMello to add paragraph 2.13 "Consensus" to bylaws. Discussion. **Motion withdrawn.**

Motion S. Todd to tentatively approve bylaws as amended. Final approval is to await the next regular meeting of the committee. Support, Mac Dashney.
Call the Question S. Todd. **Motion approved by voice vote.**

Regular meeting of the Region 21 700 MHZ Public Safety Band
Regional Planning Committee continued.

Election of Officers: Mr. R. DeMello calls for nominations for the positions of Vice-Chairman, Treasurer, and Permanent Secretary. Mr. Stephen Todd accepts nomination for Vice-Chairman. Ms. Pat Coates accepts nomination for position of Treasurer. Mr. Keith M. Bradshaw accepts nomination for position of Permanent Secretary. **Motion John Grant to accept nominations and install these officers. Support, Joe Turner. Motion carried by voice vote.**

Mr. DeMello discusses need for web page development. Discussion of website follows. Mr. DeMello suggest the Writing Committee should use the 800 MHZ Regional Plan as a guide to writing the 700 MHZ plan. Chairman Brooks calls for members to fill a Website Committee.

Motion R. DeMello to approve the NCC planning documents as presented with final approval deferred until the next regular meeting. Support W. Folske. Motion carried by voice vote.

The next regular meeting of the Region 21 Planning Committee will be held in Lansing, Michigan on January 16th, 2001.

We adjourn at 12:30 pm.

Respectfully submitted by Keith M. Bradshaw.

18 October, 2001

Regular Meeting of the Region 21 700 MHZ Public Safety Band Planning Committee
Zehnder's Restaurant
Frankenmuth, MI

We begin at 1:25 pm.

Present are: Richard DeMello, Convener; Patricia Coates, Oakland County, Secretary; Harry Warner, MSP; Dean Alger, MDCIS-EMS; Bill Folske, APCO Frequency Advisor; Karl Beckman, Rick Uslan, Motorola; Mike Whately, Phil Hempel, CSI; Robert Andrus, City of Dearborn; Keith Bradshaw, Macomb County, Secretary; Lloyd Fayling, Genesee County

Mr. Bradshaw presents the latest changes to the draft plan to the committee. Discussion.

We notice that Appendix T is the improper version. Secretary will update Appendix T with the proper version.

Add to page 12 under the heading "Coverage", language asserting that TIA TR 8.8 standard is to be used.

If possible, we should include the federal form "S-160" in Appendix O.

Motion Folske, support Beckman, to adopt draft plan with changes as mentioned above. Motion approved by voice vote.

Motion DeMello, support Coates, to authorize the purchase of flat bed scanner software for the purpose of rendering the plan with appendices into electronic format. Motion approved by voice vote.

Motion Alger, support Andrus, to thank Mr. DeMello, Ms. Coates and Mr. Bradshaw for their efforts in preparing the draft for presentation at this meeting. Motion approved.

We adjourn at 2:23pm.

Respectfully submitted by
Keith M. Bradshaw

Appendix G - COVERAGE REQUIREMENTS

Coverage parameters are to be consistent with TR 8.8 and NCC Planning Committee guidelines. That is, the designed mean signal strength shall not exceed +40 dBμ (+40 decibels above one microvolt per meter as measured using a λ/4 antenna at five (5) feet above ground level see Appendix I) at a uniform distance from the boundary of the applicant's service area of:

i) three (3) miles for RURAL areas,
ii) four (4) miles for SUBURBAN areas and
iii) five (5) miles for URBAN areas.

Co-channel assignments may be made using the modified R-6602 contour (with 9 dBμ correction factor) as described in TIA/EIA TSB88-A1 as; the interfering 11 dBμ (50,50) co-channel contour will be allowed to touch, but not overlap the 40 dbμ (50,50) contour of the incumbent station.

Adjacent channel assignments may be made when the interfering systems 60 dBμ (50,50) contour does not overlap the incumbent stations 40 dBμ (50,50) contour. The interfering contour may touch the incumbent contour. In cases where the 60 dB (50,50) contour is considered too restrictive, the applicant can make a showing based on good engineering practice that the ACCPR would not exceed 65 dB.

For purposes of frequency coordination, contours are to be predicted using either method described in TIA/EIA TSB88 – A1; the modified Carey R-6602 curves , or the Okumura – Hata – Davidson radial method, whichever describes the worst case.

APPENDIX G - LOADING

Each applicant for a trunked system shall certify that a minimum of 100 mobiles for each 12.5 kHz channel block will be placed in service within five years of the initial plan approval date. If that is not the case, then less than fully loaded channels shall be returned to the allotment pool and the licensee shall modify their license accordingly. Conventional channels shall be loaded to 100 mobile stations per 12.5 kHz channel block. Where an applicant does not load a 12.5 kHz channel block to 70 mobile radios, the channel block will be available for assignment to other licensees. Mobile, portable and control stations will be considered as mobile units. An applicant will be required to provide loading information consistent with this plan. If an applicant is unable to reach minimum loading criteria, and should a system licensed to a higher level of government be available in the area, the applicant must consider utilizing this system. As the higher-level systems reach their capacity, the smaller systems in the public safety service must then consider uniting their communications efforts to formulate one large system, when feasible.

APPENDIX G - REQUIRED SUBMITTALS

Each application must contain the following:

- FCC ULS 601 Form(s) and PSCC FDR3 (formally APCO FDR3):
- Statement of need for installing a new 700 MHz system. Statement to include justification for requested frequencies based on loading criteria in this Appendix.
- Details of engineering surveys showing radio coverage will *not* exceed applicant's minimum requirements. System engineering is to conform with the Coverage Requirements section of this Appendix.
- Explain any budget commitment that has been made for the proposed system; include agency budgets and/or agency resolution(s).
- Explain your systems future growth for all agencies involved in the system.
- Local Interoperability Plan explaining and certifying that applicant's agency will comply with interoperability requirements.
- Frequency Give Back Plan to include:
  - List of agencies transitioning to the 700 MHz system
  - Reference copies of FCC licenses held by these agencies
  - List of frequencies used by these agencies to be returned to frequency pool.

- Applicants must provide proof they communicated an announcement of their intent to seek new 700 MHz frequencies and offered an invitation to the State of Michigan, the county or counties within which the proposed system is located and local governmental units within their county of residence, to participate in a discussion of interoperability issues.

- 821 MHz systems that are expanded to 700 MHz shall explain how they plan to meet the interoperability requirements of both plans.
- Stipulate the PW frequency coordinator you desire to have coordinate your license application: AASHTO, APCO, FCCA, or IMSA.
- The application shall provide a complete review of matrix issues, including what the applicant feels their point score is for the MPSFAC to review in case there is a competing application.

Appeal Procedure

Appeals from decisions made with respect to a variety of matters regulated by the Regional Planning process and MPSFAC will be heard. The formal requirements of the appeal process are set out below.

In order to ensure that the appeal process is open and understandable to the public, the Regional Committee has developed this procedure. Those involved in the appeal process can expect the Committee and its members to follow the procedures. Where any matter arises during the course of an appeal that is not dealt with in this document, the Committee will do whatever is necessary to enable it to be resolved fairly, effectively and completely on the appeal. The Committee may dispense with any part of this procedure where it is appropriate to do so.

The MPSFAC will make every effort to process appeals in a timely fashion and issue decisions expeditiously.

Appeals Committee

Members

The MPSFAC Chairman may organize the Committee into Sub-Committees, each comprised of one or more members.

Where an appeal is scheduled to be heard be a Sub-Committee the chair is determined as follows:

(a) if the chair of the Committee is on the Sub-Committee they are the chair:
(b) if the chair of the Committee is not on the Sub-Committee but the vice-chair is than the vice-chair will be the chair; and
(c) if neither the chair nor the vice-chair is on the Sub-Committee, the MPSFAC Committee will designate one of the members to be the chair.

Withdrawal or Disqualification of a Committee Member on the Grounds of Bias

Where the chair or a Committee member becomes aware of any facts that would lead an informed person, viewing the matter reasonably and practically, to conclude that a member, whether consciously or unconsciously, would not decide a matter fairly, the member will be prohibited from conducting the appeal unless consent is obtained from all parties to continue. In addition, any party to an appeal may challenge a member on the basis of real or a reasonable apprehension of bias.

THE APPEAL PROCESS

An official of the entity who filed the original application to the MPSFAC must be the person who files the appeal on behalf of the entity.

How to appeal

A notice of appeal must be served upon the MPSFAC. The notice of appeal may be “delivered” by mail, courier, or hand delivered to the office of the Chair and all Members

of the Committee. See page 18 for information. The Committee will also accept a notice of appeal by electronic means to the Chair and Secretary with the original paper copy of the notice of appeal served as indicated above.

Certain things must be included in a notice of appeal for it to be accepted. The notice of appeal **must** include:

1. the name and address of the appellant;
2. the name of the person, if any, making the request for an appeal on behalf of the appellant;
3. the address for service of the appellant;
4. the grounds for appeal (a detailed explanation of the appellant's objections to the determination – describe errors in the decision);
5. a description of the relief requested (what do you want the MPSFAC/Committee/Sub-Committee to order at the end of the appeal);
6. the signature of the appellant or the appellant's representative; and data.

Time limit for filing the appeal

To appeal a determination or allocation the entity must deliver a notice of appeal within 10 business days after receiving the decision. If a notice of appeal is not delivered within the time required, the right to an appeal is lost. However, the Committee is allowed to extend the deadline, either before or after its expiration based upon a 2/3 majority of the Committee.

Rejection of a notice of appeal

The Committee may reject a notice of appeal if:

(a) it is determined that the appellant does not have standing to appeal; or

(b) the Committee does not have jurisdiction over the subject matter or the remedy sought.

Before a notice of appeal is rejected, the MPSFAC will inform the appellant of this in writing, with reasons. The appellant an opportunity to make submissions within 10 business days.

Appeal Meeting

The MPSFAC and/or established Sub-Committee will set a meeting date to review the appeal documents submitted by the applicant and meet with them to discuss the issue in an open meeting. The MPSFAC will arrive at a decision based upon the documents presented, FCC rules, NCC requirements, and the regional plan and advise the applicant of the decision.

Committee members will not contact a party on any matter relevant to the merits of the appeal, unless that member puts all other parties on notice and gives them an opportunity to participate.

APPENDIX C

RADIATED EMISSIONS MEASUREMENT SYSTEMS TUTORIAL

BY
MICHAEL A. NICOLAY

INTRODUCTION

Measuring radiated electromagnetic emissions first requires a measurement system. A basic measurement system usually contains a minimum of an antenna and a receiver. To measure very small signal levels may require the addition of a pre-amplifier to the receiver system. Figure 1 shows a typical receiver system block diagram *including a pre-amplifier*. Figure 1 will be used for the following discussion.

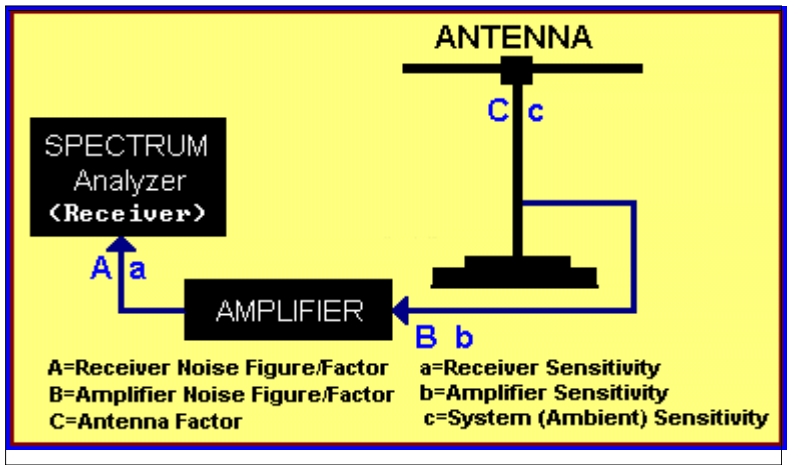

FIGURE 1. RECEIVER SYSTEM BLOCK DIAGRAM

It is beyond the scope of this text to address in detail such measurement errors as receiver detection mode errors, radio frequency pre-selection (RF) filtering, or tuner overload errors. Peak detection of continuous waves (CW) will mainly be discussed.

There are many *terms* currently used to define radiated electromagnetic energy. Some common terms used are non-ionizing radiation (NIR), electromagnetic fields (EMFs), radiated emissions, and broadcast signals. In this paper, "emissions" will be used to describe radiated electromagnetic energy.

Electromagnetic measurement systems are used to measure power densities, or power spectral densities, of electromagnetic fields at a point in space. Power density is defined as the "power per unit area normal to the direction of propagation usually expressed in units of Watts per square meter W/m^2), or for convenience in units such as milliwatts per square meter (mW/m^2), or even in microwatts per square centimeter ($\mu W/cm^2$)." Plane-waves, power densities, electric field strengths (E), and magnetic field strengths (H) are related by *free space* loss, i.e, 377 ohms (Ω). Electric field strengths and magnetic field strengths are expressed in units of Volts per meter (V/m) and Amperes per meter (A/m), respectively. A field strength is therefore defined as:

$$E = \text{Square Root } (120\pi P)$$

where,

```
E = rms value of field strength in Volts/meter
P = power density in watt/meter²
120  = impedance of free space in ohms
```

Power density (P_D) is related to the electric field strength (E) and the magnetic field strength (H) as:

$$P_D = E^2/377\Omega = 377\Omega H^2$$

Again, the rate at which electromagnetic energy (power) is propagated by a wave -- power density -- is usually specified in Watts per square meter (W/m^2). The power density equation is:

$$P_D = P_T/4\pi r^2$$

where,

```
P_D = power density in watts/meter²
P_T = transmitted power in Watts
 r = distance in meters
```

Radiated electromagnetic fields -- radiated emissions -- are produced from many sources. Sources of electromagnetic energy range from

manmade sources such as commercial broadcast stations and automobile ignition systems to natural sources such as galactic noise and lightning. To further complicate matters, these emissions can drastically differ in frequencies and in their magnitudes.

Because of the potential wide range of measurement requirements special measurement systems are sometimes necessary. These systems must be well-planned or inaccurate measurements may result. Important design specifications should include *system selectivity* and *system sensitivity*. These terms will be defined and demonstrated in the following sections.

THE ANTENNA

Measuring radiated emissions, or electromagnetic energy, begins with the antenna. Antennas are devices that receive (capture) electromagnetic energy traveling through space. Antennas can also
be used for transmitting electromagnetic energy. There are many different types of antennas, some are designed to be "broad-banded," to receive or transmit over a large frequency range, and some are designed to receive or transmit at specific frequencies. In any case, all receive antennas are intended to capture "off-air" electromagnetic energy and to deliver these "signals" to a receiver. For this discussion, electric fields (E) will mainly be addressed.

Because antennas can only capture a small portion of the radiated power, or energy, a correction factor must be added to the detected emission levels to accurately determine the radiated power being measured. The actual power received by an antenna is determined by multiplying the *power density* of the emission by the receiving area of the antenna, A_e. This antenna correction factor is called the "antenna factor."

To further understand antenna factors see Figure 2. Below are the antenna factor derivation equations.

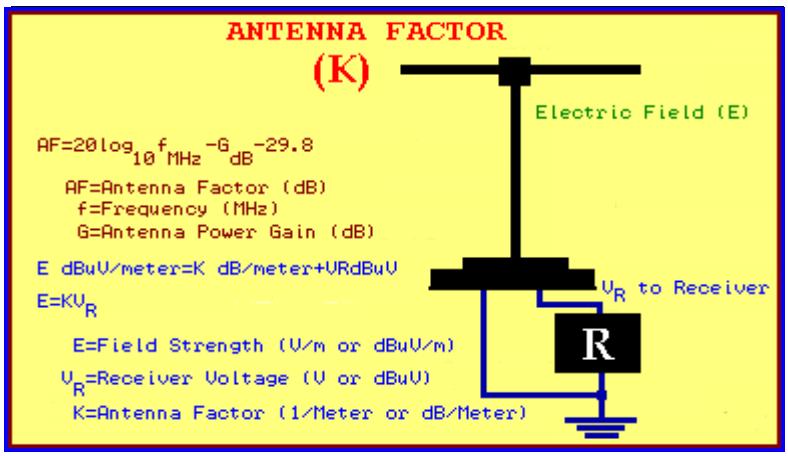

FIGURE 2. ANTENNA FACTOR

$$A_e = \lambda^2/4\pi \text{ (Meters}^2\text{)}$$

The power received by the antenna is then defined by:

$$P_r = PA_e = PG\lambda^2/4\pi \text{ (Watts)}$$

where,

P = power density in Watts/meter^2
G = antenna (power) gain
λ = wavelength in meters

Combining these equations with the field strength equation yields:

$$P_r = E^2G\lambda^2/480\pi^2$$

also,

$$P_r = V_r^2/Z_o$$

where,

V_r = received voltage
Z_o = receiver input impedance

then,

$$V_r^2/Z_o = E^2G\lambda^2/480\pi^2$$

Knowing that:

$$\lambda = 300 \text{ meters/second}/f_{(MHz)}$$

since an antenna factor is defined as:

$$E = (V_r f\pi/50\Omega)(\text{Square Root } (30/Z_o G))$$

we can simplify and rearrange terms to yield:

$$K = E/V_r$$

then,

$$K = (f\pi/50\Omega)(\text{Square Root}(30/Z_o G))$$

or in logarithmic form [*for* Z_o = 50 Ω (ohm) system]:

$$K = 20\log_{10} f_{MHz} - G_{dB} - 29.78 \text{ (dB)}$$

THE RECEIVER AND AMPLIFIER

A receiver is an electro-mechanical device that receives electromagnetic energy captured by the antenna and then processes (extracts) the information, or data, contained in the "signal."

The basic function of all receivers is the same regardless of their specific design intentions, broadcast radio receivers receive and reproduce commercial broadcast programming, likewise, TV receivers detect and reproduce commercial television broadcasting programming. Special, or unique, receivers are sometimes needed to detect and measure all types of radiated, or transmitted, electromagnetic emissions. These specialized receivers may be called tuned receivers, field intensity meters (FIMs), or spectrum analyzers.

Radiated emissions that receiver systems may be required to measure can be generated from intentional radiators or unintentional radiators. The information contained in intentionally radiated signals may contain analog information, such as audio, or they may contain digital data, such as radio navigation beacon transmissions. Television transmissions, for example, contain both analog and digital information. This information is placed in the transmitted emission, called the "carrier," by a process called "modulation." Again, there are many different types of modulation, the most common being amplitude modulation (AM) and frequency modulation (FM). Receivers detect, or extract, the information/data from radiated emissions by a process called "demodulation", the reverse of modulation.

Many radiated emissions requiring measurements do not contain any useful information or data at all. As an example, radiated emissions from unintentional radiators, such as computer systems, are essentially undesired byproducts of electronic systems and serve no desired or useful purpose. These undesired emissions can, however, cause interference to communications system, and *if strong enough*, they can cause interference to other unintentional radiating devices. Radiated signals (if strong enough) can also present possible health hazards to humans and animals. Because these emissions must be measured to determine any potential interference problems or health hazard risks, specialized receiver systems must be used.

An important parameter for any receiver is its *noise figure*, or *noise factor*. This parameter will basically define the *sensitivity* that can be achieved with a particular receiver.

An amplifier, usually called a pre-amplifier, is sometimes required when attempting to measure very small signals or emission levels. Because these devices amplify signals, they will also amplify ambient electromagnetic noise. If improperly used, amplifiers can detract from the overall system's sensitivity as well as possibly causing overloading to the receiver's tuner input stage. Overloading a tuner's input stage is simply supplying a larger signal amplitude than the receiver's tuner input circuitry is capable of handling, thus, saturating the tuner's input stage.

Just as with the receiver, it is important to know what the *noise figure*, or *noise factor*, of the selected amplifier is when designing or specifying a measurement system containing a pre-amplifier.

The noise figure (N_{fig}) for a device (receiver or amplifier) is defined as:

$$N_{fig} = 10\log_{10} N_o - 10\log_{10} G_d - (-174 \text{ dB} + 10\log_{10} B_r)$$

where,

N_o = measured noise in milliwatts
G_d = device power gain - linear ratio
B_R = receiver bandwidth in Hz

The use of these parameters for designing or specifying measurement systems will be explained and demonstrated in the following section.

SPECIFYING OR DESIGNING RADIATED MEASUREMENT SYSTEMS

When specifying or designing any measurement receiver system, one should consider that the "system" will include other devices such as antennas, amplifiers, cabling, and possibly filters.

Because a receiver's selectivity, the ability to select frequencies or frequency bands, is primarily a function of the receiver's tuner design, and will

be chiefly dependent on the individual receiver selection, selectivity will not be specifically addressed in this text. Receiver system *sensitivity*, however, presents one of the greatest difficulties, or challenges, when designing or specifying receiver measurement systems. Therefore, the sensitivity of the two basic types of receiver systems, *one with a pre-amplifier* and *one without a pre-amplifier*, will be addressed in some detail.

Because antennas are not perfect devices and have associated "losses," the following examples will include explanations for these error corrections. As mentioned previously, amplifiers will not only amplify the emissions being measured but they will also amplify ambient electromagnetic noise. These ambient conditions can drastically change the overall sensitivity of a measurement system. Another potential problem associated with using amplifiers is that they also generate internal electromagnetic noise. Being active devices they will introduce their own internal electromagnetic noise into the receiver system, again having an influence on the total system's noise level, thus, its sensitivity.

Some corrections for the above mentioned problems are necessary to accurately calculate both the receiver's signal input sensitivity and (more importantly) the total system's *ambient* sensitivity. Without knowing the total measurement system's *ambient sensitivity*, measurements may not be possible down to anticipated emission levels.

In electromagnetic measurement systems terms such as ambient sensitivity, system sensitivity, and receiver sensitivity have been used interchangeably. More confusing expressions commonly used are terms such as "receiver noise floor," or "system noise floor."

In this text, the term "system sensitivity" will be defined as ambient electromagnetic noise level seen by, and at, the antenna for 0 dB *Signal-to-Noise* ratio at the receiver's intermediate- frequency (I-F) stage. System sensitivities defined herein are for *far-field* conditions.

The following are general terms and definitions that will be used in describing and calculating the following receiver/system parameters:

General Definitions:

1. N_{fig} (dB) = Noise Figure = $10\log_{10}$ Noise Factor (NF)
2. A_e (dB) = Effective Capture Area = $10\log_{10}(\lambda^2/4\pi)$ - for *unity gain*
3. T (dB) = Average Room Temperature = $10\log_{10}$ 290°K
   (K=degrees Kelvin)
4. B_R (dB) = $10\log_{10}$ Receiver Bandwidth (Hertz)
5. K (dB) = Boltzman's Constant
   = $10\log_{10}$ 1.4 x 10^{-23} Watts/K/Hz
6. S_e (dBm/m^2) = System Sensitivity = $N_{fig}-174+B_R-A_e$

THE RECEIVER AND ANTENNA SYSTEM SENSITIVITY

Receiver sensitivity is one of the most important design parameters to consider when designing or specifying any measurement system. This parameter will determine the lowest signal level that the receiver will be capable of detecting or measuring. However, when designing a system to measure radiated radio frequency (RF) emissions (signals), it is important to go further in your analysis. The sensitivity level at the receiver may be considerably different than the sensitivity level at the antenna, especially if a pre-amplifier is attached between the antenna and the receiver. If not considered, measuring the "noise floor" of the *receiver system*, itself, instead of the anticipated radiated emissions levels may result. The following measurement system discussion will be as shown in Figure 1, *without the use of the pre-amplifier*.

Receiver sensitivity (S_R) is defined as the RF noise power level generated within the receiver. It may also be defined as the co-channel interference level for 0 dB *signal-to-noise ratio*, defined as:

$$S_R = NF\ K\ T\ B_r \text{ (Watts)}$$

or in logarithmic form:

$$S_R=10\log_{10}NF+10\log_{10}K+10\log_{10}T+10\log_{10}B_R \text{ (dBW)}$$

where,

K = Boltzman's Constant = 1.4 x 10^{-23} Watts/K/Hz
T = temperature in degrees Kelvin
B_R = receiver I-F bandwidth in Hertz
NF = receiver noise factor

Note: *Noise figures and noise factors are different ways of specifying noise. In this text, noise factors will be used to describe linear ratios, and noise figures will be used to describe logarithmic ratios.*

Again, a receiver's selectivity, the ability to select frequencies or frequency bands, is chiefly dependent on the receiver's tuner design, which is mainly the function of the receiver selection. Because receiver system sensitivity presents one of the greatest challenges, sensitivity will be ddressed in detail.

For simplicity, a *spectrum analyzer* will be used as the receiver for this discussion. We will first determine the receiver's sensitivity from its indicated power level. The indicated power level of a spectrum analyzer is essentially the base-line trace observed on its cathode-ray tube (CRT) display,
usually expressed in dBm. It may be more useful to convert this unit (dBm) to a more useful unit such as dBV. In a 50Ω system this conversion is

done by adding 107 dB to the indicated power level displayed on the analyzers CRT display. As an example, an indicated power level of -90 dBm (on the CRT display) is equivalent to an electric plane-wave of 17µV. **Note:** *The 107 dB factor is only applicable in a 50Ω system.*

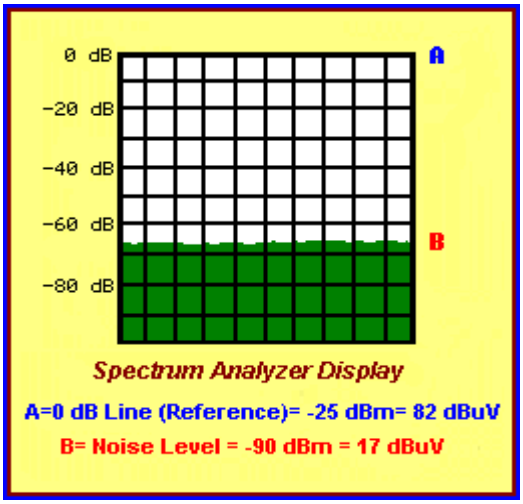

FIGURE 3. SPECTRUM ANALYZER DISPLAY

Converting the *receiver's sensitivity* into a plane-wave field strength equivalency, ambient field strength reference at the antenna, is not difficult but may be confusing at first because of the unit conversions and the concept of equivalent field strengths. As shown above, it may be easier to first convert the receiver's indicated sensitivity power level (dBm), to a plane-wave equivalent voltage (dBµV). After this conversion, the equivalent field strength sensitivities can be easily calculated in units of dBµV/m or V/m. This conversion can be accomplished using "antenna factors."

The antenna factor (dB/m) when added to the indicated sensitivity level (dBµV) of the receiver will produce the equivalent field strength sensitivity referenced at the antenna (dBµV/m), referenced to an isotropic antenna. For example, an indicated field strength of 17 dBµV plus an antenna factor of 25 dB/m is equal to a field strength of 42 dBµV/m.

Because the *antenna factor* does not include any losses such as cable losses and filter losses, these losses will have to be accounted for to accurately calculate equivalent field strengths or field strength sensitivities.

For ease in calculating, these losses (in dB) can be added to the antenna factor. This resultant number, when added to the indicated receiver sensitivity, in dBµV, will yield an equivalent ambient field strength or electric plane-wave sensitivity. **Note:** *This will only be true for a particular antenna at a specific frequency. Each antenna factor will be different for each measurement frequency.*

Using the following measurement receiver (*spectrum analyzer*) system specifications as an example:

System Specifications:

1. Receiver sensitivity (indicated) = -90 dBm
2. The antenna factor at 45.50 MHz = 25 dB
3. The cable loss at 45.50 MHz = 2 dB

By performing the following steps the measurement system's plane-wave equivalent sensitivity, in dBµ V/m, would be:

Step 1. First, converting the indicated receiver sensitivity level from a power (dBm) to an equivalent voltage (dBµV), assume a 50Ω system, would yield:

$$\mathbf{S_R = -90\ dBm + 107\ dB = 17\ dB\mu V}$$

Step 2. Correcting for cable losses and antenna factors, the system sensitivity (S_e) would be:

$$\mathbf{S_e = 17\ dB\mu V + 25\ dB/m + 2\ dB = 44.0\ dB\mu V/m}$$

Step 3. By taking the antilog of the sensitivity level calculated in step 2, the equivalent, or effective, plane-wave electric field strength sensitivity (S_e) in µV/m will be:

$$\mathbf{S_e = 44.0\ dB\mu V/m = 10^{(44.0 dB\mu V/m/20)} = 158.49\ \mu V/m}$$

THE RECEIVER, PRE-AMPLIFIER, AND ANTENNA SYSTEM SENSITIVITY

Now that the sensitivity of a receiver system with just an antenna has been defined, the sensitivity of a measurement system *including a pre-amplifier* will be explained -- *without the use of antenna factors*. This will be slightly more complicated than a measurement system containing only a receiver and an antenna.

Again, the system's sensitivity will be defined as the minimum ambient signal level, power density, or field strength that the system can detect or measure referenced at the receive antenna.

To determine the overall system sensitivity the total system's noise factor must be calculated using the noise factors of each active device within the system. If the manufacturer of each device has not specified these parameters they can be measured and/or calculated.

To calculate the system noise factor the following equation is used when a preamplifier is included in the measurement system:

$$NF_s = NF_1 + ((NF_2-1)/G))$$

where,

NF_s = noise factor of the system
NF_1 = noise factor of the preamplifier
NF_2 = noise factor of the receiver
G = Gain of the Preamplifier (Power)

Because antenna factors will not be used, there are two other parameters that will be needed to complete the overall system sensitivity calculations, the *measurement frequency* must be defined and the antenna gain must be known. The frequency is important because the *effective capture area* (A_e) of the antenna must be known. This calculation is based on the equation $\lambda^2/4\pi$; Lambda (λ) being the emission wavelength specified in meters. The antenna gain is important because it obviously effects the system's sensitivity.

To make the system sensitivity calculations easier, logarithmic expressions will be used in most cases. Again, noise figures will be used to express noise factors in logarithmic form.

The system sensitivity (S_e) of the measurement system can be calculated using the following:

$$S_e = N_{fig}-174^{*}+B_r-A_e \ (dBW/m^2)$$

where,

N_{fig} = system noise figure (dB)
B_R = receiver bandwidth, in Hertz (dB)
A_e = antenna effective capture area (dB)
* = 10 $\log_{10}$ Boltzman's Constant x 290 °K + 30 dB

As an example, the following will demonstrate how to calculate the system's sensitivity (S_e) using the following device parameters:

Device Parameters:

1. Receiver I-F Bandwidth = 9 kHz
2. Receiver Noise Figure = 15 dB
3. RF Preamplifier Power Gain = 26 dB
4. Preamplifier Noise Figure = 4.15 dB
5. Measurement Frequency = 635 MHz

First, the receiver sensitivity (S_R) is equal to:

$$S_R = 15+(-228.5)+24.6+39.5=-149.4 \ (dBW)$$
$$= \mathbf{-119.4 \ (dBm)}$$

(For convenience in later comparisons, *dBW* was converted to *dBm*. You will notice (later) the difference between the *receiver sensitivity* and the ambient *system's sensitivity*.)

Next, we must calculate the system noise figure (N_{fig}). This will be more complicated because we must obtain the answer in *logarithmic form* from calculations done in a *linear manner*:

1. NF_1 = 4.15 dB=$10^{(4.15/10)}$= **2.6**
2. NF_2 = 15 dB=$10^{(15/10)}$= **31.6**
3. G = 26 dB=$10^{(26/10)}$= **398**
4. NF_3=2.6+((31.6-1)/398)=**2.68**

then,

$$N_{fig} = 10\log_{10} 2.68 = \mathbf{4.3\ dB}$$

The effective capture area of the antenna, A_e, will now be calculated as follows (for unity gain antenna):

1. λ= 300 m/s ÷ frequency (MHz)
   = 300 / 635 = **.47 meters**
2. $A_e = \lambda^2 / 4\pi$
   = .472 / (4 x 3.1415)
   = **.0176 meters^2**
   = 10 $\log_{10}$ .0176 = **-17.5 dB**

The receiver bandwidth (B_R) calculation will be:

1. B_R = 10 $\log_{10}$ Frequency (Hz)
2. B_R = 10 $\log_{10}$ 9000 Hz = **39.5 dB**

Finally, using equation $S_e = N_{fig} - 174 + B_r - A_e$, we can calculate the total system sensitivity. The system sensitivity (power density) will be:

$$S_e = 4.3 - 174 + 39.5 - (-17.5) = \mathbf{-112.7\ dBm/m^2}$$

Now that the system sensitivity (S_e) is known, defined in power density units (dBm/m^2), it may be more useful to convert further to more commonly used units such as field strengths. Again, the units of measurement for field strengths are Volts per meter (V/m), or for convenience dBµV/m (decibel ratio of V/m referenced to 1 microvolt).

For ease in understanding, and for simplicity in calculating, it is recommended that unit changes be done by first converting power densities (dBm/m^2) to milliwatts per square centimeter (mW/cm^2), then converting to field strength units such as V/m or dBµV/m. In converting *power densities* to *field strengths* the following conversion factors will be helpful:

1. Units/**cm^2** (square centimeters) = units/**m^2** - 40 dB
2. Volts/meter (**V/m**) = Square Root (mW/**cm^2** x 3763.6Ω)

Using the above conversion factors (1 and 2), the equivalent field strength sensitivity would be:

1. -112.7 dBm/m^2 = -152.7 dBm/cm^2
2. -152.7 dBm/cm^2 = $10^{(-152.7\text{dBm}/10)}$ = 5.4 x 10^{-16} mW/cm^2
3. Square Root (5.4 x 10^{-16}mW/cm^2 x 3763.6Ω) = 1.4 x 10^{-6}V/m
4. 20$\log_{10}$1.4 x 10^{-6}V/m = **2.9dBµV/m**

Some additional helpful conversion factors for radiated measurement units are:

dBW/m^2 = dBV/m-25.8
dBW/m^2 = dBµV/m-145.8
dBm/m^2 = dBµV/m-115.8
dBm/cm^2 = dBµV/m-155.8
dBm/cm^2 = dBV/m-35.8
dBW/m^2 = dBm/m^2-30.0
dBW/m^2 = dBW/cm^2+40.0
dBW/m^2 = dBm/cm^2+10.0

The measurement system's sensitivity has now been calculated and defined. It is important to note, however, that the system may not be capable of measuring all ambient signal levels down to this level. As mentioned earlier, ambient noise levels may be higher than the measurement system sensitivity. This will result in the ambient noise levels masking potential measurements down to these levels.

These potential problems can be resolved with proper system pre-selection (RF input filtering) and receiver I-F bandwidth adjustments.

SUMMARY

In summary, designing or specifying receiver systems requires that each system be designed or specified for its particular application. Two important design parameters that must be addressed are the system's selectivity and its sensitivity. This can become demanding because measurement systems may be required to detect and measure radiated emissions comprised of narrow-band and/or wide-band signals, they may also be required to measure radiated signal strengths varying from very small to very large amplitude levels.

Selectivity, the ability to tune (select) to a frequency or a band of frequencies, is primarily dependent on the particular tuner (receiver) selection in addition to any radio frequency (RF) input filtering, called pre-selection. By filtering undesired input RF emissions, and with proper receiver intermediate-frequency (I-F) filter adjustments, it is possible to measure very low emission amplitudes present in frequency bands containing much higher amplitude emissions or noise levels. These filter selections will be based on the emission types being measured and on the ambient conditions under which the measurements are made.

Sensitivity, the lowest rf amplitude levels that a receiver system will be capable of measuring, is dependent on several variables. These variables are involved with specific antenna selections, receiver noise figures/factors, pre-amplifier gains and noise figures/factors (if used), and the system's filtering and cabling. If not properly planned, all these devices can detract from the overall system's performance.

The first step in designing or specifying a measurement system is to understand the actual measurement requirements. This should include the emission frequencies, their bandwidth's, and probable emission amplitude levels. This information will determine any required RF and I-F filtering and, in particular, the overall system's sensitivity needs.

The second step should be to calculate the total system parameters to include all the devices selected to be used in the measurement system. Any pre-selection required can usually be accomplished using passive high-pass, low-pass, or band-pass filters. These types of filters can greatly assist in removing any undesired ambient noise or signals removed from the intended measurement frequency or frequency band of interest.

The RF filtering will primarily determine the "*carrier-to-noise ratio*" of the system. RF filtering will also prevent possible overloading to the system's pre-amplifier or to the receiver if a pre-amplifier is not used. Overloading, exceeding the maximum allowed input levels, to the system's pre-amplifier or receiver input levels can result in creating intermodulation products within these devices and may result in inaccurate measurement results.

The I-F filtering selection will primarily determine the "*signal-to-noise ratio*" within the receiver itself.

The overall system sensitivity will thus be dependent on the noise figure of the selected receiver, the noise figure and gain of the preamplifier (if used), the system cabling losses, and the gains of the selected antennas.

For high-gain systems, used for measuring low signal levels, extreme caution should be taken to ensure that the combination of the antenna gains and amplifier gains will not produce signal levels that exceed the maximum input levels allowed for the selected receiver. Again, because of the importance, saturating an amplifier or a receiver's input stage may create intermodulation products and may result in inaccurate measurements.

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APPENDIX J

TABLE OF INTEROPERABILITY CHANNELS FOR SPECIFIC USES/SERVICES (PROPOSED 06/02/2000 ALTERNATE BAND PLAN)

Table of Interoperability Channels
For Specific Uses/Services
(proposed 06/02/2000 alternate band plan)

CHANNEL SETS	DESCRIPTION	LABEL
Channel 54 & 55	*General Public Safety Services (secondary trunked)*	*GTAC 5*
Channel 134 & 135	*General Public Safety Services (secondary trunked)*	*GTAC 7*
Channel 214 & 215	*General Public Safety Services (secondary trunked)*	*GTAC 9*
Channel 294 & 295	*General Public Safety Services (secondary trunked)*	*GTAC 11*
Channel 374 & 375	*General Public Safety Services (secondary trunked)*	*GTAC 13*
Channel 14 & 15	Calling Channel	CALL 7A
Channel 94 & 95	Emergency Medical Services	ETAC 15
Channel 174 & 175	Fire Services	FTAC 17
Channel 254 & 255	Law Enforcement Services	LTAC 19
Channel 334 & 335	General Public Safety Services (data I/O)	GTAC 21
Channel 22 & 23	Mobile Repeater	MTAC 23
Channel 62 & 63	Emergency Medical Services	ETAC 25
Channel 142 & 143	Fire Services	FTAC 27
Channel 222 & 223	Law Enforcement Services	LTAC 29
Channel 102 & 103	General Public Safety Services	GTAC 31
Channel 182 & 183	Other Public Services	OTAC 33
Channel 534 & 535	*General Public Safety Services (secondary trunked)*	*GTAC 35*
Channel 614 & 615	*General Public Safety Services (secondary trunked)*	*GTAC 37*
Channel 694 & 695	*General Public Safety Services (secondary trunked)*	*GTAC 39*
Channel 774 & 775	*General Public Safety Services (secondary trunked)*	*GTAC 41*
Channel 854 & 855	*General Public Safety Services (secondary trunked)*	*GTAC 43*
Channel 494 & 495	Calling Channel	CALL 7B
Channel 574 & 575	Emergency Medical Services	ETAC 45
Channel 654 & 655	Fire Services	FTAC 47
Channel 734 & 735	Law Enforcement Services	LTAC 49

Channel 814 & 815	General Public Safety Services (data I/O)	GTAC 51
Channel 502 & 503	Mobile Repeater	MTAC 53
Channel 542 & 543	Emergency Medical Services	ETAC 55
Channel 582 & 583	Fire Services	FTAC 57
Channel 622 & 623	Law Enforcement Services	LTAC 59
Channel 662 & 663	General Public Safety Services	GTAC 61
Channel 702 & 703	Other Public Services	OTAC 63

Trunking is permitted on the 10 channel sets indicated in italic.[1]

[1] Channel nomenclature and the specific trunking channels are subject pending Petitions for Reconsideration to the 4th Report & Order in Docket 96-86. This table subject to change once those Petitions are finalized.

Interoperability Channel Technical Parameters

Project 25 Common Air Interface

Certain common P25 parameters need to be defined to ensure digital radios operating on the 700 MHz Interoperability Channels can communicate. This is analogous to defining the common CTCSS tone used on NPSPAC analog Interoperability channels.

Network Access Code

In the Project 25 Common Air Interface definition, the Network Access Code is analogous to the use of CTCSS and CDCSS signals in analog radio systems. It is a code transmitted in the pre-amble of the P25 signal and repeated periodically through-out the transmission. Its purpose is to provide selective access to and maintain access to a receiver. It is also used to block nuisance and other co-channel signals. There are up to 4096 of these NAC codes. For ease of migration in other frequency bands, a NAC code table was developed which shows a mapping of CTCSS and CDCSS signals into corresponding NAC codes. Document TIA/EIA TSB102.BAAC contains NAC code table and other Project 25 Common Air Interface Reserve Values.

Recommendation: Since NPSPAC Interoperability Channels use CTCSS tone 156.7 Hz (5A), use of corresponding NAC code $61F is recommended for the 700 MHz Interoperability Channel NAC code.

Talkgroup ID

In the Project 25 Common Air Interface definition, the Talkgroup ID on conventional channels is analogous to the use of talkgroups in trunking. In order to ensure that all users can communicate, all units should use a common Talkgroup ID.

Recommendation: Use P25 default value for Talkgroup ID = $0001

Manufacturer's ID

The Project 25 Common Air Interface allows the ability to define manufacturer specific functions. In order to ensure that all users can communicate, all units should not use a specific Manufacturer's ID, but should use the default value of $00.

Message ID

The Project 25 Common Air Interface allows the ability to define specific message functions. In order to ensure that all users can communicate, all units should use the default Message ID for unencrypted messages of $00000000000000000000.

Encryption Algorithm ID and Key ID

The Project 25 Common Air Interface allows the ability to define specific encryption algorithms and encryption keys. In order to ensure that all users can communicate, encryption should not be used on the Interoperability Calling Channels, all units should use the default Algorithm ID for unencrypted messages of $80 and default Key ID for unencrypted messages of

$0000. These same defaults may be used for the other Interoperability channels when encryption is not used.

Use of encryption is allowed on the other Interoperability channels. Regional Planning Committees need to define appropriate Message ID, Encryption Algorithm ID, and Encryption Key ID to be used in the encrypted mode on Interoperability channels.

REGION 21 - APPENDIX J

NPSTIC APPENDIX 0

APPENDIX O
SIMPLIFIED 700 MHZ PRE-ASSIGNMENT RULES RECOMMENDATION

APPENDIX O
Simplified 700 MHz Pre-assignment Rules Recommendation

Introduction

A process for doing the initial block assignments of 700 MHz channels before details of actual system deployments is required. In this initial phase, there is little actual knowledge of what specific equipment is to be deployed and where the sites will be. As a result, a high level simplified 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 of each applicant. For Public Safety entities this will normally be a geographically defined area such as city, county or by a data file consisting of line segments creating a polygon that encloses the defined area.

For co-channel assignments, the 40 dB□ 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 low density. The interfering co-channel 5 dB□ will be allowed to touch but not overlap the 40 dB□ contour of the system being evaluated. All contours are (50,50).

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

Discussion

The FCC limits the maximum field strength to 40 dB relative to 1□V/m (customarily denoted as 40 dB□). It is assumed that this limitation will be applied similarly to the way it is applied in the 821-824/866/869 MHz band. That is, a 40 dB□ □field strength can be deployed up to a defined distance from 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 as the potential for interference from CMRS infrastructure demands that public safety systems have adequate margins for reliability in the presence of interference. The value of 40 dB□□ 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 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.

Allowing for a 3 dB reduction in the available margin due to CMRS OOBE noise lowers the reliability and/or the channel performance of Public Safety systems. TIA TR8 made this allowance during the meetings in Mesa, AZ, January 2001. In addition, there are various channel bandwidths with different performance criteria and 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. There would be a single co-channel source, but potentially several adjacent or alternate channel sources involved.

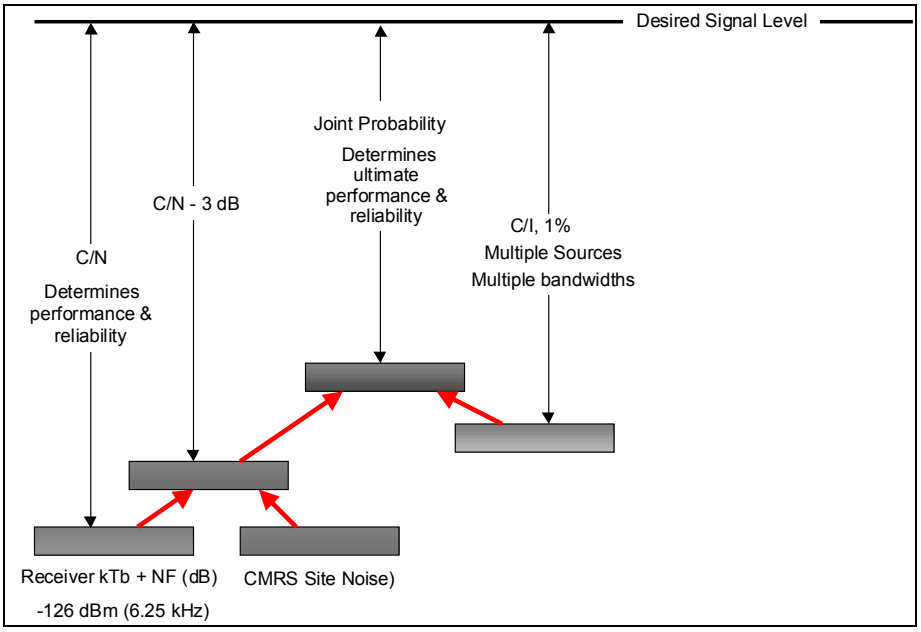


Figure 1 - Interfering Sources Create A "Noise" Level Influencing Reliability

It is recommended that co-channel assignments limit the C/I at the edge (worst case mile) be sufficient to limit that interference to <1%. A C/I ratio of 26.4 dB plus the required capture value required to achieve this goal.[1]. A 17 - 20 dB C/N is required to achieve channel performance. Table 1 shows estimated performance considering the 3 dB noise floor rise at the 40 dB signal level. Performance varies due to the different Cf/N requirements of the different modulations and channel bandwidths. These values are appropriate for a mobile on the street, but are considerably short to provide reliable communications to portables inside buildings.

[1] See Appendix A for an explanation of how the 1% interference value is defined and derived.

Comparison of Joint Reliability for various configurations				
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)	**94.2%**	**94.2%**	**90.4%**	**75.8%**
40 dBu = -92.7 dBm @ 770 MHz				

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

To analyze the impact of requiring portable in building coverage, several scenarios are presented. The different scenarios involve a given separation from the desired sites. Then the impact of simulcast is included to show that the 40 dB□ must be able to fall outside the edge of the service area. From the analysis, recommendations of how far the 40 dB□ extensions should be allowed to occur are made.

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 suppressed to TIA's most recent recommendation and the "site isolation" is maintained at 65 dB minimum.
- The 40 dB□ 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 that simulcast is required to achieve public safety levels of reliability. The difference in performance margin requirements would require more sites and closer site to site separation for wider bandwidth channels.

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)

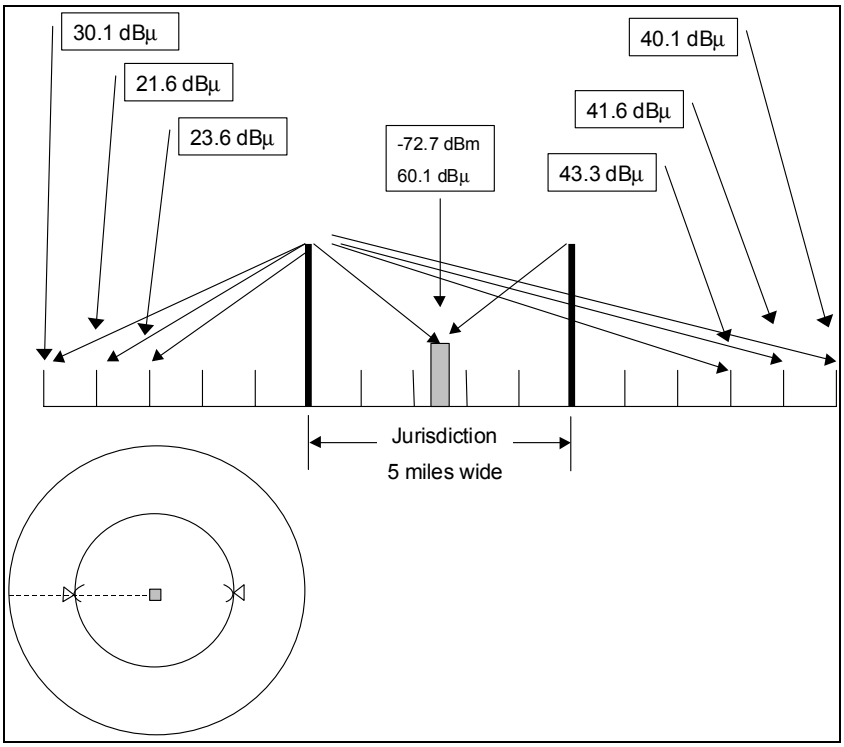


Figure 2 - Field Strength From Left Most Site.

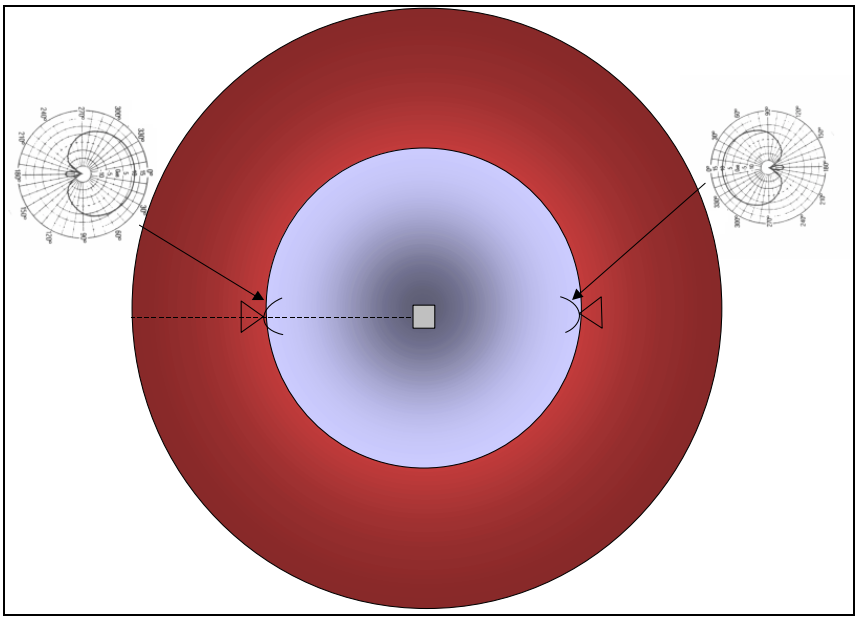


Figure 3 - Antenna Configuration Required To Limit Field Strength Off "Backside"

Figure 2 is for an urbanized area with a jurisdiction of 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 utilizing direction antennas opriented 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 dB□. 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 dB□. 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 to control the 40 dB□ is not practical as the difference in angular discrimination from a 200 foot tall tower at 2.5 miles and 10 miles is approximately 0.6 degrees.

Tables 3 and 4 represent the same configuration, but for less dense buildings. In these cases, the distance to extend the 40 dBm can be determined from Table Z. Recommendations are made in Table 6.

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 2.5 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)

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 2.5 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.

Overshoot Distance (mi)	Field Strength (dB□)	20 dB F/B (dB□)
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

This allows the overshoot to be 11 miles so the extension of the 40 dBm can be 4 miles for surbanized territory . For the more rural territory, the limit is the signal strength off the back of the antenna. So the result is that for various types of urbanized areas the offset of the 40 dBm should be:

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 dB□ Field Strength

The 40 dB□ can then be constructed based on the defined service area without having to perform an actual prediction. Since the 40 dB□ is beyond the edge of the service area, some relaxation in the level of I is reasonable. Therefore a 35 dB ration is recommended and is consistent with what is currently being licensed in the 821-824/866-869 MHz Public Safety band.

Co-Channel Recommendation

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

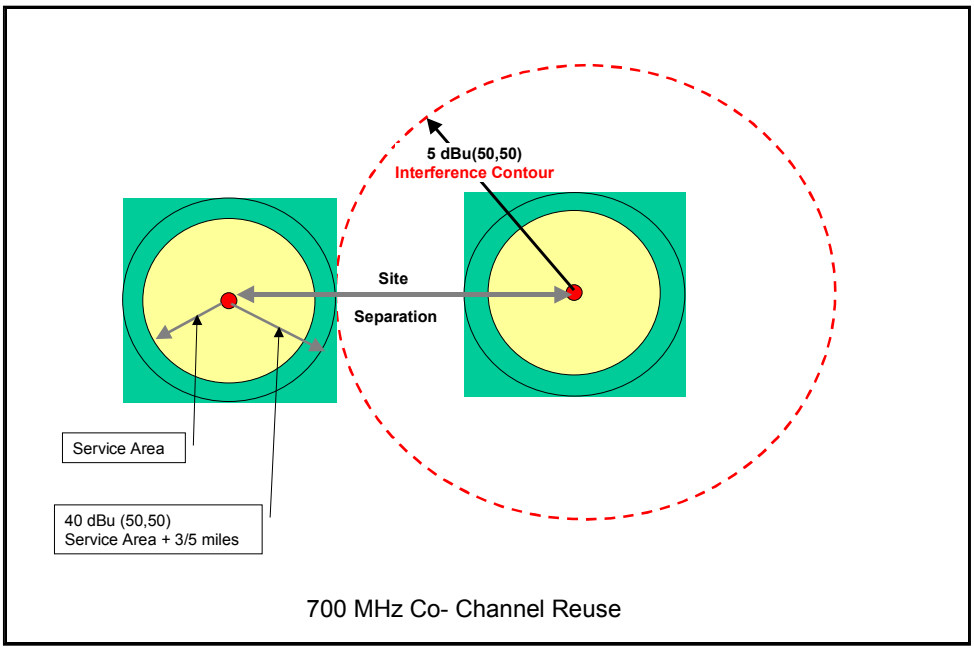


Figure 4 - Co-Channel Reuse Criterion

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. ACP defines the energy in a measured bandwidth that is typically wider than the receiver. 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 a channel bandwidth is increased, the total noise is allowed to rise as it is initially defined in a 6.25 kHz channel bandwidth. However, the effect is diminished at very close spacings as the noise is rapidly falling off. At greater spacings, the noise is essentially flat and the receiver's filter limits the noise to the specified 3 dB 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 receiver muting. Therefore at least 17 dB plus the margin for keeping the interference below 1% probability requires a total margin of 43.4 dB. However, this margin would be at the edge of the service area and the 40 dB 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 block.

Base initial (presorts) on 25 kHz 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.

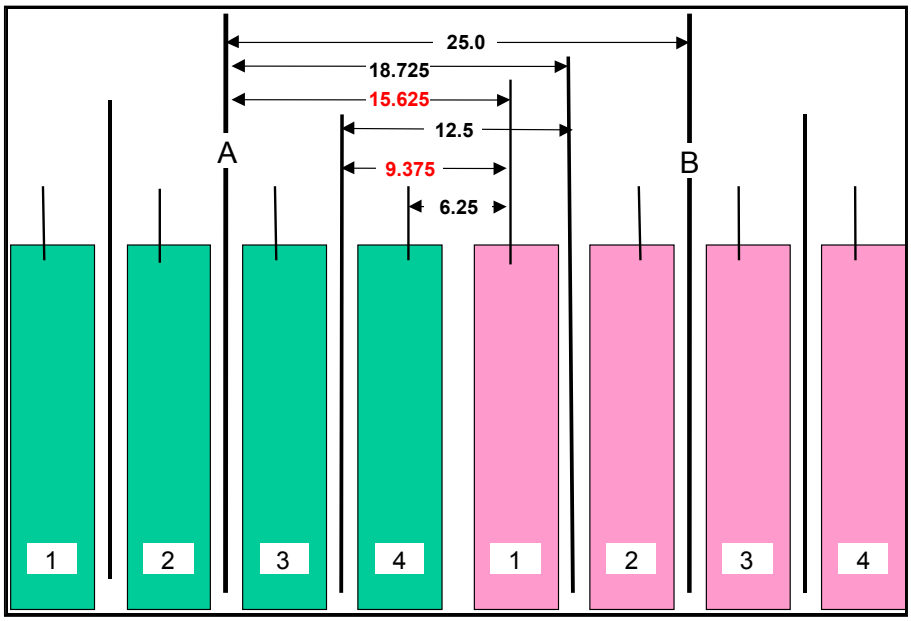


Figure 5, Potential Frequency Separations

Case	ACCPR
25 kHz	65 dB
18.725 kHz	65 dB
15.625 kHz	>40 dB
12.5 kHz	65 dB
9.375 kHz	>40 dB
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 Phase 2 narrowband 6.25 kHz channel. If system designers keep this consideration in mind and move the edge 6.25 kHz channels inward on their own systems, then a constant value of 65 dB ACCPR can be applied across all 25 kHz channels regardless of what is eventually deployed.

For other blocks, it must be assumed that transmitter filtering in addition to transmitter performance improvements with greater frequency separation will further reduce the ACCPR.

Therefore it is recommended that a consistent value of 65 dB ACCPR be used for coordinating adjacent 25 kHz channel blocks. Rounding to be conservative due to the possibility of multiple sources allows the "I" contour to be approximately 20 dB above the 40 dB□ contour, 60 dB□.

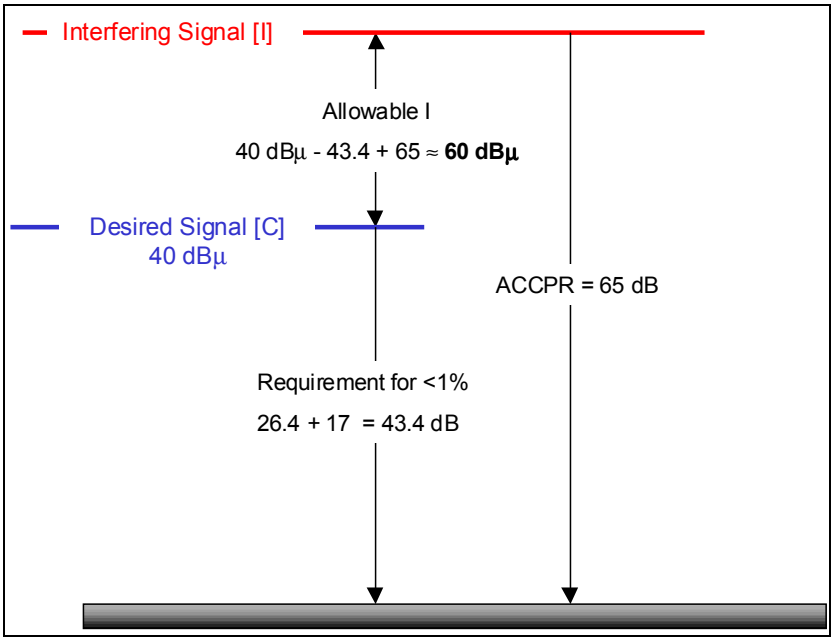


Figure 6 - Adjusted Adjacent 25 kHz Channel Interfering Contour Value

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

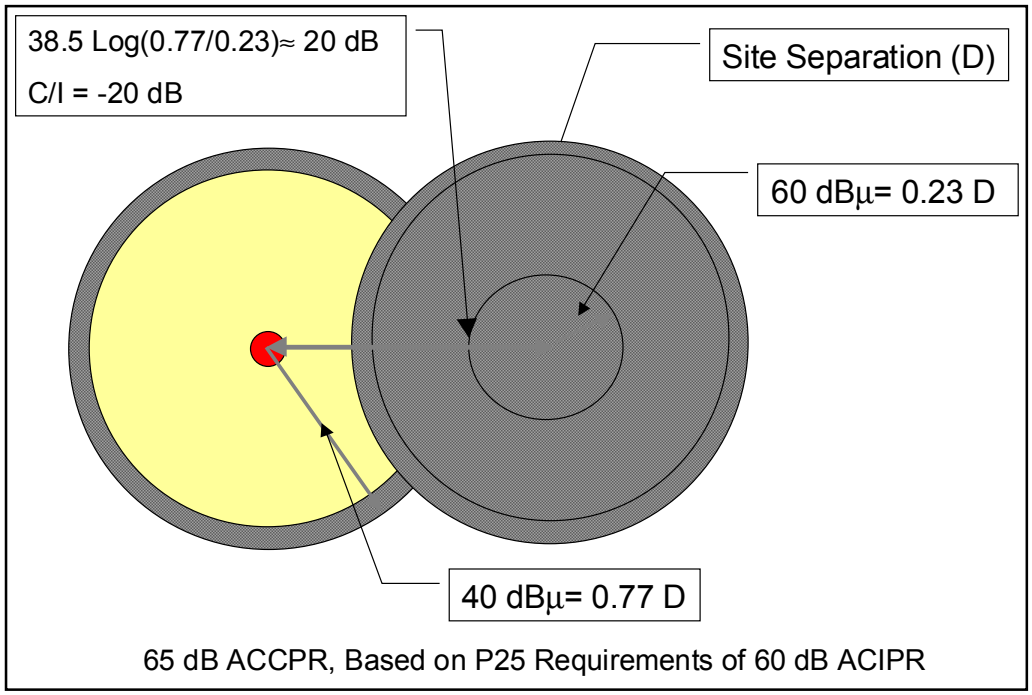


Figure 7 - Example Of Adjacent/Alternate Overlap Criterion

This simple method is only adequate for presorting large blocks 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, a 10% Interference is specified, the C/I implies 90% probability of successfully achieving the desired ratio. At 1% interference, means that there is a 99% probability of achieving the desired C/I.

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

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, $Z = 1.28$.

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

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

Location Standard Deviation (□) 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.

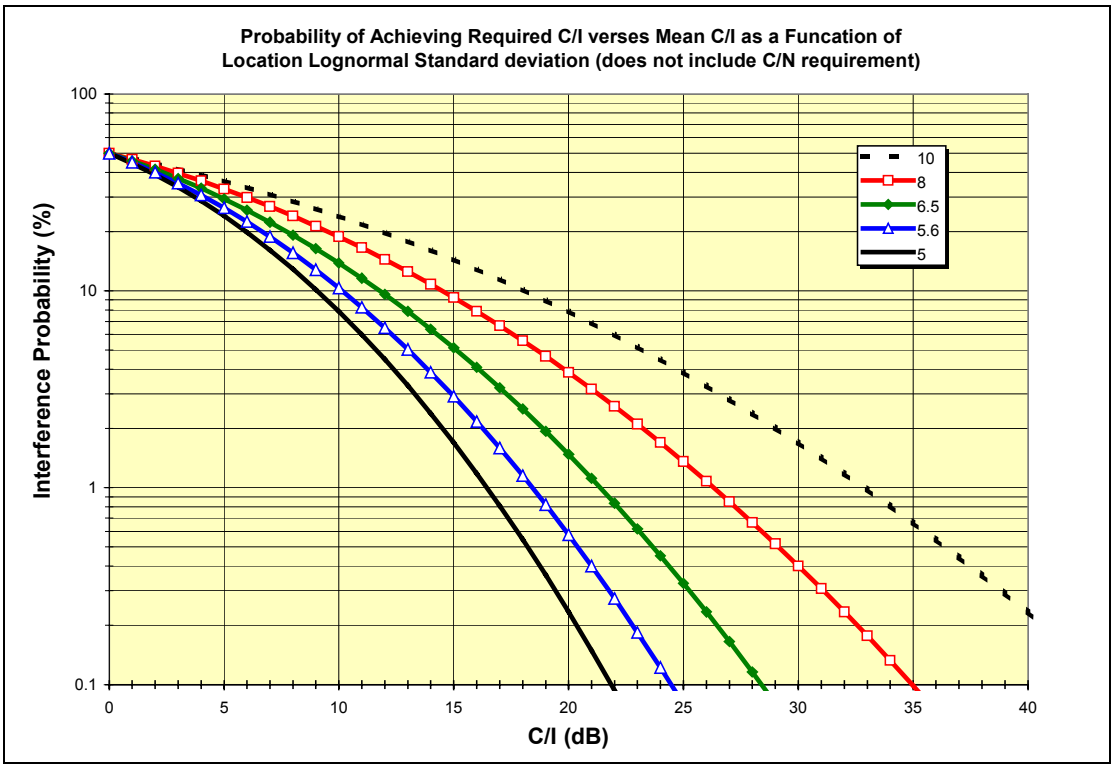


Figure A1, Probability Of Achieving Required C/I As A Function Of Location Standard Deviation

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. This provides the additional flexibility necessary to complete the 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 is a less degradation of the 90%

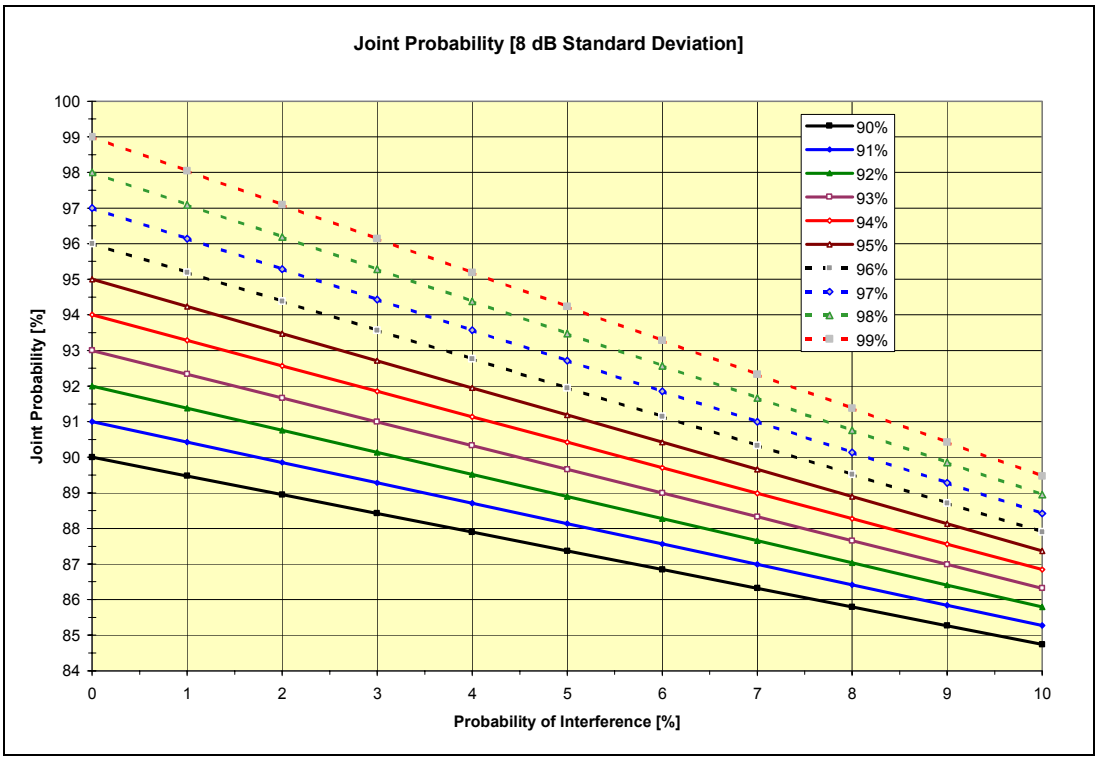


Figure A2 - Effect Of Joint Probability On The Composite Probability

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 L
FUNDING REQUEST FORM

Invoice # 37009

Date:	
Host Organization:	
RPC Chair/Convener:	
State / Region #	
Phone:	
Address:	
City, State, Zip:	
Alternate Contact:	
Alt Phone:	
Fax:	

Charged to the National Law Enforcement and
Corrections Technology Center - Rocky Mountain
c/o The University of Denver 800-416-8086
2050 E. Iliff Ave. , Denver CO 80208

Amount Due: $2,500.00
Terms: Net 45

OPTION 1

Signature: _____

I am requesting PRELIMINARY FUNDING. I understand and agree to comply with authorized expenditure limitations. I agree to submit to the NLECTC an annual financial summary report specifying each area of expenditure until all such funds are depleted.

(OR)

OPTION 2

Signature: _____

I am requesting REIMBURSEMENT FUNDING. I understand and agree to comply with authorized expenditure limitations. I agree to submit to the NLECTC an accurate financial summary report specifying each area of expenditure requested for reimbursement.

Population for Counties in Michigan: 1990 and 2000

Note: Data not adjusted based on the Accuracy and Coverage Evaluation. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see http://factfinder.census.gov/home/en/datanotes/expplu.html

Geographic area	Population		Population change, 1990 to 2000	
	2000	1990	Number	Percent
United States	281,421,906	248,709,873	32,712,033	13.2
Michigan	9,938,444	9,295,297	643,147	6.9
Alcona County	11,719	10,145	1,574	15.5
Alger County	9,862	8,972	890	9.9
Allegan County	105,665	90,509	15,156	16.7
Alpena County	31,314	30,605	709	2.3
Antrim County	23,110	18,185	4,925	27.1
Arenac County	17,269	14,931	2,338	15.7
Baraga County	8,746	7,954	792	10.0
Barry County	56,755	50,057	6,698	13.4
Bay County	110,157	111,723	-1,566	-1.4
Benzie County	15,998	12,200	3,798	31.1
Berrien County	162,453	161,378	1,075	0.7
Branch County	45,787	41,502	4,285	10.3
Calhoun County	137,985	135,982	2,003	1.5
Cass County	51,104	49,477	1,627	3.3
Charlevoix County	26,090	21,468	4,622	21.5
Cheboygan County	26,448	21,398	5,050	23.6
Chippewa County	38,543	34,604	3,939	11.4
Clare County	31,252	24,952	6,300	25.2
Clinton County	64,753	57,883	6,870	11.9
Crawford County	14,273	12,260	2,013	16.4
Delta County	38,520	37,780	740	2.0
Dickinson County	27,472	26,831	641	2.4
Eaton County	103,655	92,879	10,776	11.6
Emmet County	31,437	25,040	6,397	25.5
Genesee County	436,141	430,459	5,682	1.3
Gladwin County	26,023	21,896	4,127	18.8
Gogebic County	17,370	18,052	-682	-3.8
Grand Traverse County	77,654	64,273	13,381	20.8
Gratiot County	42,285	38,982	3,303	8.5
Hillsdale County	46,527	43,431	3,096	7.1
Houghton County	36,016	35,446	570	1.6
Huron County	36,079	34,951	1,128	3.2
Ingham County	279,320	281,912	-2,592	-0.9
Ionia County	61,518	57,024	4,494	7.9
Iosco County	27,339	30,209	-2,870	-9.5
Iron County	13,138	13,175	-37	-0.3
Isabella County	63,351	54,624	8,727	16.0
Jackson County	158,422	149,756	8,666	5.8
Kalamazoo County	238,603	223,411	15,192	6.8
Kalkaska County	16,571	13,497	3,074	22.8
Kent County	574,335	500,631	73,704	14.7
Keweenaw County	2,301	1,701	600	35.3
Lake County	11,333	8,583	2,750	32.0
Lapeer County	87,904	74,768	13,136	17.6
Leelanau County	21,119	16,527	4,592	27.8
Lenawee County	98,890	91,476	7,414	8.1
Livingston County	156,951	115,645	41,306	35.7
Luce County	7,024	5,763	1,261	21.9
Mackinac County	11,943	10,674	1,269	11.9

1990 census counts are as published in 1990 census reports and thus do not include any changes published subsequentially due to boundary changes or to the Count Question Resolution program.

Source: U.S. Census Bureau, Census 2000 Redistricting Data (P.L. 94-171) Summary File, Tabls PL1, and 1990 census.

Compiled by: Michigan Information Center.

Population for Counties in Michigan: 1990 and 2000

Note: Data not adjusted based on the Accuracy and Coverage Evaluation. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see http://factfinder.census.gov/home/en/datanotes/expplu.html

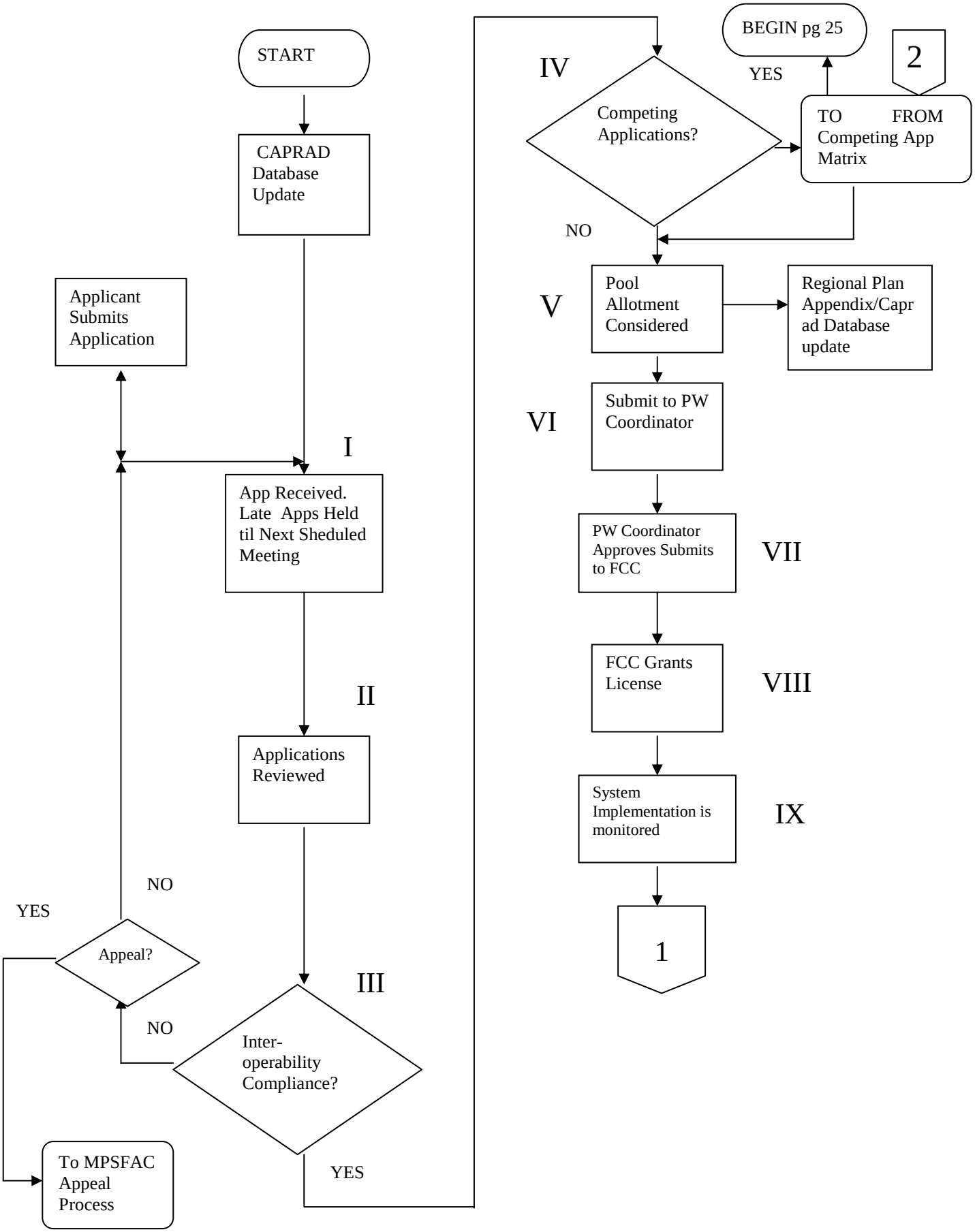
Geographic area	Population 2000	Population 1990	Population change, 1990 to 2000 Number	Percent
Macomb County	788,149	717,400	70,749	9.9
Manistee County	24,527	21,265	3,262	15.3
Marquette County	64,634	70,887	-6,253	-8.8
Mason County	28,274	25,537	2,737	10.7
Mecosta County	40,553	37,308	3,245	8.7
Menominee County	25,326	24,920	406	1.6
Midland County	82,874	75,651	7,223	9.5
Missaukee County	14,478	12,147	2,331	19.2
Monroe County	145,945	133,600	12,345	9.2
Montcalm County	61,266	53,059	8,207	15.5
Montmorency County	10,315	8,936	1,379	15.4
Muskegon County	170,200	158,983	11,217	7.1
Newaygo County	47,874	38,202	9,672	25.3
Oakland County	1,194,156	1,083,592	110,564	10.2
Oceana County	26,873	22,454	4,419	19.7
Ogemaw County	21,645	18,681	2,964	15.9
Ontonagon County	7,818	8,854	-1,036	-11.7
Osceola County	23,197	20,146	3,051	15.1
Oscoda County	9,418	7,842	1,576	20.1
Otsego County	23,301	17,957	5,344	29.8
Ottawa County	238,314	187,768	50,546	26.9
Presque Isle County	14,411	13,743	668	4.9
Roscommon County	25,469	19,776	5,693	28.8
Saginaw County	210,039	211,946	-1,907	-0.9
St. Clair County	164,235	145,607	18,628	12.8
St. Joseph County	62,422	58,913	3,509	6.0
Sanilac County	44,547	39,928	4,619	11.6
Schoolcraft County	8,903	8,302	601	7.2
Shiawassee County	71,687	69,770	1,917	2.7
Tuscola County	58,266	55,498	2,768	5.0
Van Buren County	76,263	70,060	6,203	8.9
Washtenaw County	322,895	282,937	39,958	14.1
Wayne County	2,061,162	2,111,687	-50,525	-2.4
Wexford County	30,484	26,360	4,124	15.6

1990 census counts are as published in 1990 census reports and thus do not include any changes published subsequentially due to boundary changes or to the Count Question Resolution program.

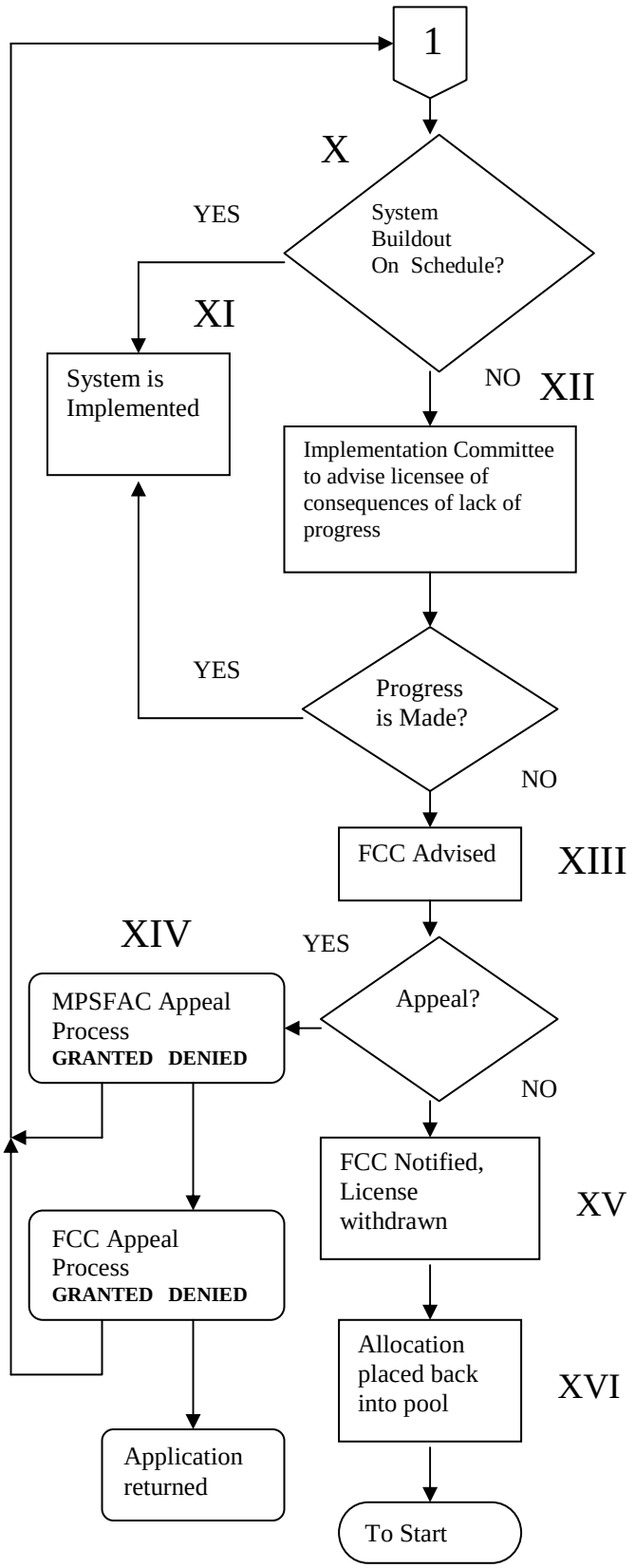
Source: U.S. Census Bureau, Census 2000 Redistricting Data (P.L. 94-171) Summary File, Tabls PL1, and 1990 census.

Compiled by: Michigan Information Center.

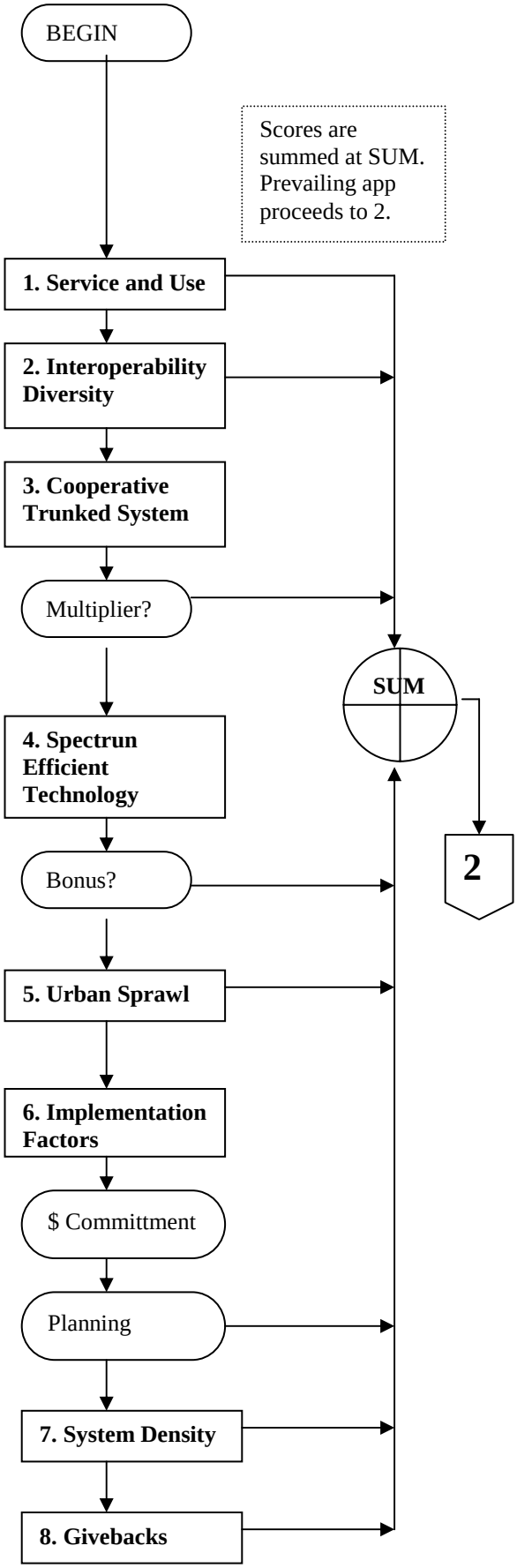
Application Submission and Approval Matrix



Application Submission and Approval, cont



Competing Application Matrix



09/17/04

Region 21 - Michigan
Allotments by FCC Channel

FCC Channel Notation	Bandwidth	Mobile Frequency	Base Frequency	County
13-16	25.00 KHz	794.087500 MHz	764.087500 MHz	Baraga
				Bay
				Cass
				Charlevoix
				Delta
				Ingham
				Mecosta
				St. Clair
17-20	25.00 KHz	794.112500 MHz	764.112500 MHz	Dickinson
				Gogebic
				Kent
				Keweenaw
				Leelanau
				Luce
				Mason
				Presque Isle
				Roscommon
				Wayne
41-44	25.00 KHz	794.262500 MHz	764.262500 MHz	Emmet
				Houghton
				Muskegon
				Ogemaw
				Saginaw
				Schoolcraft
				Washtenaw
45-48	25.00 KHz	794.287500 MHz	764.287500 MHz	Alpena
				Chippewa
				Grand Traverse
				Huron
				Kalamazoo
				Macomb
				Marquette
				Montcalm
49-52	25.00 KHz	794.312500 MHz	764.312500 MHz	Cheboygan
				Clare
				Genesee
				Iosco
				Ontonagon
				Ottawa
53-56	25.00 KHz	794.337500 MHz	764.337500 MHz	Antrim
				Berrien
				Calhoun
				Delta
				Gratiot
				Monroe
				Sanilac
57-60	25.00 KHz	794.362500 MHz	764.362500 MHz	Bay
				Dickinson
				Kent
				Luce
				Montmorency

				Oakland Wexford
81-84	25.00 KHz	794.512500 MHz	764.512500 MHz	Allegan Crawford Gogebic Ingham Isabella Keweenaw Mackinac St. Clair
85-88	25.00 KHz	794.537500 MHz	764.537500 MHz	Alpena Grand Traverse Marquette Oceana Saginaw Wayne
89-92	25.00 KHz	794.562500 MHz	764.562500 MHz	Chippewa Clare Iosco Jackson Lapeer Ottawa
93-96	25.00 KHz	794.587500 MHz	764.587500 MHz	Antrim Huron Kalamazoo Mason Menominee Monroe Shiawassee
97-100	25.00 KHz	794.612500 MHz	764.612500 MHz	Alger Cheboygan Houghton Kent Midland Oakland Wexford
121-124	25.00 KHz	794.762500 MHz	764.762500 MHz	Bay Crawford Delta Ingham Keweenaw Macomb Newaygo
125-128	25.00 KHz	794.787500 MHz	764.787500 MHz	Branch Dickinson Genesee Grand Traverse Isabella Luce Presque Isle
129-132	25.00 KHz	794.812500 MHz	764.812500 MHz	Cass Eaton Emmet Muskegon Ontonagon Roscommon Sanilac

				Wayne
133-136	25.00 KHz	794.837500 MHz	764.837500 MHz	Allegan
				Alpena
				Antrim
				Chippewa
				Lake
				Lenawee
				Marquette
				Saginaw
137-140	25.00 KHz	794.862500 MHz	764.862500 MHz	Calhoun
				Cheboygan
				Houghton
				Huron
				Missaukee
				Montcalm
				Oakland
				Schoolcraft
161-164	25.00 KHz	795.012500 MHz	765.012500 MHz	Bay
				Jackson
				Kalkaska
				Keweenaw
				Mackinac
				Macomb
				Newaygo
165-168	25.00 KHz	795.037500 MHz	765.037500 MHz	Genesee
				Iosco
				Isabella
				Kalamazoo
				Manistee
				Menominee
				Presque Isle
169-172	25.00 KHz	795.062500 MHz	765.062500 MHz	Emmet
				Hillsdale
				Iron
				Kent
				Luce
				Roscommon
				Wayne
173-176	25.00 KHz	795.087500 MHz	765.087500 MHz	Alcona
				Grand Traverse
				Ingham
				Mecosta
				Tuscola
177-180	25.00 KHz	795.112500 MHz	765.112500 MHz	Alger
				Berrien
				Branch
				Charlevoix
				Midland
				Oakland
				Ottawa
201-204	25.00 KHz	795.262500 MHz	765.262500 MHz	Allegan
				Chippewa
				Gratiot
				Huron
				Macomb
				Marquette
				Otsego

205-208	25.00 KHz	795.287500 MHz	765.287500 MHz	Calhoun Genesee Houghton Iosco Muskegon Wexford
209-212	25.00 KHz	795.312500 MHz	765.312500 MHz	Alpena Antrim Delta Gladwin Sanilac Van Buren Wayne
213-216	25.00 KHz	795.337500 MHz	765.337500 MHz	Gogebic Jackson Kent Missaukee Saginaw
217-220	25.00 KHz	795.362500 MHz	765.362500 MHz	Alcona Alger Baraga Benzie Charlevoix Isabella Oakland Oceana St. Joseph
241-244	25.00 KHz	795.512500 MHz	765.512500 MHz	Berrien Branch Huron Livingston Mackinac Marquette Mason Midland Otsego Ottawa
245-248	25.00 KHz	795.537500 MHz	765.537500 MHz	Clinton Grand Traverse Houghton Macomb Ogemaw
249-252	25.00 KHz	795.562500 MHz	765.562500 MHz	Alpena Bay Delta Emmet Kalamazoo Mecosta Washtenaw
253-256	25.00 KHz	795.587500 MHz	765.587500 MHz	Chippewa Genesee Iosco Iron Kent Manistee
257-260	25.00 KHz	795.612500 MHz	765.612500 MHz	Calhoun Cheboygan

				Gratiot Keweenaw Menominee Oceana Roscommon Sanilac Schoolcraft Wayne
281-284	25.00 KHz	795.762500 MHz	765.762500 MHz	Berrien Eaton Huron Mackinac Marquette Mason Midland Oakland Otsego Ottawa
285-288	25.00 KHz	795.787500 MHz	765.787500 MHz	Arenac Grand Traverse Houghton Montcalm
289-292	25.00 KHz	795.812500 MHz	765.812500 MHz	Alger Crawford Kalamazoo Muskegon Saginaw Washtenaw
293-296	25.00 KHz	795.837500 MHz	765.837500 MHz	Chippewa Dickinson Gogebic Hillsdale Iosco Isabella Leelanau Macomb
297-300	25.00 KHz	795.862500 MHz	765.862500 MHz	Baraga Cass Delta Emmet Kent Livingston Manistee Roscommon Sanilac
321-324	25.00 KHz	796.012500 MHz	766.012500 MHz	Clare Clinton Huron Mackinac Ontonagon Otsego Ottawa Wayne
325-328	25.00 KHz	796.037500 MHz	766.037500 MHz	Alpena Bay Grand Traverse Jackson

				Keweenaw
				Oceana
				St. Clair
				Van Buren
329-332	25.00 KHz	796.062500 MHz	766.062500 MHz	Barry
				Genesee
				Luce
				Marquette
				Mecosta
				Ogemaw
333-336	25.00 KHz	796.087500 MHz	766.087500 MHz	Charlevoix
				Gratiot
				Macomb
				Missaukee
				St. Joseph
337-340	25.00 KHz	796.112500 MHz	766.112500 MHz	Dickinson
				Kent
				Mason
				Montmorency
				Washtenaw
341-344	25.00 KHz	796.137500 MHz	766.137500 MHz	Antrim
				Berrien
				Calhoun
				Chippewa
				Delta
				Isabella
				Lapeer
345-348	25.00 KHz	796.162500 MHz	766.162500 MHz	Iron
				Leelanau
				Lenawee
				Muskegon
				Oscoda
				Saginaw
349-352	25.00 KHz	796.187500 MHz	766.187500 MHz	Alger
				Arenac
				Cheboygan
				Kalamazoo
				Montcalm
				Oakland
				Wexford
353-356	25.00 KHz	796.212500 MHz	766.212500 MHz	Alcona
				Ingham
				Midland
357-360	25.00 KHz	796.237500 MHz	766.237500 MHz	Cass
				Houghton
				Newaygo
				Presque Isle
				Roscommon
				Schoolcraft
				Tuscola
361-364	25.00 KHz	796.262500 MHz	766.262500 MHz	Clinton
				Manistee
				Menominee
				Wayne
365-368	25.00 KHz	796.287500 MHz	766.287500 MHz	Alpena
				Jackson
				Kalkaska

				Mackinac
				Ottawa
				St. Clair
369-372	25.00 KHz	796.312500 MHz	766.312500 MHz	Barry
				Clare
				Genesee
				Gogebic
				Marquette
				Monroe
373-376	25.00 KHz	796.337500 MHz	766.337500 MHz	Branch
				Emmet
				Gratiot
				Iosco
				Lake
				Luce
				Macomb
377-380	25.00 KHz	796.362500 MHz	766.362500 MHz	Bay
				Crawford
				Dickinson
				Kent
				Keweenaw
				Washtenaw
381-384	25.00 KHz	796.387500 MHz	766.387500 MHz	Berrien
				Delta
				Eaton
				Grand Traverse
				Lapeer
				Mecosta
385-388	25.00 KHz	796.412500 MHz	766.412500 MHz	Allegan
				Chippewa
				Gladwin
				Livingston
				Montmorency
				Oceana
389-392	25.00 KHz	796.437500 MHz	766.437500 MHz	Alger
				Antrim
				Ionia
				Iron
				Lenawee
				Osceola
				Sanilac
393-396	25.00 KHz	796.462500 MHz	766.462500 MHz	Calhoun
				Leelanau
				Midland
				Oakland
				Oscoda
397-400	25.00 KHz	796.487500 MHz	766.487500 MHz	Arenac
				Cheboygan
				Newaygo
				Schoolcraft
				Shiawassee
401-404	25.00 KHz	796.512500 MHz	766.512500 MHz	Huron
				Kalamazoo
				Roscommon
405-408	25.00 KHz	796.537500 MHz	766.537500 MHz	Alcona
				Benzie
				Charlevoix

				Menominee Muskegon Ontonagon Saginaw Wayne
409-412	25.00 KHz	796.562500 MHz	766.562500 MHz	Ingham Isabella Kalkaska Presque Isle St. Clair Van Buren
413-416	25.00 KHz	796.587500 MHz	766.587500 MHz	Baraga Barry Emmet Genesee Iosco Luce Manistee
417-420	25.00 KHz	796.612500 MHz	766.612500 MHz	Bay Crawford Dickinson Gogebic Washtenaw
421-424	25.00 KHz	796.637500 MHz	766.637500 MHz	Clare Clinton Keweenaw Lapeer Ottawa St. Joseph
425-428	25.00 KHz	796.662500 MHz	766.662500 MHz	Lake Livingston Mackinac Marquette Otsego
429-432	25.00 KHz	796.687500 MHz	766.687500 MHz	Grand Traverse Houghton Kent Lenawee Tuscola
433-436	25.00 KHz	796.712500 MHz	766.712500 MHz	Alger Alpena Calhoun Gladwin Oakland Oceana
437-440	25.00 KHz	796.737500 MHz	766.737500 MHz	Antrim Cass Iron Monroe Montcalm
441-444	25.00 KHz	796.762500 MHz	766.762500 MHz	Branch Chippewa Huron Montmorency Shiawassee Wexford
445-448	25.00 KHz	796.787500 MHz	766.787500 MHz	Allegan

				Arenac Charlevoix Macomb Mecosta Menominee Ontonagon
449-452	25.00 KHz	796.812500 MHz	766.812500 MHz	Ingham Missaukee Muskegon Sanilac Schoolcraft
453-456	25.00 KHz	796.837500 MHz	766.837500 MHz	Genesee Iosco Isabella Kalamazoo Leelanau Presque Isle
457-460	25.00 KHz	796.862500 MHz	766.862500 MHz	Bay Berrien Dickinson Gogebic Newaygo St. Clair Washtenaw
461-464	25.00 KHz	796.887500 MHz	766.887500 MHz	Baraga Benzie Emmet Ionia Luce Roscommon St. Joseph
465-468	25.00 KHz	796.912500 MHz	766.912500 MHz	Jackson Lapeer Mason Midland Ottawa
469-472	25.00 KHz	796.937500 MHz	766.937500 MHz	Barry Cheboygan Delta Grand Traverse Ogemaw Wayne
473-476	25.00 KHz	796.962500 MHz	766.962500 MHz	Alpena Houghton Lenawee Osceola Saginaw
477-480	25.00 KHz	796.987500 MHz	766.987500 MHz	Gladwin Kent Mackinac Manistee Marquette Oakland Otsego
481-484	25.00 KHz	803.012500 MHz	773.012500 MHz	Alcona Grand Traverse Keweenaw

				Mackinac Muskegon Saginaw Van Buren Wayne
485-488	25.00 KHz	803.037500 MHz	773.037500 MHz	Delta Eaton Isabella Lapeer Mason Otsego
489-492	25.00 KHz	803.062500 MHz	773.062500 MHz	Bay Houghton Kent Luce Missaukee Monroe
493-496	25.00 KHz	803.087500 MHz	773.087500 MHz	Benzie Iosco Kalamazoo Livingston Marquette Mecosta Sanilac
497-500	25.00 KHz	803.112500 MHz	773.112500 MHz	Cheboygan Gladwin Ionia Lenawee Macomb Oceana
501-504	25.00 KHz	803.137500 MHz	773.137500 MHz	Gogebic Ingham Oscoda Schoolcraft St. Joseph Tuscola Wexford
505-508	25.00 KHz	803.162500 MHz	773.162500 MHz	Baraga Chippewa Gratiot Hillsdale Leelanau Menominee Oakland Ottawa
509-512	25.00 KHz	803.187500 MHz	773.187500 MHz	Alpena Barry Berrien Emmet Ontonagon Osceola
513-516	25.00 KHz	803.212500 MHz	773.212500 MHz	Jackson Montcalm Ogemaw St. Clair
517-520	25.00 KHz	803.237500 MHz	773.237500 MHz	Alger Allegan

				Clare Genesee Montmorency
521-524	25.00 KHz	803.262500 MHz	773.262500 MHz	Arenac Iron Keweenaw Mackinac Manistee Muskegon Washtenaw
525-528	25.00 KHz	803.287500 MHz	773.287500 MHz	Delta Roscommon Shiawassee
529-532	25.00 KHz	803.312500 MHz	773.312500 MHz	Alcona Grand Traverse Kent Lapeer Monroe
533-536	25.00 KHz	803.337500 MHz	773.337500 MHz	Bay Charlevoix Lake Livingston Marquette Van Buren
537-540	25.00 KHz	803.362500 MHz	773.362500 MHz	Calhoun Houghton Isabella Kalkaska Luce Macomb Presque Isle
541-544	25.00 KHz	803.387500 MHz	773.387500 MHz	Benzie Clinton Dickinson Lenawee Newaygo Oscoda
545-548	25.00 KHz	803.412500 MHz	773.412500 MHz	Cheboygan Gogebic Huron Kalamazoo Missaukee Oakland Schoolcraft
549-552	25.00 KHz	803.437500 MHz	773.437500 MHz	Antrim Ingham Mason Menominee Midland Ottawa
553-556	25.00 KHz	803.462500 MHz	773.462500 MHz	Berrien Branch Emmet Ionia Tuscola Wayne Wexford

557-560	25.00 KHz	803.487500 MHz	773.487500 MHz	Alger Allegan Clare Montmorency St. Clair
561-564	25.00 KHz	803.512500 MHz	773.512500 MHz	Chippewa Iron Manistee Muskegon Ogemaw Saginaw St. Joseph Washtenaw
565-568	25.00 KHz	803.537500 MHz	773.537500 MHz	Delta Eaton Mecosta Otsego
569-572	25.00 KHz	803.562500 MHz	773.562500 MHz	Alpena Gladwin Grand Traverse Hillsdale Keweenaw Mackinac Oceana Sanilac Shiawassee
573-576	25.00 KHz	803.587500 MHz	773.587500 MHz	Crawford Marquette Montcalm Van Buren
577-580	25.00 KHz	803.612500 MHz	773.612500 MHz	Calhoun Houghton Lapeer Luce Osceola Presque Isle
581-584	25.00 KHz	803.637500 MHz	773.637500 MHz	Bay Charlevoix Kent Livingston
585-588	25.00 KHz	803.662500 MHz	773.662500 MHz	Baraga Clinton Huron Lake Leelanau Lenawee Macomb Oscoda Schoolcraft
589-592	25.00 KHz	803.687500 MHz	773.687500 MHz	Genesee Isabella Kalamazoo Kalkaska Menominee Ontonagon
593-596	25.00 KHz	803.712500 MHz	773.712500 MHz	Cheboygan Iosco

				Jackson
				Newaygo
597-600	25.00 KHz	803.737500 MHz	773.737500 MHz	Benzie
				Berrien
				Roscommon
				Tuscola
				Wayne
601-604	25.00 KHz	803.762500 MHz	773.762500 MHz	Alcona
				Alger
				Emmet
				Ingham
				Iron
				Mason
				Midland
				Ottawa
				St. Clair
				St. Joseph
605-608	25.00 KHz	803.787500 MHz	773.787500 MHz	Arenac
				Ionia
				Monroe
				Wexford
609-612	25.00 KHz	803.812500 MHz	773.812500 MHz	Allegan
				Alpena
				Antrim
				Chippewa
				Clare
				Dickinson
				Hillsdale
				Keweenaw
				Oakland
				Oceana
613-616	25.00 KHz	803.837500 MHz	773.837500 MHz	Cass
				Delta
				Manistee
				Montcalm
				Ogemaw
				Sanilac
617-620	25.00 KHz	803.862500 MHz	773.862500 MHz	Barry
				Gogebic
				Luce
				Osceola
				Otsego
				Saginaw
				Washtenaw
621-624	25.00 KHz	803.887500 MHz	773.887500 MHz	Gladwin
				Grand Traverse
				Lapeer
				Marquette
				Van Buren
625-628	25.00 KHz	803.912500 MHz	773.912500 MHz	Branch
				Houghton
				Huron
				Kent
				Livingston
				Montmorency
				Schoolcraft
629-632	25.00 KHz	803.937500 MHz	773.937500 MHz	Charlevoix

				Clinton Lake Lenawee Macomb
633-636	25.00 KHz	803.962500 MHz	773.962500 MHz	Baraga Genesee Iosco Isabella Kalamazoo Leelanau Mackinac Menominee
637-640	25.00 KHz	803.987500 MHz	773.987500 MHz	Bay Eaton Missaukee Muskegon Ontonagon Presque Isle Wayne
661-664	25.00 KHz	804.137500 MHz	774.137500 MHz	Benzie Cheboygan Gogebic Ingham Keweenaw Luce Mecosta Tuscola Van Buren
665-668	25.00 KHz	804.162500 MHz	774.162500 MHz	Kalkaska Kent Marquette Mason Midland Oakland
669-672	25.00 KHz	804.187500 MHz	774.187500 MHz	Alpena Calhoun Chippewa Houghton Osceola Sanilac
673-676	25.00 KHz	804.212500 MHz	774.212500 MHz	Berrien Delta Grand Traverse Ogemaw Ottawa Saginaw Washtenaw
677-680	25.00 KHz	804.237500 MHz	774.237500 MHz	Emmet Huron Kalamazoo Macomb Montcalm
701-704	25.00 KHz	804.387500 MHz	774.387500 MHz	Antrim Bay Eaton Gogebic Keweenaw

				Mecosta Menominee Wayne
705-708	25.00 KHz	804.412500 MHz	774.412500 MHz	Alger Baraga Cheboygan Iosco Kent Missaukee St. Clair
709-712	25.00 KHz	804.437500 MHz	774.437500 MHz	Alpena Benzie Chippewa Ingham Isabella Oceana Tuscola Van Buren
713-716	25.00 KHz	804.462500 MHz	774.462500 MHz	Delta Houghton Ionia Oakland
717-720	25.00 KHz	804.487500 MHz	774.487500 MHz	Dickinson Emmet Jackson Luce Ogemaw Ottawa Saginaw Wexford
741-744	25.00 KHz	804.637500 MHz	774.637500 MHz	Arenac Genesee Kalamazoo Leelanau Lenawee Marquette Osceola Presque Isle
745-748	25.00 KHz	804.662500 MHz	774.662500 MHz	Berrien Crawford Kent Keweenaw Midland Schoolcraft Wayne
749-752	25.00 KHz	804.687500 MHz	774.687500 MHz	Alcona Chippewa Grand Traverse Ingham Iron Mecosta Tuscola
753-756	25.00 KHz	804.712500 MHz	774.712500 MHz	Gladwin Ionia Mason Oakland Otsego

757-760	25.00 KHz	804.737500 MHz	774.737500 MHz	Alpena Baraga Calhoun Delta Monroe Muskegon Saginaw Wexford
781-784	25.00 KHz	804.887500 MHz	774.887500 MHz	Charlevoix Clare Genesee Houghton Iosco Manistee Ottawa
785-788	25.00 KHz	804.912500 MHz	774.912500 MHz	Kalamazoo Kalkaska Menominee Montcalm Presque Isle Wayne
789-792	25.00 KHz	804.937500 MHz	774.937500 MHz	Alger Arenac Eaton Emmet Iron Osceola St. Clair
793-796	25.00 KHz	804.962500 MHz	774.962500 MHz	Berrien Chippewa Crawford Kent Keweenaw Tuscola Washtenaw
797-800	25.00 KHz	804.987500 MHz	774.987500 MHz	Cheboygan Gladwin Grand Traverse Macomb Marquette Oceana Shiawassee
821-824	25.00 KHz	805.137500 MHz	775.137500 MHz	Hillsdale Huron Mackinac Manistee Midland Muskegon Oakland Otsego
825-828	25.00 KHz	805.162500 MHz	775.162500 MHz	Delta Houghton Ingham Leelanau Mecosta Ogemaw St. Joseph

829-832	25.00 KHz	805.187500 MHz	775.187500 MHz	Dickinson Emmet Gratiot Ottawa Sanilac Wayne Wexford
833-836	25.00 KHz	805.212500 MHz	775.212500 MHz	Baraga Chippewa Clare Genesee Iosco Kalamazoo Mason
837-840	25.00 KHz	805.237500 MHz	775.237500 MHz	Alger Alpena Bay Gogebic Grand Traverse Jackson Kent Keweenaw Macomb
861-864	25.00 KHz	805.387500 MHz	775.387500 MHz	Alcona Allegan Antrim Hillsdale Lake Mackinac Midland Oakland
865-868	25.00 KHz	805.412500 MHz	775.412500 MHz	Ingham Marquette Presque Isle Roscommon Tuscola
869-872	25.00 KHz	805.437500 MHz	775.437500 MHz	Charlevoix Gratiot Houghton Ottawa Wayne Wexford
873-876	25.00 KHz	805.462500 MHz	775.462500 MHz	Chippewa Genesee Kalamazoo Mecosta Ogemaw
877-880	25.00 KHz	805.487500 MHz	775.487500 MHz	Bay Berrien Cheboygan Grand Traverse Kent Macomb Menominee Schoolcraft
901-904	25.00 KHz	805.637500 MHz	775.637500 MHz	Allegan Keweenaw

				Leelanau Mackinac Monroe Osceola Oscoda Saginaw
905-908	25.00 KHz	805.662500 MHz	775.662500 MHz	Calhoun Huron Kalkaska Marquette Muskegon Oakland Presque Isle
909-912	25.00 KHz	805.687500 MHz	775.687500 MHz	Alcona Charlevoix Clare Gogebic Manistee Shiawassee Van Buren
913-916	25.00 KHz	805.712500 MHz	775.712500 MHz	Crawford Delta Montcalm Tuscola Washtenaw
917-920	25.00 KHz	805.737500 MHz	775.737500 MHz	Berrien Cheboygan Eaton Houghton Luce Macomb Midland Ottawa Wexford
941-944	25.00 KHz	805.887500 MHz	775.887500 MHz	Genesee Isabella Kalamazoo Oceana Ontonagon Otsego Schoolcraft
945-948	25.00 KHz	805.912500 MHz	775.912500 MHz	Alpena Bay Chippewa Grand Traverse Hillsdale Kent Marquette Wayne

New York State Technology Enterprise Corporation

Presents a

Technical Proposal Exhibit

700-MHz National Pre-Allotment

The Immediate Need, and a Proposed Process for Generation of the Narrowband Spectral Allotments

Submitted to:

The National Public Safety Telecommunications Council

NPSTC
2050 E. Iliff Avenue
Denver, CO 80208

August 7, 2001
Version 5

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Introduction

The NYSTEC/SRC team is pleased to present this proposal to the National Public Safety Telecommunications Council (NPSTC). The purpose of the proposal is to illustrate the need for, and the issues relating to, the generation of initial 700-MHz general-pool frequency allotments. It outlines a proposed conceptual methodology for generating these pre-allotments, and identifies areas that may require further discussion with the stakeholders within the process. The NYSTEC/SRC team is uniquely qualified to address these issues through innovative approaches and the application of advanced modeling concepts and tools.

The New York State Technology Enterprise Corporation, NYSTEC[1], is a private not-for-profit technology-engineering company whose mission is to provide systems engineering and technical assistance to government clients on a wide range of information and communication technologies. NYSTEC prides itself on remaining independent from manufacturers and system integrators, which allows it to be an independent trusted partner for its clients. Since its founding in 1995, NYSTEC has developed proven skills in working in diverse, multi-agency environments at the state, local, and federal levels. NYSTEC has a strong focus on the public-safety land-mobile radio market and is well versed in radio propagation measurement and analysis as well as the regulatory aspects. NYSTEC has a staff of about 45 people and is headquartered in Rome, New York.

The other member of the team is NYSTEC's sister company, Syracuse Research Corporation (SRC)[2]. SRC is also a not-for-profit, independent R&D organization serving both government and industry since 1957. The unique expertise of SRC scientists and engineers lies in their ability to analyze complex technological problems and to develop innovative, practical solutions. SRC's approximately 340 staff members hold more than 100 advanced degrees in 40-plus technical disciplines. SRC is headquartered in North Syracuse NY and maintains 10 offices across the US to serve a wide range of federal agencies.

NYSTEC and SRC are affiliates of SRC Management, Inc. (SMI). SMI is a separate not-for-profit corporation that provides general and administrative support services and acts as a holding company for NYSTEC and SRC. The three corporations all share a common Board of Trustees and Corporate Officers, so they are tightly linked together enabling strong partnerships on projects.

As this proposal will discuss, the NYSTEC/SRC team recommends that NPSTC work towards the generation of nationwide geographic pre-allotments for the general-use 700-MHz public-safety spectrum and that these allotments be used to populate the NPSTC pre-coordination database. NYSTEC/SRC have gone through considerable review of this proposed effort with the NPSTC Database Subcommittee, and the methodologies proposed herein reflect the consensus of the subcommittee in regards to this undertaking.

[1] More information can be found at the Web site http://www.nystec.com
[2] More information can be found at the Web site http://www.syrres.com

Pre-Allotment of 700-MHz Spectrum

The 700-MHz spectrum has never before been available for use by land-mobile radio operations. Because of this, it offers many exciting possibilities for creating new paradigms in the way that it is allotted, and used. In particular, the use of more detailed models within the pre-allotment and regulatory realms could allow for a higher level of spectral efficiency than has previously been achievable.

Regulatory and Rule-making procedures for the 700-MHz Public Safety Narrowband spectrum are drawing near completion. Once these processes are completed, many areas of the country will be able to make immediate use of the 700-MHz spectrum (pending equipment availability). In addition to this, state-wide reserve allocations of this spectrum might be made available for licensing later this year. Because of these factors, there is a genuine need for pre-allotment of the spectrum, especially for frequency coordination and Regional Planning purposes. Pre-allotment produces "pools" of channels that may be used in a given area. As actual application data is received from Regional Planning Committees, the process can be run again to re-optimize the "pool" allotments that would remain available within a Planning Region.

The Need for Pre-Allotment

NPSTC has made a pre-allotment database available to all authorized frequency coordinators for the new 700-MHz narrowband public-safety spectrum. In order to maximize the utility of NPSTC's pre-coordination database, and to effectuate its use within frequency coordination and regional planning, it is imperative to completely populate the database as soon as possible. In order to accomplish this, it will be necessary to perform the allotments on a national basis.

This database is in its final stages of acceptance — from both NPSTC and its intended user base — and therefore is nearly ready to be populated with initial "pool" allotments. It was anticipated that the allotments would be provided over time on a regional basis — but with input required from around 55 individual regional planning committees. NYSTEC/SRC propose that the allotments be developed all at once, on a national basis, and without the need for massive collaborative efforts from the individual regional committees – many of which have not yet formed. However, NYSTEC/SRC also propose that actual allotment application data from those 700 MHz Regional Planning committees, which have already been formed, should be solicited early in the pre-allotment process.

Pre-Allotment Boundaries

In general, the geographical structure of the 700-MHz Regional Planning Committees (RPCs) will be based upon state borders, and will be similar to the structure shown in Figure 1 (depicting the 800-MHz National Public Safety Planning boundaries). Note that some large states are broken into multiple regions.

Site-specific parameters are generally not available during the pre-allotment process. However, the spectrum must be allotted based upon <u>some</u> type of bounded area. An obvious choice (and with precedent set from past processes) is to allot the spectrum based upon county-type boundaries. It is the recommendation of the NYSTEC/SRC team that the 700-MHz narrowband spectrum be pre-allotted according to these boundaries — especially since *most* public-safety usage falls naturally into these subdivisions. A map of the suggested county-type divisions is shown as Figure 2. Note that, while the figure mainly depicts county boundaries, many cities that are not incorporated within counties are also depicted. These will be treated as their own individual allocable areas.

700 MHz Structure of RPCs?

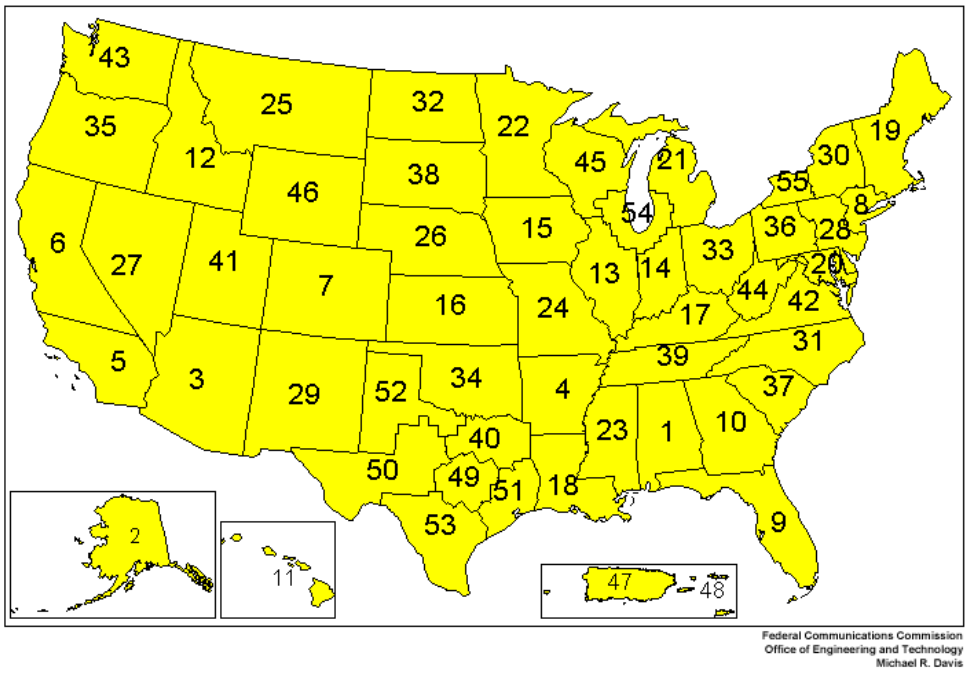

Figure 1, Regional Boundaries

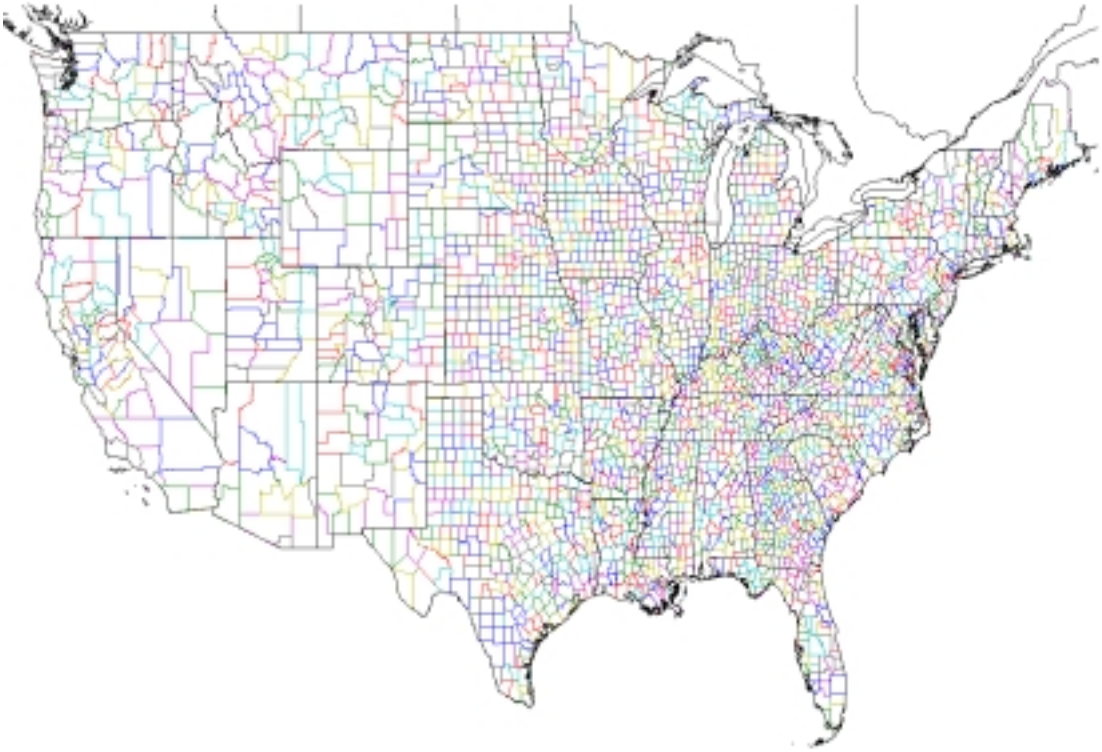

Figure 2, County and Large Municipal Boundaries

Proposed Methodology

It should again be stressed that the opportunity exists for implementing more detailed models and processes when allocating the spectrum. This allows for a higher level of spectral efficiency than has been possible in past efforts of this nature.

Spectral Needs Assessment

Based upon discussions with the NPSTC database subcommittee, it has been decided that each indicated county/area receive some minimum allotment (e.g., three 25 kHz channel pairs for voice, and one 25 kHz channel pair for data - see Allotted Bandwidth Section on pages 8-9), regardless of aggregate capacity needs. Beyond this, the pre-allotment process will provide additional spectrum based upon some measure of individual capacity needs. In the past, this additional capacity assessment was based solely on population. This proposal recommends that the past approach be modified.

In the NYSTEC/SRC team's analysis of public-safety capacity needs within New York, it was found that these needs varied tremendously across the State. It was clear that there was a strong correlation between population and public-safety capacity needs. However, it was also found that, when only considering county populations, a large number of public-safety and public service users were not accurately represented in the rural areas. This is illustrated in Figure 3.

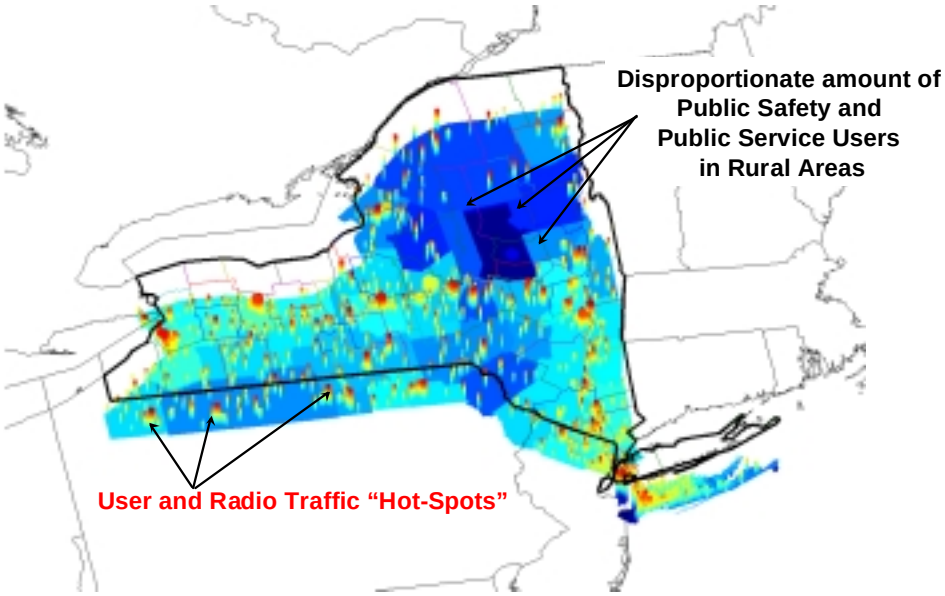

Figure 3, Distribution of Spectral Needs

The NYSTEC/SRC team proposes an approach similar to PSWAC's approach, in which both population and population-density are used to predict the total number of public-safety users within a specific area to be allotted spectrum. The most recent population data available will be used, and can be projected out to a future date (such as 2010). Modifications to PSWAC's models will need to be incorporated — since the original models incorporated little data from rural areas. This algorithm would be submitted for approval to NPSTC. In addition to this, a statewide law-enforcement component must also be integrated into the models. Similar models, developed by SRC/NYSTEC, are shown in Figure 4.

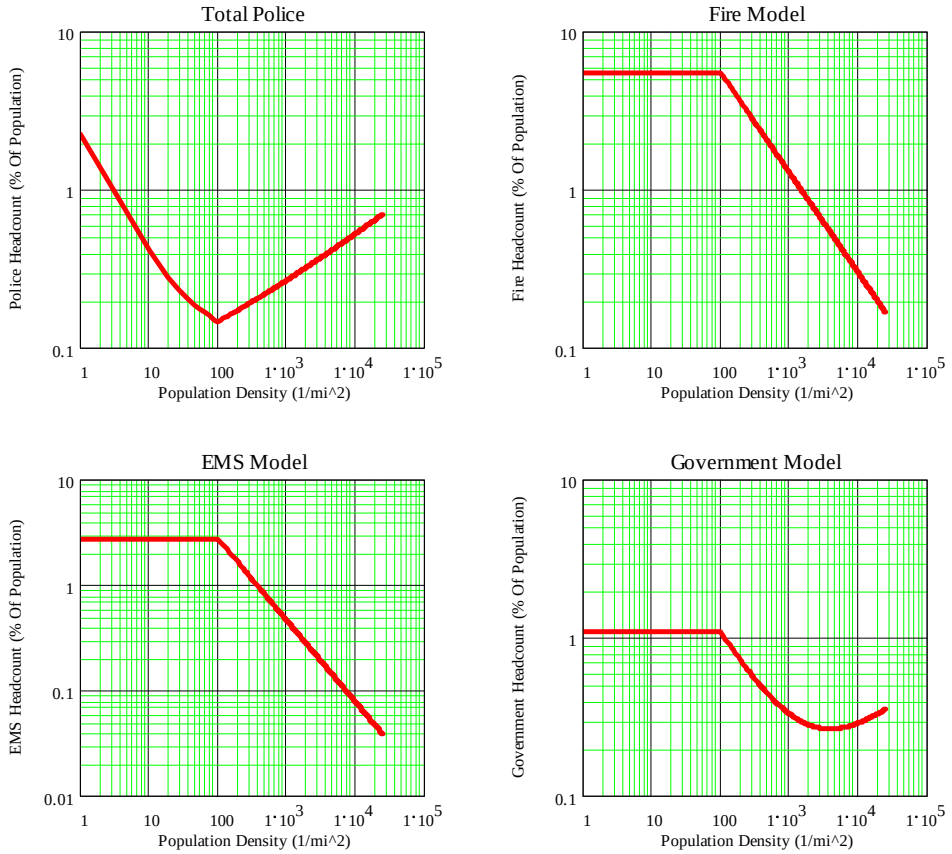

Figure 4, Modified PSWAC User Density Models

Once public-safety and public service user populations are projected for a given area, they will be used to distribute the spectrum pre-allotments, normalized by the total amount of available spectrum (with reuse), and by the total national public-safety user projections.

It should be noted that more detail could be included in the capacity-assessment models by applying service-based usage and voice/data penetration levels to the projected user group populations. By using service-group-based models in summing the resulting Erlang loads, estimates of aggregate capacity needs can created for all of the various user groups. These will then provide Erlang load projections that could be incorporated with traffic models[3] to estimate channel needs.[4] After this process, similar normalization methods would be applied.

Service Area Evaluation and Interference Prediction

It is clear that accurate modeling of coverage and interference effects allows for tighter site/frequency "packing" and greater spectral efficiency. Again, since this frequency band is a new allocation, the ability exists to utilize more accurate methods of assessing these effects during the pre-allotment stages of spectrum planning and plan development. The NYSTEC/SRC team has experience in developing innovative techniques for spectral assignment processes, and continues to work with Telecommunications Industry Association (TIA) TR-8.18's working groups in developing the next generation of coverage- and interference-assessment methodologies.

For the 700 MHz pre-allotments, the service area/contour for each of the counties will be represented by a bounding polygon that extends beyond the county border by 3 to 5 miles. This actual

[3] For example, Erlang-C, or extended-Erlang-B for trunked networks, Erlang-B or Engset/Molina for conventional networks.

[4] This process was followed in New York State, and culminated in the generation of a statewide 250x250-meter resolution traffic-density/capacity grid. Details available upon request.

distance from the county border can be a uniform decision, affecting all service areas, or can be individually based upon population-density metrics (TIA recommendations call for 3 miles for rural areas and 5 miles for urban areas).

There are several possibilities for generating the interference contour(s), all utilizing some measures of local terrain characteristics. From Figure 5 it is apparent that there is a tremendous variance in terrain roughness in the US (Northwest US shown). It is also clear that utilization of terrain features allows for a much more accurate representation of signal propagation and interference prediction, especially when compared to simple "rule-of-thumb" reuse distances.

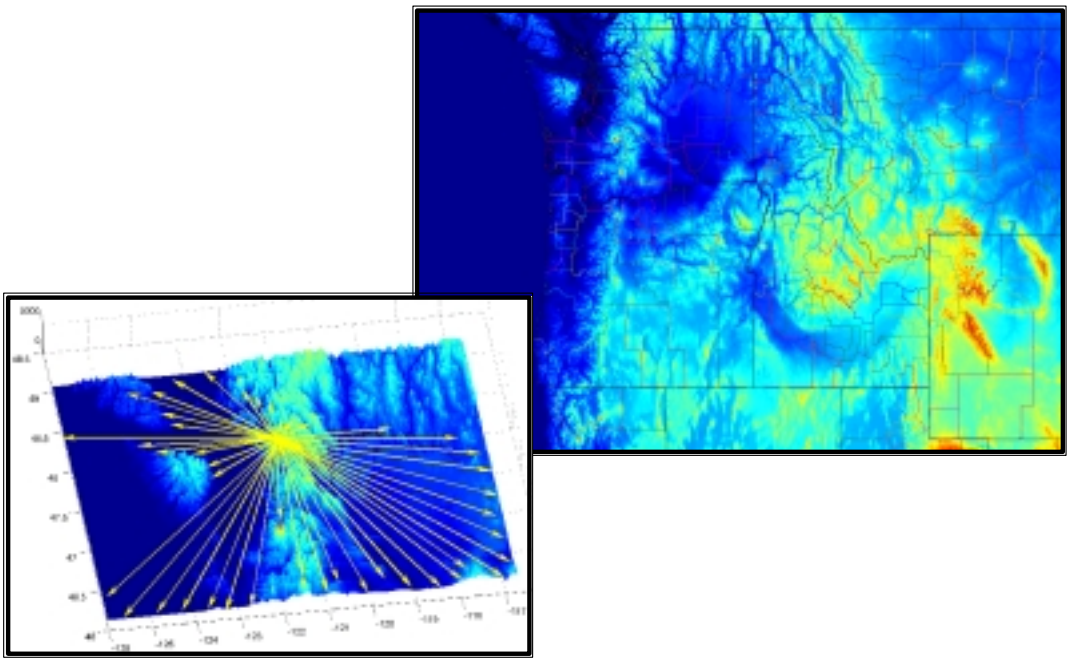

Figure 5, National Terrain Variance and Increased Accuracy through the use of Terrain Features

With no site-specific information available, several options are possible for predicting frequency reuse parameters. An example, shown in Figure 6, places a site location at the highest terrain elevation within a given county, then uses directional height above average terrain (HAAT) calculations to compute the interference range in each direction outward from the site. The model used to compute these distances can be Okumura-Hata-Davidson-based (as in NPSPAC), Carey-based (i.e. R6602, F(50,50)), or new models, such as the "TIA-6602" method (proposed modification to FCC R-6602) under consideration by TR-8.18.[5] Examples of the Okumura-based contours are shown in this figure, with ray-traced radio horizon limits included for reference.

[5] All interference contours utilizing standard values (such as 5 dBu), and with all contours being median levels (i.e. 50,50).

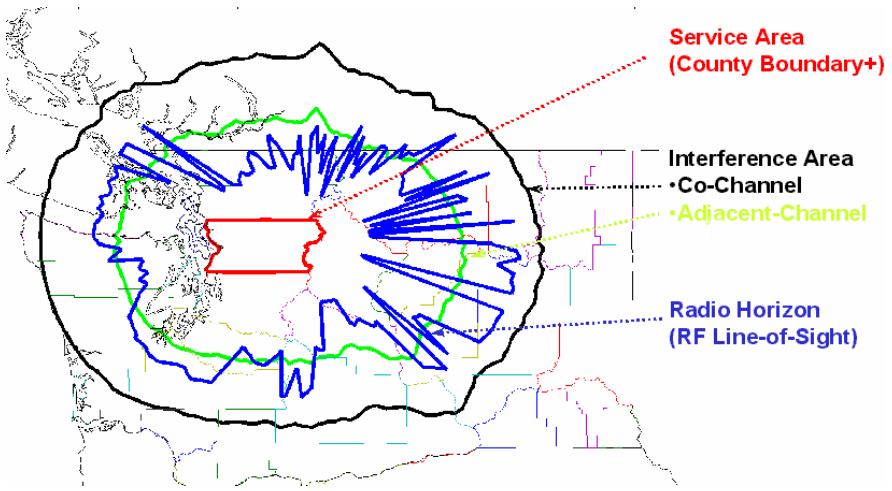

Figure 6, Example of a Possible Contour Methodology

Allotment Approach

NYSTEC and SRC also have experience in generating spectrally efficient frequency assignment methodologies - as evidenced by recent work generating spectrum plans for a statewide wireless network, and generating and proposing alternative Digital Television Transition plans for Canada[6].

Basic Allotment Process

The recommended spectrum-allotment approach is based upon the non-intersection of contours — an approach familiar to regulators and frequency coordinators alike. Specifically it will apply rules within the allotment process that specify that service and interference contours for co-channel frequency allotments cannot intersect. In addition to this, it may specify that adjacent-channel interference contours cannot intersect the service contours on an adjacent-channel examination.[7] The program could iterate, so that, if not enough spectrum is available to meet the recommended levels of any given county, it will spread the load over all counties involved within the allotment process. This ensures that every county reaches a similar level of capacity - relative to its projected needs.

This process provides the ability to pack the spectrum geographically to a very large degree, as illustrated in Figure 8. Note that the NYSTEC/SRC team can also provide periodic re-packing of the spectrum, once site-specific licenses are issued and more detailed models can be applied. Note that, *when* site-specific parameters are available, it is important to populate the database with contours that represent coverage and interference parameters as accurately as possible. For this, a tile-based contouring (such as the NYSTEC/SRC team has proposed to TIA[8]) method is recommended.

[6] These Canadian plans would completely eliminate the need for 700 MHz DTV allotments, and essentially align 700 MHz spectrum on both sides of the US/Canadian border.

[7] TIA's recommendations of 60 dBu contour values for adjacent-channel interference (based upon 65 dB ACCPR into a 6.0 kHz) may render the adjacent-channel consideration within this process unnecessary.

[8] Details available upon request.

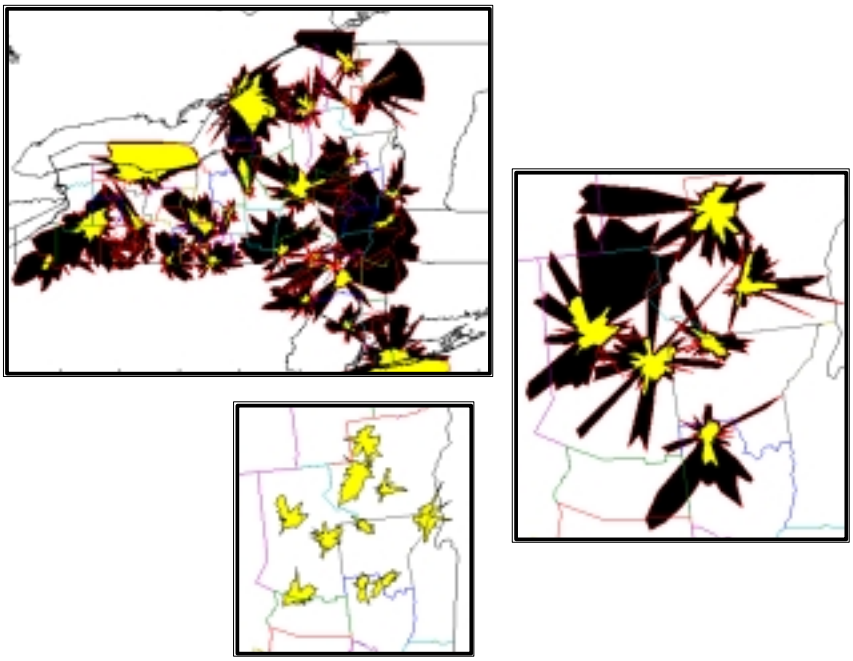

Figure 7, Contour-Intersection Methodologies

Allotted Bandwidth

One very important parameter of the pre-allotment process is the bandwidth of the pre-allotted voice and data channels. This has proved to be a strongly debated topic of discussion.

Figure 8 shows a portion of the 700-MHz narrowband spectral layout. The potential for many diverse technologies within the same spectrum is troublesome in regards to determining the smallest building blocks to allot. It is clear to see that the spectrum may be allotted in either 6.25-kHz (allowing the use of future FDMA technologies) allotments, 12.5-kHz (allowing the use of current FDMA and future TDMA technologies) "bundles", and 25-kHz “blocks” (allowing the use of 25 kHz TDMA technologies). The inherent problem is that allotting anything smaller than 25-kHz blocks precludes the future use of 25-kHz technologies on the pre-allotted channel sets. Presently, no US 25-kHz TDMA technology product is available for operation in this band, although FCC Rules allow such operation.

NPSTC and TIA have previously recommended that 25-kHz blocks be pre-allotted for both voice and data applications. At the May 2001 NCC meeting it was proposed that three (3) 25-kHz voice channels and one (1) 25-kHz data channel would be the minimum default allotments in the absence of actual specific applications for channel allotment. This would permit different technologies to be implemented using 6.25, 12.5, or 25 kHz channel widths at some future date. Therefore, the pre-allotments will be generated based upon aggregating 25-kHz blocks of spectrum.

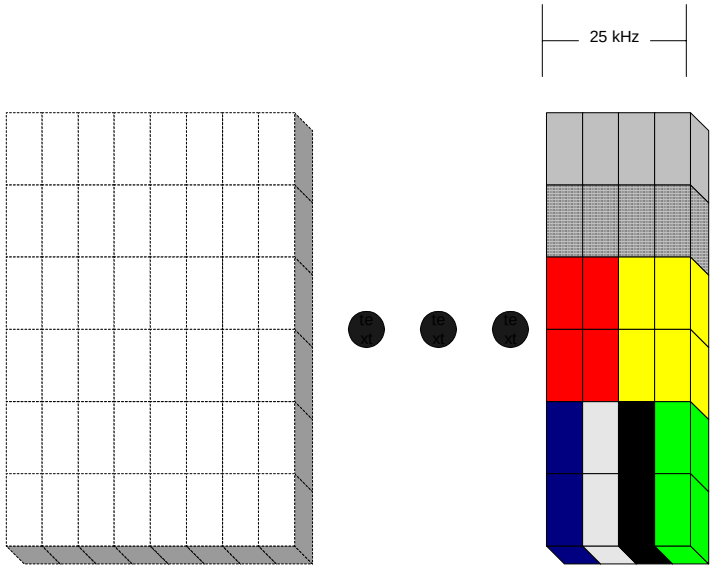

Figure 8, Channel Allotment Possibilities

The pre-allotment process will also account for realistically achievable multi-coupler spacing. For this reason, all-individual pre-allotment channel sets will have an internal separation of no less than 250 kHz.

Geographic Boundaries and Regional Penetration of Pre-allotments

NPSTC has previously recommended that the pre-allotments be performed only along the borders of each region. After discussions with the NYSTEC/SRC team, it was seen that better spectral efficiency could result from allotting all areas of all regions during the pre-allotment process. Pre-allotment of all areas, even within regions, can also result in significantly faster availability of channels to an applicant, since the regional planning process has already taken place. Otherwise one might have to wait for a regional planning process to follow an application.

NYSTEC/SRC proposes that the pre-allotments be performed throughout all of the regions, but that allotments outside of the border areas could be modified without restriction by individual regional planning committees without the need for inter-regional coordination. However, if such change results in an interference contour impact upon any adjacent region, inter-regional concurrence is required.

Treatment of Television Services

There are many additional constraints that can be imposed upon the pre-allotment process; most are based upon the existence of current and future television broadcast services within the 700-MHz band. These include incumbent US analog stations as well as US digital allotments that occur in certain areas of the nation. Aggravating the problem is the uncertainly related to international broadcast services (in particular Canada and Mexico) that may claim protection from, and cause interference to, US operations within the spectrum. An illustration of this is in Figure 9, where the locations of primary-class 700-MHz digital and analog broadcast television services within 400 km of the US/Canadian border are depicted.

While it is possible to alter the allotment process to take all of these broadcast services into account, the final result will not provide the same spectral efficiency that would otherwise be possible. It is also possible that consideration of all of the stations may over-constrain the problem, generating inefficient results for no valid reason. An example of the process of considering these television services is illustrated in Figure 10, where similar tools were used to generate spectrum assignments in New York, while working around existing and proposed television services from both the US and Canada.

The actual selection of allotment criteria and stations to consider during the allotment process depends on many factors — among them US 700-MHz spectrum availability; the DTV transition timelines

of the US, Mexico, and Canada; and international negotiations and treaties. The NYSTEC/SRC team has a firm understanding of these issues, and would be pleased to assist in any discussions regarding their resolution — or in recommending the best course of action to take for the pre-allotment process. However, for the purposes of this proposal, NYSTEC/SRC propose that no consideration be given to allotting spectrum based upon broadcast television services emanating from within the US or abroad.

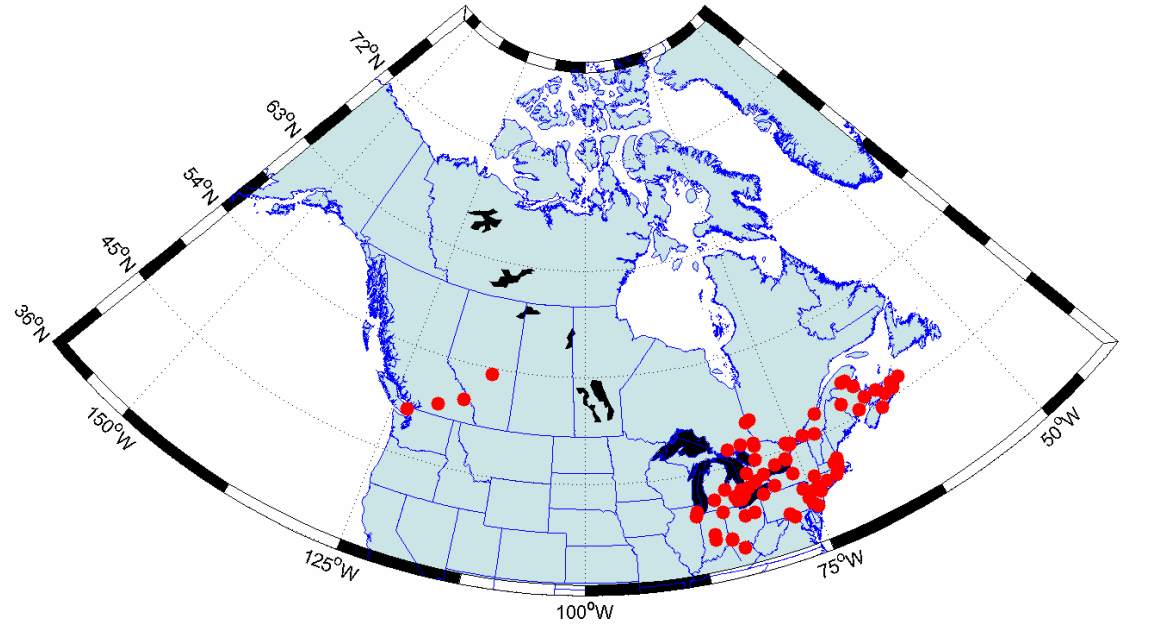

Figure 9, Canadian Border Area Television, Channels 62 through 69

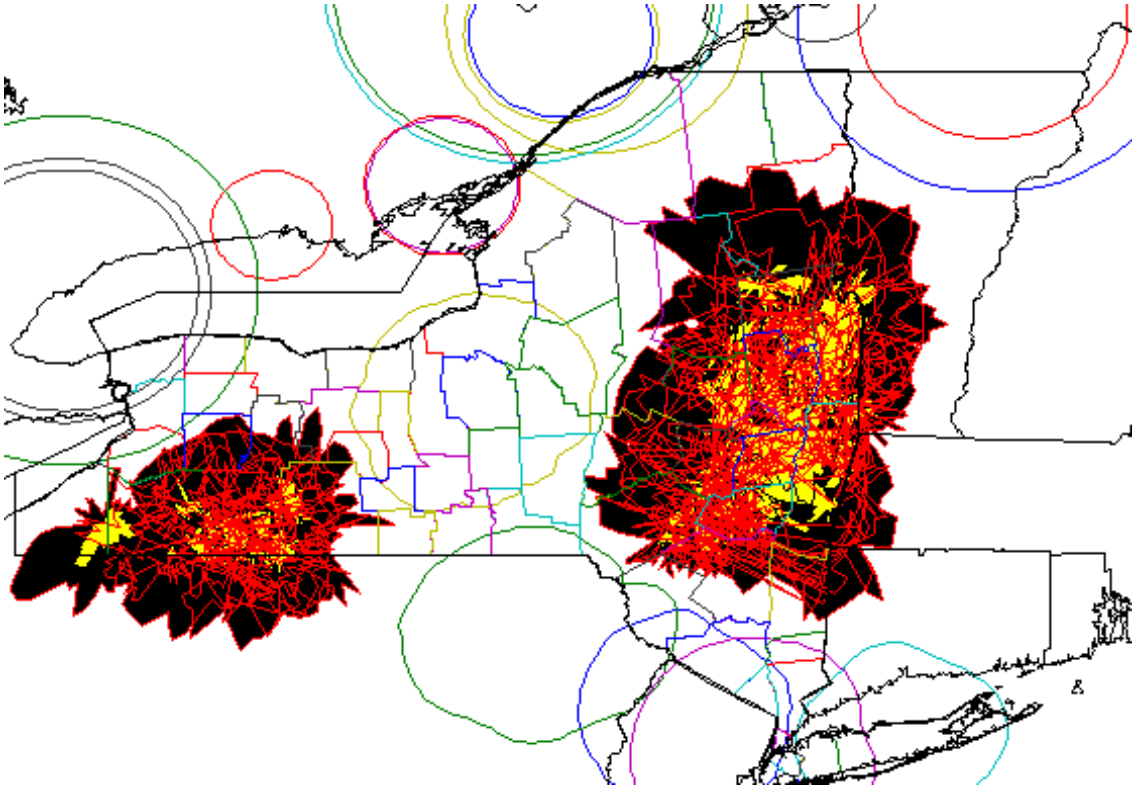

Figure 10, Example of Consideration of Analog and Digital Television Factors

Consideration of Regional Planning Committee Efforts

It must be noted that many 700 MHz regional Planning Committees (RPCs) have now formed and commenced their meetings. Therefore, it is appropriate to solicit input from the 700 MHz Regional Planning committees that have already been formed; and that this should be done at the very beginning of the pre-allotment process.

NYSTEC/SRC will assist NPSTC in the solicitation of this information, and will attempt to utilize any efforts completed by the RPCs. If possible, NYSTEC/SRC will alter the allotment process to better conform to the needs of these individual RPCs. However, note that this may lead to essentially unbounded efforts that cannot be defined at this point. These will need to be carefully considered, and will require further discussion between NPSTC and NYSTEC/SRC to resolve scope and compensatory issues relating to these portions of the re-allotment efforts.

Summary

The NYSTEC/SRC team believes that, in order to maximize the utility of NPSTC's 700-MHz public safety pre-coordination database, and to effectuate its use for regional planning and frequency coordination in a multiple vendor environment, it is imperative to completely populate the database as soon as possible. In order to accomplish this with optimal spectral efficiency, it will be necessary to perform the allotments on a national basis, and to utilize accurate models and spectral assignment strategies.

A summary of the proposed methodologies is as follows:

- Utilize population and population density characteristics in the evaluation of capacity needs. Employ PSWAC-like capacity requirement models to introduce increased accuracy in the modeling process.
- Utilize terrain data for service area evaluation and interference prediction. This will allow greater accuracy in the pre-allotment process, and will result in better reuse of the spectrum.
- Use contour intersections to evaluate the validity of pre-allotment channel sets. Build upon past experience in developing quasi-optimal spectral allotment solutions.
- Solicit input from the 700 MHz Regional Planning committees that have already formed. NYSTEC/SRC will assist NPSTC in the solicitation of this information, and will use Regional Planning Committee allotment application data where available. Such data will specify the channel bandwidth (6.25, 12.5, or 25 kHz)
- Pre-allot "pool" channels in aggregate 25 kHz blocks around any initial Regional Plan allotments. Allow a minimum of four blocks per allotted (county-like) area, three for voice, and one for data. Allot additional spectrum based upon projected need, and normalized by the spectrum available (considering reuse).
- Upon request at a later time, re-run the program in order to update it with additional Regional Planning Committee allotment application data, and revise the "pool" pre-allotments within those regions accordingly.
- Allot all areas. Pre-allotments may be altered without the need for inter-regional coordination as long as adjacent regions are not impacted. Changes that impact adjacent region(s) can only be made with inter-regional concurrence(s).
- When considering allotable spectrum blocks, do <u>not</u> attempt to work around either US or International broadcast-television services. Many of these station assignments are either temporary, or subject to change, and working around them will result in allotment inefficiencies.

NYSTEC/SRC will be pleased to provide NPSTC with a separate Statement of Work and Cost Proposal that addresses the entire scope of this effort.

APPENDIX P S-160

S-160 refers to the use of frequencies that are licensed under Part 90 of the FCC rules by federal Government radio stations for intercommunication with non-Government radio stations. Any frequency authorized under Part 90 may be used by the Government, provided that a suitable, mutually approved, agreement has been reached between the FCC, the Government agency involved, and the affected non-Governmental user.

The conditions and terms of operation under an S-160 assignment are given in the NTIA Manual, section 7.12 and 8.3.3.

Appendix P

SHARING AGREEMENT TEMPLATE

(Agency letterhead of Licensee)

TO: (recipient person and title)
(recipient agency)

FROM: (authorizing person and title)
(authorizing agency)

DATE: (mm/dd/yyyy)

SUBJECT: Sharing Agreement

_____(grantor) authorizes _____(grantee) to operate _____ (quantity) mobile (vehicular or hand-held) radios. Such operation shall be per the following parameters.

Call Sign	Frequency(ies)	Max. Power	Channel Description
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(Use additional attachments as necessary for more frequencies/channels)

This written agreement applies to operations in cooperation and coordination with activities of the licensee per Region (#) Plan, FCC Rules 47 CFR Parts 2.102(c), 2.103 and 90.421 and Part 7.12 of the NTIA Manual. Furthermore, grantor reserves the right to effectively eliminate the possibility of unauthorized operation, which ultimately could result in terminating this written agreement.

_____ (typed or printed name of authorized signer)
_____ (authorized signer identified above)
_____ (date)
_____ (agency name)
_____ (agency address)
_____ (agency address)
_____ (agency address)
_____ (signer's phone)
_____ (signer's email address, if available)

Michigan Public Safety Frequency Advisory Committee

Region 21 Public Safety National Plan Application Review

MEMORANDUM OF UNDERSTANDING

TO: (signer of application and title)
(agency name)

FROM: (name), Chairman

DATE: (mm/dd/yyyy)

SUBJECT: Memorandum of Understanding for Operating the 700 MHz Interoperability Channels

This memorandum of understanding (hereafter referred to as MOU) shall be attached to the application when submitting it. By virtue of signing and submitting the application and this MOU, (agency name) (hereafter referred to as APPLICANT) affirms its willingness to comply with the proper operation of the Interoperability (interoperability) channels as dictated by the Region Planning Committee (here after referred to as RPC) as approved by the Federal Communications Commission (hereafter referred to as FCC) and by the conditions of this MOU.

The APPLICANT shall abide by the conditions of this MOU which are as follows:

- To operate by all applicable State, County, and City laws/ordinances.
- To utilize “plain language” for all transmissions.
- To monitor the Calling Channel(s) as may be appropriate.
- To coordinate use of the Tactical Channels.
- To identify and eliminate inappropriate use.
- To limit secondary Trunked operation to the interoperability channels specifically approved on the application and limited to channels listed below.
- To relinquish secondary Trunked operation of interoperability channels to requests for primary conventional access.
- To grant access to channels according to the Priority Levels identified in this MOU.

The preceding conditions are the primary, though not complete, requirements for operating in the interoperability channels. Refer to the Region Plan for the complete requirements list.

Priority Levels:

1. Disaster or extreme emergency operation for mutual aid and interagency communications;
2. Emergency or urgent operation involving imminent danger to life or property;
3. Special event control, generally of a preplanned nature (including Task Force operations)

4. Single agency secondary communications.

To resolve contention within the same priority, the channel should go to the organization with the wider span of control/authority. This shall be determined by the State Interoperability Executive Committee or RPC for the operation or by the levels of authority/government identified in the contention.

For clarification purposes and an aid to operate as authorized, any fixed base or mobile relay stations identified on the license for temporary locations (FCC station class FBT or FB2T, respectively) shall remain within the licensed area of operation. Similarly, vehicular/mobile repeater stations (FCC station class MO3) shall remain within the licensed area of operation. Federal agencies are permitted access to interoperability channels only as authorized by 47 CFR 2.102 (c) & 2.103 and Part 7.12 of the NTIA Manual.

Any violation of this MOU, the Region Plan, or FCC Rule shall be addressed immediately. The first level of resolution shall be between the parties involved, next the State Interoperability Executive Committee or RPC, and finally the FCC.

Secondary Trunked Channels

GTAC5 - Channel 54 & 55
GTAC7 - Channel 134 & 135
GTAC9 - Channel 214 & 215
GTAC11 - Channel 294 & 295
GTAC13 - Channel 374 & 375
GTAC35 - Channel 534 & 535
GTAC37 - Channel 614 & 615
GTAC39 - Channel 694 & 695
GTAC41 - Channel 774 & 775
GTAC43 - Channel 854 & 855

_____ (typed or printed name of authorized signer)
_____ (authorized signer identified above and consistent with application)
_____ (date)
_____ (agency name)
_____ (agency address)
_____ (agency address)
_____ (agency address)
_____ (signer's phone)
_____ (signer's email address, if available)

Note: MPSFAC membership includes but is not limited to the following entities: City of Detroit APCO representative, EMS Service Providers, FCCA, Michigan APCO Frequency Advisor, Fire Department Representative, Michigan Association of Chiefs of Police, Michigan Department of Natural Resources, Michigan Department of Public Health, Michigan Department of Transportation, Michigan Municipal League, Michigan

Sheriff's Association, Michigan State Police and at-large APCO representatives from city and county public safety agencies

IV. NATIONAL/REGIONAL PLAN TEMPLATE OUTLINE FOR 764-776/794-806 NATIONAL/REGIONAL PLANS

1. REGIONAL CHAIRPERSON

The Regional Planning Committee shall designate a Chairperson. The plan shall include the chairperson's name, title, address, phone number, agency affiliation, e-mail address and/or any additional contact information.

2. RPC MEMBERSHIP

The Plan shall list all RPC members and include agency affiliation and contact information such as: mailing addresses, phone numbers, email addresses (if available), etc. The officers of the RPC shall be noted , such as Secretary, 1st Vice Chairperson, etc.

3. DESCRIPTION OF THE REGION

This section of the plan shall include the following information:

- Definition of the region and its boundaries, a list of the counties and cities within the boundaries.
- Description of existing interoperability contracts, compacts, mutual aid agreements, etc.[1]
- Description of the effect of the addition of 700 MHz channels and interoperability requirements will affect existing plans.[2]
- Overview of public safety entities that have jurisdiction within or over any or all portions of the region (e.g. state agencies, federal agencies).
- Description of the types of public safety, law enforcement, government, public service, or other entities (federal, county, regional, city, town, etc.) that are included in the region.

4. NOTIFICATION PROCESS

This section shall contain a complete description of the process used by the Regional Planning Committee to notify the eligible entities within the region. This section shall contain at a minimum:

- The dates and publications in which the meetings were announced

[1] In the 4th R&O in Docket 96-86, the FCC decided that each State would to be responsible for administering the I/O channels and gave a deadline of 12/31/01 for each State to notify the Commission whether it would accept that responsibility. If notification from the state is not received by 12/31/01, the administration of the I/O channels reverts to the RPC on 1/01/02. The NCC recommends that States who choose to administer the 700 MHz I/O channels use the recommendations provided in the Guidelines for 764-776/794-806 Regional Planning Committees, Document IM0020-H-20010322-(P009-H). If the State is administering the I/O channels, the RPC need not include this information. A statement to the effect that the State is administering the I/O channels will suffice. If administration of the I/O channels has reverted to the RPC, this information must be included in the Regional Plan.

[2] Ibid.

- The dates and websites on which the meetings were announced.
- A description of the process by which comments were solicited from all eligible parties
- Copies of all notices, comments and submissions obtained through the process
- A description of the process used to consider the comments submitted by concerned parties,

5. REGIONAL PLAN SUMMARY

This section shall include:

- The guidelines and procedures for operation of the RPC;
- The procedures for requesting channels;
- The procedures for frequency coordination;
- Guidelines and procedures for protection of incumbent TV/DTV stations within the Region or near the Region's border during the DTV transition period.
- Descriptions of the region's applicable interoperability plans and interoperability requirements[3]
- Bylaws
- Spectrum Utilization agreements with other regions
- Description of the pre-coordination allocation method used at the region's borders.
- An overview of the "700 MHz Public Safety Frequency Coordination Database" and application flowchart

6. UTILIZATION OF INTEROPERABILITY CHANNELS[4,5]

[PLEASE NOTE: This section is updated as I/O sub-committee changes verbiage of IO-0062. Current verbiage is per IO-0062D020010118.]

The narrowband voice & data interoperability channels (sixty-four at 6.25 kHz bandwidth) are defined on a nationwide basis. Appendix A shows the designation of these channels as defined by the 700 MHz National Coordination Committee (NCC). Since they are nationwide channels, each channel must have the same usage within each region and across regional borders. They have been sub-divided into different service categories.

The current proposal, adopted by the NCC, is to use the ANSI/TIA 102 Standards (i.e., Project 25 digital protocols) as the Digital Interoperability Standard for the conventional-only mode of operation on the narrowband voice & data interoperability channels. [6]

[3] Ibid.
[4] Ibid.
[5] The FCC adopted many, but not all, the NCC's recommendations for the I/O channels and incorporated those recommendations into the 700 MHz rules. The FCC encouraged States (or RPCs) to follow the NCC recommendations that were not included in Part 90.
[6] Voice and Data Interoperability standards were decided in the 4th R&O ini 96-86 and can be found in Part 90 of the Code of Federal Regulations (CFR). Voice I/O standard documents are listed in 90.548(a)(i); data I/O standard documents are listed in 90.548(a)(ii).

There are 2 Calling channel sets and 30 Tactical channel sets. Channel Sets are comprised of two 6.25 kHz channels each.

The Tactical channel sets are subdivided into the following recommended categories: [7]

4	for Emergency Medical Services,
4	for Fire Services,
4	for Law Enforcement Services,
2	for Mobile Repeater operation,
2	for Other Public Services, and
12	for General Services.
2	for Data

Calling Channels

Because the 700 MHz band will be initially encumbered by broadcast television, two of the interoperability channels sets are reserved as "Calling Channels".[8] The State (or RPC)[9] must define when and where the two calling channels are to be used. These calling channels, which appear in the Table of Interoperability Channels (Appendix A) as "7CALL A" and "7CALLB"[10] must be monitored, as appropriate, by licensees who employ interoperability infrastructure in the associated channel group .[11] When calling channels are integrated into infrastructure, their coverage must at least match the coverage of the other interoperability channels in the system. In addition to the usual calling channel functions, the calling channels may to be used to notify users when a priority is declared on one or more of the tactical interoperability channels

Tactical Channels

All Interoperability channels, except as described below, shall be used for conventional-only operation. Normally, users will 'call' a dispatch center on one of the "Calling Channels" and be assigned an available tactical channel. Deployable narrowband operations (voice, data, trunking) shall be afforded access to the same pool of channels used for similar fixed infrastructure operations. In the event of conflict between multiple activities, prioritized use shall occur.

[7] In the 4th R&O, the Commission declined to adopt the NCC's recommended channel designations into the rules. The categories listed above were recommended by the Interoperability Subcommittee (IOSC) . The Implementation Subcommittee supports the IOSC's recommendations.

[8] The 764-776 and 794-806 MHz spectrum was re-allocated from television broadcasting (channels 63, 64, 68, & 69) to Public Safety. Until incumbent broadcasters move out of this spectrum, Public Safety may be blocked from implementing systems. Therefore, two channel groups have been established, 63 paired with 68 and 64 paired with 69. Anticipating that one of these channel groups may become available prior to the other, two Calling Channels were defined, one in each channel group.

[9] See Footnote 1.

[10] The 700 MHz calling channels are listed in 90.531(b)(1)(ii)

[11] In the 4th R&O, the FCC declined to mandate monitoring or other administrative requirements for the I/O channels. Instead, the State (or RPC) is tasked with addressing those issues.

Encryption
Use of encryption is prohibited on Calling channels and permitted on all other interoperability channels. A standardized encryption algorithm for use on the interoperability channels must be TIA/EIA IS AAAAA Project 25 DES encryption protocol. [12]

Deployable Systems
General Public Safety Services Channels labeled 7TAC01 through 7TAC07, 7TAC15 through 7TAC21, or both, shall be made available for "deployable" equipment used during disasters and other emergency events that place a heavy, unplanned burden upon in-place radio systems. States (or Regional Planning Committees)[13] shall consider the need for both "deployable trunked" and "deployable conventional" systems and make those channels available to all entities in their State/region.

Trunking on the Interoperability Channels
Trunking the Interoperability channels on a secondary basis shall be limited to operation on eight specific 12.5 kHz channel sets, divided into two subsets of four 12.5 kHz channels. One subset is defined by 7TAC01 through 7TAC07 and the other by 7TAC15 through 7TAC21.[14]

Any licensee implementing base station operation in a trunking mode on Interoperability Channels shall provide and maintain on a continuous (24 hr x 7 day) basis at its primary dispatch facility the capability to easily remove one or more of these interoperability channels, up to the maximum number of such trunking channels implemented, from trunking operation when a conventional access priority that is equal to or higher than their current priority is implemented.[15]

While it may be desirable for the States (or Regional Planning Committees)[16] to permit trunked radio systems to incorporate one or more of the Interoperability channels into a single trunking system as a means of enhancing the use of the system for interoperability purposes (and by implication allow those channels to be routinely used for normal day-to-day communications), care must also be given to ensure that those channels do not become such an integral part of the trunked system operation that it becomes politically and technically impossible to extract them from the trunked system in the event of an emergency event having higher priority. For this reason, the Interoperability Subcommittee recommends that States (or Regional Planning Committees)[17] limit the number of Interoperability channels that may be integrated into any single trunked system to the following amounts:

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[12] Prohibition of encryption on the calling channels and the encryption protocol to be used on the other I/O channels was determined in the 4th R&O. Information on encryption may be found in 90.553 of the CFR.
[13] See Footnote 1.
[14] Trunking recommendations adopted in the 4th R&O. A list of the channels that may be used for secondary trunking may be found in 90.531(b)(1)(iii)
[15] In the 4th R&O, the FCC stated it was 'appropriate to require such monitoring' but delegated to the States (or RPCs) the task of determining how monitoring would be accomplished.
[16] See Footnote 1.
[17] Ibid.

For systems having 10 or fewer "general use" voice paths allocated, one (1) trunked Interoperability Channel set is permitted. For systems having more than 10 "general use" voice paths allocated, two (2) trunked Interoperability Channel sets are permitted.

States (or Regional Planning Committees)[18] may consider allotting additional Interoperability Channel set(s) for trunked systems having more than 20 "general use" voice paths allocated upon a showing of need and upon a determination that assignment of the Interoperability Channel set(s) will not adversely impact availability of those channels to other trunked and/or conventional radio systems in the area (e.g. a single consolidated trunked system servicing all public safety agencies in an area might satisfy this criterion). The maximum number of Interoperability channel sets for trunked systems permitted for use by an individual licensee is four.[19]

The channels (two 6.25 kHz pairs) in Reserve Spectrum immediately adjacent to the 7TAC channels where secondary trunking is permitted [(21, 22), (101, 102), etc. are available for secondary trunking, but only in conjunction with the adjacent Interoperability 12.5 kHz channel pair in a trunked system[20] and will be administered by the State (or RPC)[21]. If a State (or Regional Planning Committee)[22] elects to permit 25 kHz trunking on interoperability channels, these Reserve Spectrum guard channels would become part of those trunking channels. In making a decision to allow 25 kHz trunking on these interoperability channels, States (or Regional Planning Committees)[23] must consider the impact on the channels adjacent to these 25 kHz trunking channels. Additionally, the State (or RPC)[24] must consider the impact to the ability of these 25 kHz trunking channels to be immediately reverted to 12.5 kHz conventional interoperability use.

Standard Operating Procedures on the Trunked I/O Channels For I/O Situations Above Level 4

The safety and security of life and property determines appropriate interoperable priorities of access and/or reverting from secondary trunked to conventional operation. In the event secondary trunked access conflicts with conventional access for the same priority, conventional access shall take precedence. Access priority for "mission critical"[25] communications is recommended[26] as follows:[27]

[18] Ibid.
[19] See 90.531(b)(1)(iii).
[20] In the 4th R&O, the FCC adopted this recommendation. See 90.531(b)(7).
[21] See Footnote 1.
[22] Ibid.
[23] Ibid.
[24] Ibid.
[25] Mission critical use shall not include nor imply administrative or non-mission critical applications.
[26] In the 4th R&O the FCC declined to adopt the NCC's recommended priority access procedures. The state (or RPC) should develop priority access procedures and resolve disputes. The Priority Access procedures recommended by the NCC are presented here as a model for use by the States (or RPCs).
[27] These access priorities are taken from the §4.1.21 of the Final Report of the Public Safety Wireless Advisory Committee dated September 11, 1996.

1. Disaster and extreme emergency operations for mutual aid and interagency communications;
2. Emergency or urgent operation involving imminent danger to life or property;
3. Special event control, generally of a preplanned nature (including Task Force operations);
4. Single agency secondary communications.[28]

   [Priority 4 is the default priority when no higher priority has been declared.]

For those systems employing I/O channels in the trunked mode, the State (or RPC)[29] must set up interoperability talk groups and priority levels for those talk groups so that it is easy for dispatch to determine whether the trunked I/O conversation in progress has priority over the requested conventional I/O use. States (or RPCs)[30] must also determine whether a wide-area I/O conversation has priority over a local I/O conversation.

Standardized Nomenclature

Standardized nomenclature is recommended nationwide such that all 700 MHz public safety subscriber equipment using an alphanumeric display only be permitted to show the recommended label from the Table in Appendix A when the radio is programmed to operate on the associated 700 MHz channel set. The Table shows the recommended label for equipment operating in the mobile relay (repeater) mode. When operating in direct (simplex) mode, the letter "D" appended to the end of the label is recommended.[31]

Data Only Use of the I/O Channels

Narrowband data-only interoperability operation on the Interoperability channels on a secondary basis shall be limited to two specific 12.5 kHz channel sets. One set is defined by 7DTAC13 and the other by 7DTAC51. [32]

Wideband Data Standards

Within the 12 MHz of spectrum designated for high capacity, wide bandwidth (50 to 150 kHz) channel usage, there are eighteen 50 kHz (or six 150 kHz) channels designated for wideband interoperability use.

[PLEASE NOTE: The Technology Subcommittee has determined that there is no existing wideband standard that could be recommended for interoperability. The Technology Subcommittee has asked the Telecommunications Industry Association (TIA) to develop a wideband data standard. TIA TR-8 subcommittee is currently working on the development of a wideband data standard.]

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[28] This fourth priority would allow shedding traffic long in duration or overloading the non-interoperable system; but is not "two or more different entities" as defined in paragraph 76 of FCC 98-191. Overloading conditions should identify a potential need for expansion of the associated non-interoperable system.

[29] See Footnote 1.

[30] Ibid.

[31] In the 4th R&O, the FCC declined to require labeling nomenclature on radios with alphanumeric labeling. NCC was directed to consider developing an industry standard for display labeling. The NCC's recommendations are offered here as a model for State (or RPC) planning.

[32] See 90.548(a)(ii) for data interoperability standard documents.

State Interoperability Executive Committees [33]

State Interoperability Executive Committees should be formed to administer a State Interoperability Plan in each state or territory. These plans should include, but not be limited to, interoperability operations on the 700 MHz interoperability channels. These committees should include an equal number of representatives each providing regional representation from state, county/parish (where applicable), and local governments, with additional representation from special districts and federal agencies, as appropriate. Such committees may represent all disciplines, in which case emergency medical, fire, forestry, general government, law enforcement, and transportation agencies from each level of government shall be represented equally. Alternatively, Committees may represent a single discipline in which case it is only necessary to have membership from the different levels of government previously described.

The state or states within a region or multiple regions should use the Incident Command System (ICS) as a guideline in developing their regional interoperability plans. (See Appendix N) In the event that the state will not accept this responsibility, the RPC shall develop such plans.

The individual States may hold licenses on interoperability channels for all infrastructure and subscriber units within their state. In the event that a State declines to do so, it may delegate this responsibility to the RPC. [34]

The State (or RPC)[35] would have oversight of the administration and technical parameters of the infrastructure for the interoperability channels within their state (or region)[36].

Recommended templates for a *Memorandum of Understanding for Operating the 700 MHz Interoperability Channels* and a *Sharing Agreement* are attached. The MOU shall be typed on appropriate committee letterhead and the Sharing Agreement on agency letterhead.[37] (See Appendices B&C)

<u>Minimum Channel Quantity</u>

The minimum channel quantity for Calling and tactical channel sets requires 8 I/O channel slots in each subscriber unit. Including Direct (simplex) mode on these channel sets, up to 16 slots in each radio will be programmed for I/O purposes. Backbone issues are deferred to the SIECs and/or RPCs.[38] Subscriber units, which routinely roam through more than one jurisdiction up to nationwide travel will require more than the minimum channel quantity.

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[33] In the 4th R&O, the FCC determined that administration of the I/O channels should be done at the state level. While it supported the concept of SIECs, the Commission did not mandate that they be formed if a state already had a similar structure in place. See 90.525(a)

[34] See 90.525(b)

[35] See Footnote 1.

[36] Ibid.

[37] In the 4th R&O the FCC endorsed but did not require the use of the recommended MOU and Sharing Agreement templates.

[38] See Footnote 1

The "CALL"ing channel sets (7CALLA and 7CALLB) shall be implemented in all voice subscriber units in repeat-mode and direct (simplex) mode. "Direct" mode is permitted in the absence of repeat operation or upon prior dispatch center coordination. If the local CALLing channel set is not known, 7CALLA shall be attempted first, then 7CALLB. Attempts shall be made on the repeater mode first then on the direct (simplex) mode.

A minimum set of "TAC"tical channels shall be implemented in every voice subscriber unit in the direct (simplex) mode. Specific channel sets are shown below (SIECs or RPCs[39] will have the option to exceed this minimum requirement.)

- 7TAC11 & 7TAC49 channel sets (previously known an OTAC33 and 63)
- 7TAC09 & 7TAC47 channel sets (previously known as MTAC23 & 53)
- 7TAC29 & 7TAC59 channel sets (previously known as GTAC31 & 61)

NOTE: Selection of the above TAC channels based on revised Table of Interoperability Channels. Channel labels are compromise between 4th R&O and IO-0062D-20010118.

Voice subscriber units subject to multi-jurisdictional or nationwide roaming should have all I/O voice channels, including direct (simplex) mode, programmed for use.

Direct (Simplex) Mode

In direct (simplex) mode, transmitting and receiving on the output (transmit) side of the repeater pair for subscriber unit-to-subscriber unit communications at the scene does not congest the repeater station with unnecessary traffic. However, should someone need the repeater to communicate with the party who is in "direct" mode, the party would hear the repeated message, switch back to the repeater channel, and join the communications. Therefore, operating in direct (simplex) mode shall only be permitted on the repeater output side of the voice I/O channel sets.

Common Channel Access Parameters

Common channel access parameters will provide uniform I/O communications regardless of jurisdiction, system, manufacturer, etc. Thus, the Calling and Tac channels (all of them) should include a common Network Access Code (NAC) as the national standard. The secondary, trunked I/O channels would be excluded in the trunked mode. However, when reverted to conventional I/O, the common NAC would then apply. This national requirement should apply to base stations and subscriber units. This should apply to fixed or temporary operations. This should apply to tactical, vice, or other mutual aide conventional I/O use.

Common channel access parameters for all voice I/O shall utilize the default values (ANSI/TIA/EIA-102,BAAC-2000, approved April 25, 2000) provided in every radio regardless of manufacturer. Any common channel access parameters not provided shall be programmed accordingly. These parameters include the following:

[39] Ibid.

P25 Network Access Code - $293 (default value)
P25 Manufacturers ID - $00 (default value)
P25 Designation ID - $FFFFFF (designates everyone)
P25 Talkgroup ID - $0001 (default value)
P25 Message Indicator $000000…0, out to 24 zeros (unencrypted)
P25 Key ID - $0000 (default value)
P25 Algorithm ID - $80 (unencrypted)

Any deviation from $293 will not be permitted unless the SIEC (or the RPC)[40] can demonstrate in Plan amendment through the FCC-approved process that the intent of $293 will be preserved on ALL conventional voice I/O channels – transmit and receive.

7. ADDITIONAL SPECTRUM SET ASIDE FOR INTEROPERABILITY WITHIN THE REGION

An individual region shall have the ability to assign additional spectrum within that region for Interoperability. The spectrum will only be available for use within that Region. The RPC must designate which channels will be used out of the General Use spectrum, and must update the NIJ database. The RPC shall justify the assignment of this additional spectrum and include operational guidelines as well as user criteria with eligibility requirements. A Region requesting additional Interoperability spectrum must get concurrence from adjoining regions and must include a letter of concurrence from the adjoining regions.

8. ALLOCATION OF GENERAL USE SPECTRUM

This section shall contain a list of requirements and/or limitations including spectrum utilization, agreements with adjacent 700 MHz RPCs, slow growth, pre-coordination, re-assignment, recovery, etc See Guidelines, Item 8 for details.

9. AN EXPLANATION OF HOW NEEDS WERE ASSIGNED PRIORITIES IN AREAS WHERE NOT ALL ELIGIBLES COULD RECEIVE LICENSES.

A methodology shall be adopted to evaluate applicants when there is not enough spectrum to satisfy all requests. See guidelines, Item 9 for a suggested matrix.

10. AN EXPLANATION OF HOW ALL THE REGION ELIGIBLES' NEEDS WERE CONSIDERED, AND TO THE EXTENT POSSIBLE, MET.

Define how and where eligibles submit requests and/or applications for frequencies. When and where public review of applications takes place. Documentation of how the Region applied the matrix developed in Item 9, especially to mutually exclusive applications.

[40] See Footnote 1

11.ADJACENT REGION COORDINATION

The RPC shall describe the process by which their plan was coordinated with adjacent regions. The description shall include the method of contact, letters of understanding, agreements, correspondence, and all pertinent documents. If an adjacent region has not yet formed, the Region must use the pre-planning methods outlined in Item 11 of the Guidelines. If this method is used, the Region will be exempt from adjacent region concurrence until such time as the adjacent region forms and develops its own plan.

12. A DETAILED DESCRIPTION OF HOW THE PLAN PUT SPECTRUM TO THE BEST POSSIBLE USE

The plan shall describe the measures taken to ensure that applicants designed their systems to minimize coverage beyond their borders, e.g., only cover their jurisdictions. Applicants should be required to design their systems to maximize spectrum utilization, e.g., utilize simulcast or spectrum efficient technology. The 700 MHz FCC rules require trunking when using 6 or more channels unless the applicant can demonstrate that conventional use of the channels was at least as efficient as trunking. Multiple users within a given political subdivision should be required to use a common system whenever possible.

13. A DETAILED DESCRIPTION OF THE FUTURE PLANNING PROCEDURES

The plan shall include the future planning process, database maintenance and dispute resolution process selected. See Guidelines #13 for details.

14. A CERTIFICATION BY THE REGIONAL PLANNING CHAIRPERSON THAT ALL PLANNING COMMITTEE MEETINGS, INCLUDING SUBCOMMITTEE OR EXECUTIVE COMMITTEE MEETINGS WERE OPEN TO THE PUBLIC.

I hereby certify that all planning committee meetings, including subcommittee or executive committee meetings were open to the public.

Signed _____

Welcome to the Survey For New Regional Planning Thrust!

Please fill out all of the fields and, when you are finished, click the Submit button.

Name

Title

Entity

Radio band you are now using:

Interoperability major focus for major incident:

Plans for the next 5 years:

New system tracking county wide: Yes ○ No ◉

Data terminals: Yes ○ No ◉

Video: Yes ○ No ◉

Security System: Yes ○ No ◉

Snap Shot Functions:

Point to Point Functions:

Functions:

Point to Multi-point Functions:

Remote Control Systems:

Time to serve on committee:

MOTOROLA' S INTERFERENCE TECHNICAL APPENDIX

1 INTRODUCTION

With the advent of cellular type system deployments in the 800 MHz band and the future 700 MHz band, system operators are faced with having to create highly reliable communications for noise limited systems while interference limited systems are interspersed in the design service area. At this time we are seeing an increasing number of subscriber coverage holes when the radios are in close proximity to high density SMR or cellular base station sites. As more and more radio systems are fielded with varying channel bandwidths and different types of modulation, the prevention, identification and remediation of interference is increasingly important.

- With the newer digital radio systems, interference is often reported as a loss of coverage or no coverage in areas where good coverage was predicted.
- With analog radios, the interference often audibly manifests itself, making the identification somewhat easier.
- Interference can be intermittent or constant. Intermittent interference is more difficult to identify and remedy due to its inconsistent appearance.
- Trunking systems make this more difficult as often interference is for a specific channel and that channel may or may not be assigned while the interference mechanism is active. When the trunking system' s control channel is interfered with, system access and Grade of Service on alternate system resources may be affected.
- For data systems, interference from other systems may cause increased loading and response times due to the additional retires, and may affect subscriber roaming.
- The introduction of new radio systems in an existing coverage area may cause a critical point to be reached and suddenly cause degradation of system performance or complete loss of coverage in specific areas.

The purpose of this document is to sensitize system designers and maintenance personnel to these issues. First, there is a review of how the history of various band plans and hardware changes have increased the probability of interference. Next, the various mechanisms that can produce interference are defined. Common scenarios are provided to aid in identification of interference. The document closes with recommendations of hardware, procedures and actions that can greatly reduce the probability of interference both initially and in the future.

2 BACKGROUND

2.1 BAND STRUCTURE

In the early days of Land Mobile Radio there was only Low Band (25 - 50 MHz) followed later by High Band (132 - 174 MHz). The use of mobile relay (repeater) operation was quite restricted in low band, and simplex operation was the most common configuration. Simplex operation creates a higher potential for base station to base station interference, even with large physical separation. To prevent this type of interference, many systems went to two-frequency simplex, transmitting on one frequency while receiving on a second frequency. This minimizes the base-to-base interference, but prevents mobile units from being able to monitor the channel for activity prior to transmitting. This requires a highly disciplined system, as a dispatcher is the only one that can relay messages between mobile units. Unfortunately, because the mobile units can' t monitor the channel before transmitting, they cause intra system interference when more than one radio at a time contends for the channel.

High band operation had more opportunities for mobile relay operation. Unfortunately the band wasn't developed in a standardized fashion. Over time this resulted in mobile relay operation with some systems using reversed frequency plans relative to the other systems. This mixed with various combinations of "close and wide spaced" mobile relay configurations made frequency coordination and interference prevention a difficult process. In fact, before the introduction of the higher frequency bands, much of the system engineering involved designing sites to accommodate the nearly incompatible frequencies and configurations.

The UHF, 450 - 470 MHz, band was an opportunity to organize the new spectrum and prevent many of the problems systemic to the older bands. However at that time the state of the art for mobile and portable transmitter bandwidth was around 6 MHz. So it was decided to organize the band in such a manner that mobile relay systems would be quite common and that mobile radios could switch to the base station transmit frequency and talk directly to another mobile radio in close proximity (talk-around). This allows radios that are out of range of the repeater to still communicate in a simplex mode on the base station talk-out frequency. The protocol was quite simple. The first mobile to transmit would simply switch to the talk-around mode and transmit. The other mobile was already monitoring the correct frequency so the initiating mobile would simply tell the receiving mobile to switch to talk-around. Once accomplished, they could communicate in a simplex mode. No matter what they did, they were always monitoring the base talk-out frequency.

To facilitate this, the band was organized into four 5 MHz blocks with three interfaces between base transmitters and mobile transmitters. Figure 1 shows how the band was organized.

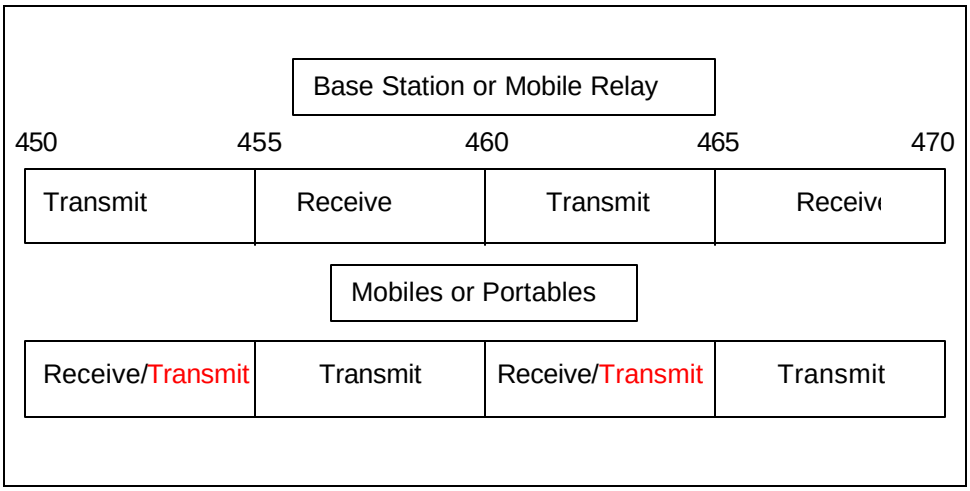


Figure 1 450 MHz Band

Later the UHF band was expanded to include sharing with UHF TV channels 14 through 20 (470 MHz - 512 MHz) in the top 13 US markets. Initially, the top ten markets got 2 TV channels each while the next three received a single TV channel. There have been additional allocations for Public Safety in Los Angeles, and some Canadian border issues preclude deployment. See CFR 47 §90.303 for specifics. To handle the different blocks of spectrum, each TV channel's band was divided in half, with land mobile base transmitters on the low half and base receivers on the high half. As a result the transmitter to receiver spacing is only 3 MHz in this portion of the band.

The next band to be allocated was the "take back" of UHF TV channels 70 - 83. This created large amounts of spectrum for private land mobile systems and for the new cellular industry. Once again, lessons from the older bands were incorporated to minimize interference potential. Transmitter/Receiver spacing was standardized at 45 MHz. To minimize the cost of subscriber units, the band was inverted from the 450 MHz band with the subscriber units transmitting on the low portion of the band.

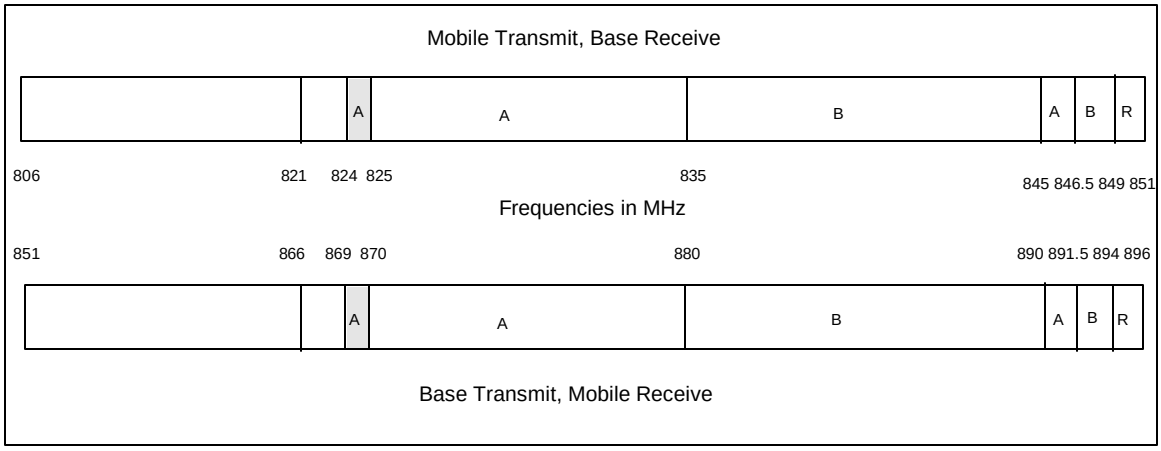


Figure 2 800 MHz Band

For trunked systems, channel assignments were made in blocks of up to five, with a constant 1 MHz separation between channels. This allowed for easy transmitter combining and minimizes some potential intermodulation. The cellular band was immediately adjacent to the land mobile band. Some reserve channels were held and later allocated to public safety and expansion of the cellular frequencies.

Later, around 1988, additional 800 MHz channels were made available exclusively for Public Safety. These new frequencies are often referred to as "821 MHz" rather than the more accurate but complex name 821-824/866-869 MHz bands. Five interoperable channels were assigned on a national basis. At that time, narrow banding to 12.5 kHz channels was difficult and operability with the existing 800 MHz channels was a requirement, so a compromise solution was developed. The channels would be 25 kHz wide, but channel assignments would be granted every 12.5 kHz. Interference would be administratively controlled by a group of Regional Frequency Coordinators. The assumption is that a receiver would provide 20 dB ACIPR and this would be considered a requirement by the frequency coordinators, but not by the FCC. Co channel frequency reuse was generally based on a 35 dB C/I, but local regional frequency planning committees policies may alter this requirement slightly. Local planning committee recommendations must be adhered to.

The last block of frequencies allocated to private land mobile is in the 900 MHz band. This was the first real narrowband allocation. Channels are 12.5 kHz wide. This creates the potential for "near-far" interference scenarios.

The "near-far" situation has two different scenarios, as shown in Figure 3.

- A unit close (near) to a site on a nearby or adjacent undesired channel interferes with a weak (far) unit talking inbound on the desired channel.

- A unit far from its desired site is interfered with when close (near) to a nearby or adjacent undesired channel base.

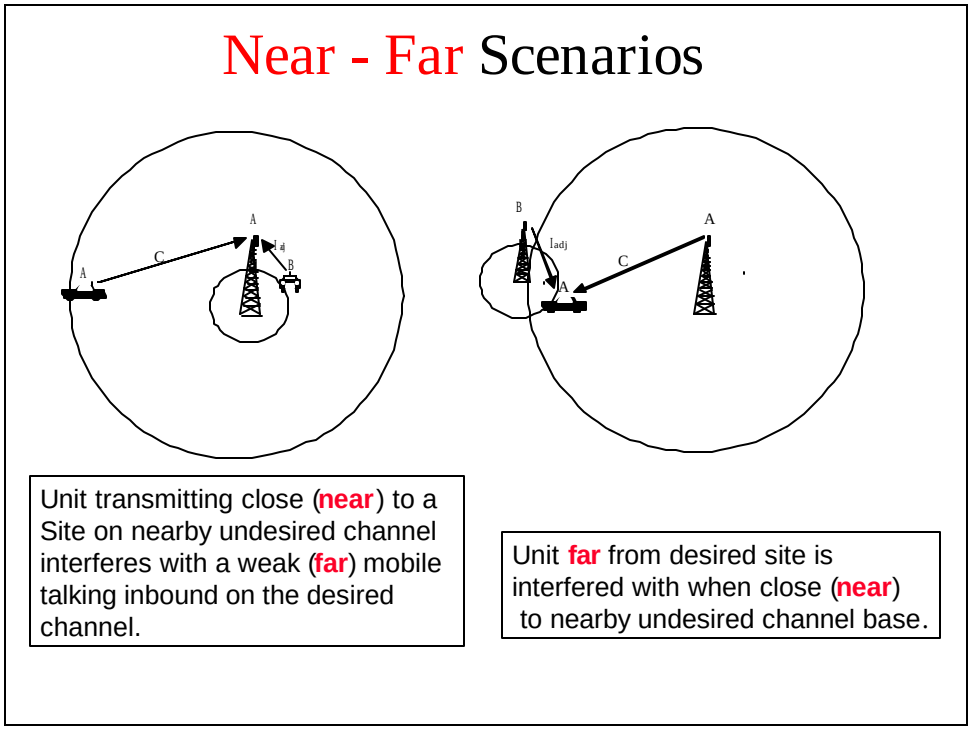


Figure 3 Near - Far Scenarios

To compensate for this possibility, the channels were allocated in blocks of 10 adjacent channels. The concept was that any money spent to be a "good neighbor" should result in improved system performance for the person that spent the money. Thus this assignment policy created the situation where a users adjacent channel assignment belonged to themselves, except for the two end channels of a block.

Channels were assigned with a transmit to receive separation of 39 MHz with the same configuration as 800 MHz, base stations transmit on the high split, and mobiles transmit on the lower split. This minimizes the cost of power transistors for the subscriber units as they operate on the lower frequencies.

2.2 HARDWARE HISTORY

Older radios used crystals or channel elements to derive its transmit and local oscillator frequencies. As a result, if a radio had four-frequency capability, it had to have a total of eight crystals or channel elements to generate the correct frequency sources. This resulted in considerable cost and space being devoted for just the frequency generation.

Crystals are a very high Q component, ~50,000, so they generate a very clean response. To stabilize their performance, heated ovens were used to keep the crystals at a constant temperature. This was a considerable current drain, even in mobiles. As greater frequency stability was required the channel element became the preferred solution. A channel element is a crystal with a temperature compensating circuit that has been calibrated for that specific crystal, thereby eliminating the requirement for heating and its current drain .

The channel element eliminated the current drain that was had been necessary to provide the temperature stability. However, they were still large and made radios quite large. The next step was to eliminate some of the channel elements by providing an offset oscillator for the receive frequency. In bands where a constant frequency difference from transmitter to receiver exists, one oscillator can be used for the specific transmit oscillator and offset it in frequency to become that pairs associated receiver local oscillator. When talk-around operation was needed, a second

offset oscillator was optionally available. Thus a normal 4-frequency radio would have 4 channel elements and one offset oscillator. When equipped with Wide Space Transmit, it would have 4 channel elements and two offset oscillators. Note that the frequency stability was decreased by the additional frequency error of the offset oscillator.

The channel element size limitation allowed receivers to be designed with relatively narrow bandwidths. As a result, helical resonators were commonly used in receiver preselectors. They provided good front-end selectivity, which provided excellent protection from undesired signals. However the next step in providing increased frequency capabilities required more flexibility, which resulted in the replacement of the highly selective front-end with one with a greater bandwidth.

The frequency synthesizer was introduced in the early 1980' s. The frequency synthesizer is a lower Q device, and only requires a single channel element at its fundamental frequency. The instructions for the synthesizer to be able to generate the appropriate frequencies are stored in a memory module that could be a PROM or code-plug.

A frequency synthesizer costs more than separate channel elements until a critical number of channels is reached. Radios were introduced with more memory to hold the additional instructions and user interfaces were developed to allow the users to keep track of what channels they are on.

To be able to use the increased frequency capability, radios had to have increased bandwidth. Transmitters were widened, as were receivers. Some representative values from that era are shown below in Figure 4.

Radio Type	Transmitter BW (MHz)	Receiver BW (MHz)
High Band Mocom 70	1, 2 w/ center tuned[1]	2
UHF Mocom 70	5	1
High Band Syntor	12	2
UHF Syntor	10	2
High Band Syntor X	24	24
800 MHz Syntor X	19	19
High Band MCX100	26/28[2]	4/12[3]
High Band MX300S	6	2
UHF MX300S	12	2

Figure 4 1980 Era Radio Frequency Limitations

[1] A special channel element was used to tune at the average frequency of the highest and lowest frequency.
[2] Low portion of band / high portion of the band
[3] Dual front ends. Two at 4 MHz each, with 12 MHz separation.

3 INTERFERENCE MECHANISMS

There are a large number of different interference mechanisms that can cause a radio to have degraded performance. To properly determine the root cause or predominant mechanism, field measurements are normally required. By the proper introduction of a step attenuator and/or cavity filter in the receiver's lineup or cavities into the suspect transmitter's lineup, the effect can be measured and from that the root cause determined.

There are several important reference standards that should be considered in making measurements of interference. They are all published by the TIA/EIA:

1. TIA/EIA-603 "Land Mobile FM or PM Measurement and Performance Standards."
2. TIA/EIA/IS-102.CAAA, "Digital C4FM/CQPSK Transceiver Measurement Methods"
3. TIA/EIA/IS-102.CAAB, "Digital C4FM/CQPSK Transceiver Performance Recommendations."
4. TIA/EIA/TSB-88A, "Wireless Communications Systems – Performance in Noise and Interference-Limited Situations – Recommended Methods for Technology-Independent Modeling, Simulation, and Verification."

The following mechanisms are the most common and will be discussed as well as recommended methods of measurement.

- Receiver Desensitization
  - ACRR - Adjacent Channel Rejection Ratio
  - ACCPR - Adjacent Channel Coupled Power Ratio
  - ACIPR - Adjacent Channel Interference Power Ratio
  - Overload
  - Local Oscillator
    - Sideband Noise
    - Radiation
  - Spurious Responses
- Intermodulation (IM)
  - Receiver
  - Transmitter
  - External
- Transmitter
  - Sideband Noise (adjacent/alternate channels)
  - OOB Emissions (>250% of channel bandwidth)
  - Spurious Emissions (Discrete frequencies)

4 EFFECTIVE RECEIVER SENSITIVITY

Receiver Desensitization occurs when a receiver requires higher signal levels to provide the same performance as when the interference source isn't present. The result is referred to as "Effective Receiver Sensitivity" as it determines what the sensitivity is in the presence of the interference mechanism and compares that to the sensitivity of a receiver when using only a signal generator, eliminating all external sources of interference. The difference between the Effective Sensitivity and the Normal Sensitivity is call Desensitization.

The Effective Receiver Sensitivity method of measurement is shown in Figure 5.

1. Measure and record the reference sensitivity of the receiver. The reference sensitivity is typically 12 dB SINAD for analog receivers or 5% static BER for digital receivers.

2. The receiver under test is connected to an "iso-tee" or directional coupler. Through the isolated leg, a signal generator is connected and the main input leg is terminated in the correct impedance (50Ω).
3. The receiver's reference sensitivity is again measured and recorded.
4. The termination is removed and the input port is connected to the normal external antenna system.
5. The signal generator is increased until the reference sensitivity is once again achieved and the value recorded.

The Effective Sensitivity is determined by determining the increase in required signal level to regain the performance provided at the reference sensitivity [Cs/N]. In this case the Cs/N is now Cs/(I+N).

$$\textit{Effective Sensitivity} = \textit{Direct Reference Sensitivity (Step 1)} \times \frac{\text{Sensitivity(Step5)}}{\text{Sensitivity(Step3)}}$$

For example, if the direct reference sensitivity is -119 dBm and the value in steps 3 and 5 are -99 dBm and -80 dBm then the effective sensitivity is -119 dBm + (-80 -(-99)) = -100 dBm, or 19 dB of desensitization.

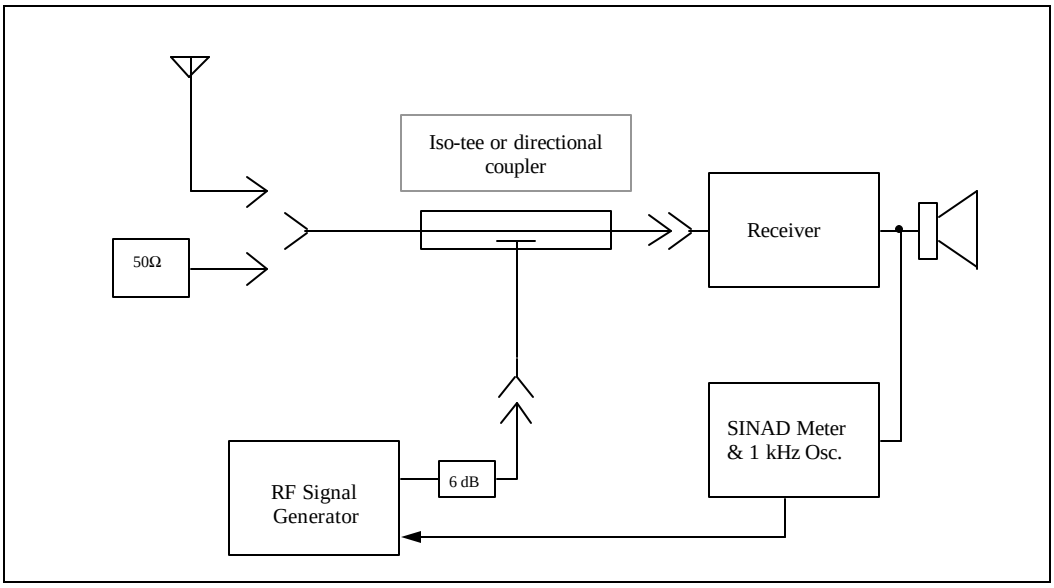


Figure 5 Receiver Desensitization Measurement

4.1 RECEIVER INTERFERENCE MEASUREMENT THEORY

Some receiver specifications are only valid when the desired signal is at reference sensitivity. When the desired is at this weak signal level, the noise floor becomes part of the consideration. As a result, it is commonly measured by injecting a desired signal into a receiver at its reference sensitivity and then boosting the desired signal by 3 dB. The potential interference is introduced and increased in level so that the original reference sensitivity is regained. This is essentially causing the interference to produce the same effect as the thermal noise floor of the receiver. The two noise floors add up to 3 dB greater than the original noise floor. Then the effect of the interference is equivalent to an on-frequency interferer reduced by the difference between the original reference sensitivity and the level of the interferer.

As will be shown later, when the desired signal is considerably above the reference sensitivity, the 3 dB boost is no longer required.

4.1.1 Receiver Overload

When a receiver is exposed to very strong signal levels, enough undesired energy could potentially force its way past the selectivity elements to cause limiters or AGC circuits to be activated. This reduces the available gain for the desired signal resulting in a loss of sensitivity. Figure 6 represents a "typical" receiver. It is general enough so it can be used for most of the receiver examples.

In this case, a strong signal passes easily through the preselector and is amplified and then down converted in frequency. The Intermediate Frequency Filters reduce the amplitude of the desired signal in addition to filtering the undesired signals. Typically its amplified again and then filtered again. Some receivers have two Local Oscillators. This is not always the case, but for the "typical" case it is included. When two Local Oscillators are being used, there is typically additional filtering at the second IF frequency. In most modern receivers, this filtering is done with Digital Signal Processors (DSP).

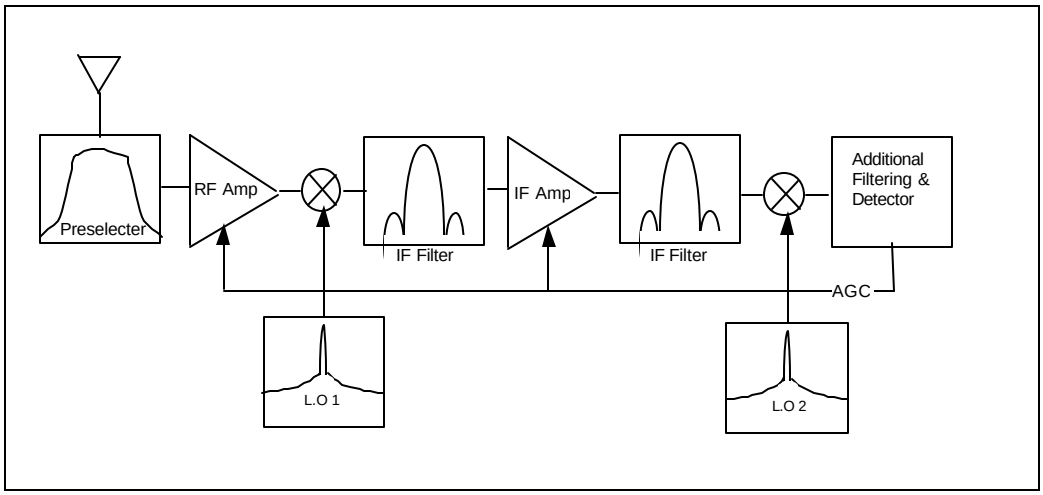


Figure 6 Typical Receiver

5 RECEIVER DESENSITIZATION

Desensitization is the measure of a receiver's ability to reject signals that are offset from the desired signal's frequency. Desensitization of a desired signal at the reference sensitivity level due to an adjacent channel signal is defined as Adjacent Channel Rejection (ACR) in the TIA-603 and IS-102CAAA documents. The measurement procedure detailed in the TIA documents for measuring ACR can be used to quantify receiver desensitization at any frequency offset and for higher desired signal levels. [Note that the TIA frequently uses a convention that produces a positive number for specified values. To accomplish this, they use ratios, always placing the largest value in the numerator and then adding an R to the end of the acronym. For example, ACR might be -75 dB, so ACRR would be 75 dB.]

There are several factors that may contribute to a receiver's desensitization characteristic. The receiver IF selectivity may be inadequate to reject strong signals, typically in excess of -50 dBm, on adjacent channels. Historically this has been a major factor determining the receiver's ability to reject strong signals on adjacent channels. With the

availability of small and inexpensive ceramic filters and digital signal processing, it is less of an issue with modern equipment.

Receiver local oscillator sideband noise can heterodyne an undesired signal into the IF pass-band by mixing with a single high level signal, typically in excess of -50 dBm, and usually within 500 kHz of the desired signal. This mechanism is often confused with adjacent channel interference, and it is a contributing factor to the receiver's ability to reject strong signals on adjacent channels.

An additional consideration is the spectrum of the interfering signal. If the interfering signal has a broad spectrum, or a high noise floor, the receiver desensitization measurement will indicate poor desensitization performance even for very well designed receivers. As receivers start utilizing very narrow IF bandwidths (12.5 kHz channel bandwidths or less) the effect due to the modulation components becomes more important. Previously receiver ACRR measurements only required a single 400 Hz tone at 60% of maximum system deviation. This no longer is considered applicable as it severely under estimates the amount of energy that the victim receiver can intercept from an adjacent channel. Currently the TIA recommendations are undergoing changes that will require that the interfering source be modulated so it simulates the energy distribution under actual operating conditions.

Figure 7 shows sensitivity level desensitization performance for a number of generic radios. Also compared in the figure are the desensitization levels due to the off-channel signal source. One of the sources is a high performance signal generator, modulating a 400 Hz tone at 3 kHz deviation. The other source is an iDEN base radio transmitting iDEN Quad-QAM modulation.

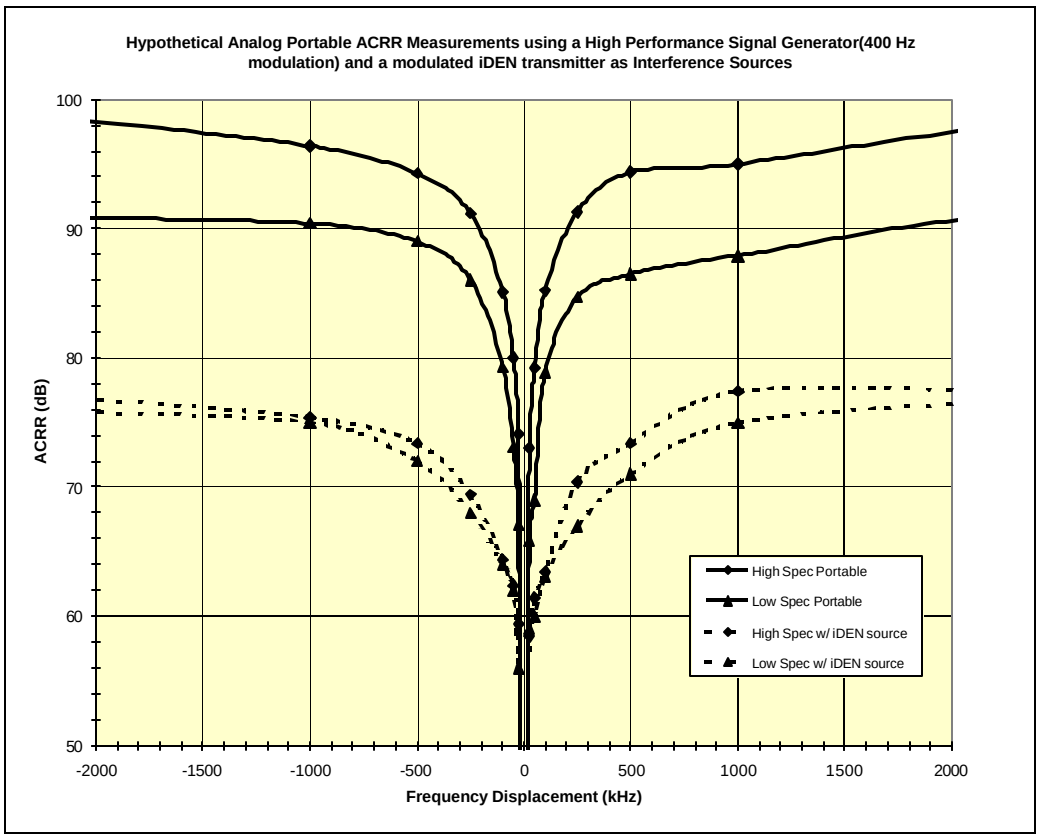


Figure 7 Receiver Desensitization

Figure 7 shows that when a high performance signal generator is used as the interference source, receivers will typically have ≥ 90 dB rejection of signals that are offset ≥ 500 kHz from the desired channel. Receivers usually will have better than ≥ 80 dB rejection for offsets exceeding approximately 50 kHz. When an iDEN base radio is used as the interfering signal source, the ACRR desensitization level is approximately 20 dB less than when the high performance signal generator is used. This occurs due to the noise floor characteristic of linear amplifiers. This indicates that high performance receiver designs may not realize improved desensitization performance because the performance is limited by an unfiltered base radio spectrum that contains high OOBE (noise). There is a penalty for noise limited systems in the same or nearby bands where interference limited systems are deployed.

6 RECEIVER BLOCKING

Excessive desired on-channel signal levels can overload the receiver, usually the result of Automatic Gain Control (AGC) design limitations. The receiver front end can be overloaded by a single high level unwanted signal, not on the desired channel, typically in excess of -25 dBm, or multiple high-level unwanted signals whose total peak instantaneous power exceeds -25 dBm. This is also known as receiver blocking.

Blocking is measured using a desensitization measurement procedure with progressively higher on-channel signal levels. Figure 8 shows the blocking of a hypothetical portable radio, as a function of frequency offset.

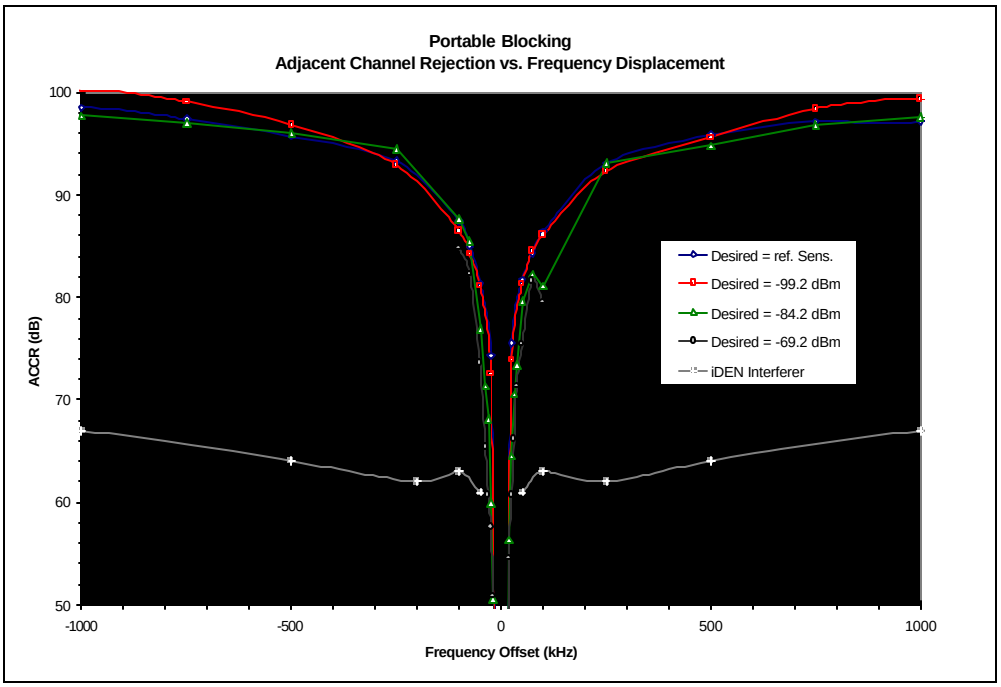


Figure 8 Receiver Blocking

Figure 8 shows that with desired signal levels as high as approximately -70 dBm signal levels, no blocking phenomena occurs. There is a small degradation of the desensitization performance at offsets ≥ 100 kHz for desired signal levels of ≥ -85 dBm.

Figure 8 also demonstrates the desensitization performance at sensitivity level due to an iDEN base radio used as the interfering signal. The desensitization limit imposed by the iDEN OOBE is nearly 20 dB worse than that of the hypothetical radio itself at any desired signal level. From this it can be concluded that ***receiver blocking due to high signal levels is not a significant source of interference, at least where the limiting interference source is from the noise contribution of a base radio generating strong OOB emissions.***

7 RECEIVER INTERMODULATION

Receiver front end (RF Amplifier) non-linearity can create intermodulation products on the desired frequency by mixing two or more high level signals, typically ≥ -50 dBm. Figure 9 shows sensitivity level intermodulation rejection (IMR) for typical receivers, relative to the receiver' s reference sensitivity signal level. For practical purposes, IMR is not a function of frequency offset, as the preselector doesn' t provide additional rejection of potential Intermodulation combinations across the receiver' s desired bandpass. As a result, the IM performance is essentially flat in the desired band. The preselector does provide additional protection from signals outside the pass band. For each additional dB of insertion loss, the IMR products are reduced by the order of the IM product, e.g. 3 dB for 3rd order IM.

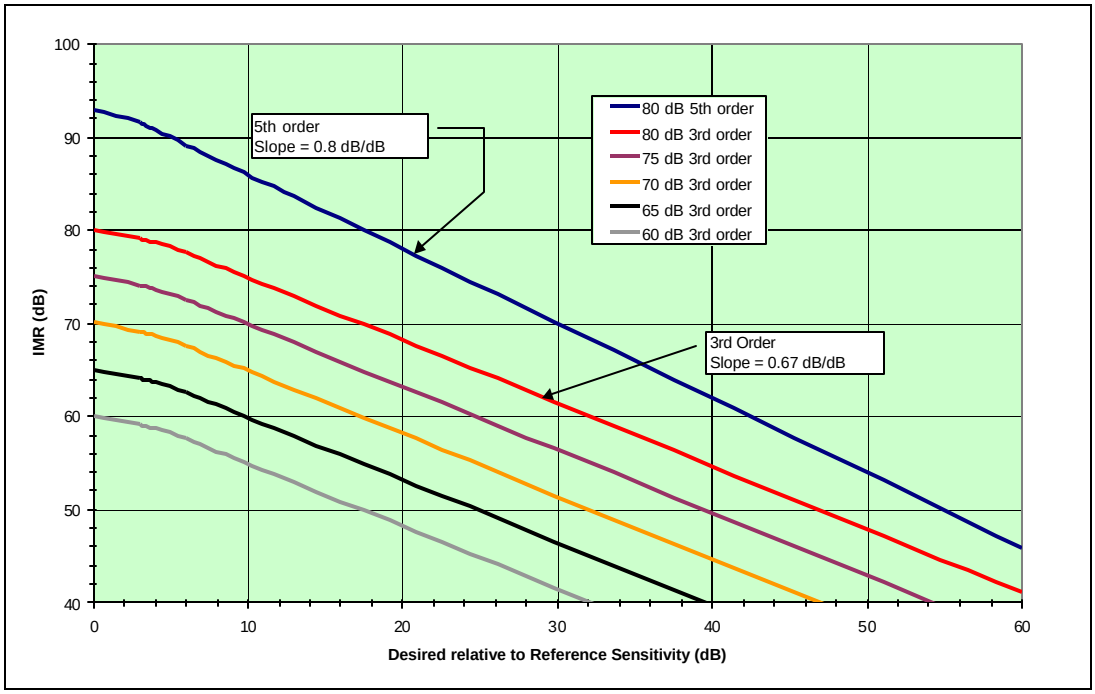


Figure 9 Receiver IM above Reference Sensitivity

While IMR is not a function of frequency offset, it is a function of the level of the desired signal. This is because the signal strength of intermodulation products grows at a rate proportional to the order of the intermodulation product. For example, third order intermodulation products grow 3 dB for every 1 dB increase in signal strengths of the carriers that produce them. Because of this, the IMR is reduced by 2/3 dB for each 1 dB increase in the desired signal level. This effect is shown in Figure 9.

Figure 9 shows that all the products normally follow the 2:3 slope expected for IMR with increasing strength of the desired signal. It is important to note at this point that IMR, as measured using TIA methods, is concerned only with two generator, third order IM processes. Higher order (5th, 7th, 9th, etc., order) processes also exist but are usually of

little concern because they usually require much larger interference signal levels than the third order process. Three generator IM processes produce a slightly lower IMR due to the increased power due to the additional signal.

In situations where there is a high concentration of high-powered transmitters with high duty cycles, the higher order IM products can become significant for receivers in close proximity to the site. Figure 9 also shows a 5th order response for an 80 dB (3rd order IMR) receiver. The 5th order IM specification is typically 12 to 15 dB higher than the 3rd order IM specification. Although the 5th order IMR is much higher than the 3rd order IMR, its slope is greater so that 5th order IM can become a problem in situations where there are a large number of carriers. Although not shown, the 1-dB compression point is also very important. The 1-dB compression point exists roughly 10 dB below the IIP^3 and represents where the theoretical slope departs by 1 dB from the linear performance. Signal levels greatly in excess of the 1-dB compression point can cause the amplifier to saturate and eventually burn out.

The use of receiver multicouplers and tower top amplifiers can have a dramatic negative effect on a base station's receiver IMR performance. This is due to the fact that the IIP^3 is constant. The reserve gain of the amplifiers in the configuration raise both the desired signal and the potential IM signals, resulting in a reduction in the system IMR. Figure 10 demonstrates this.

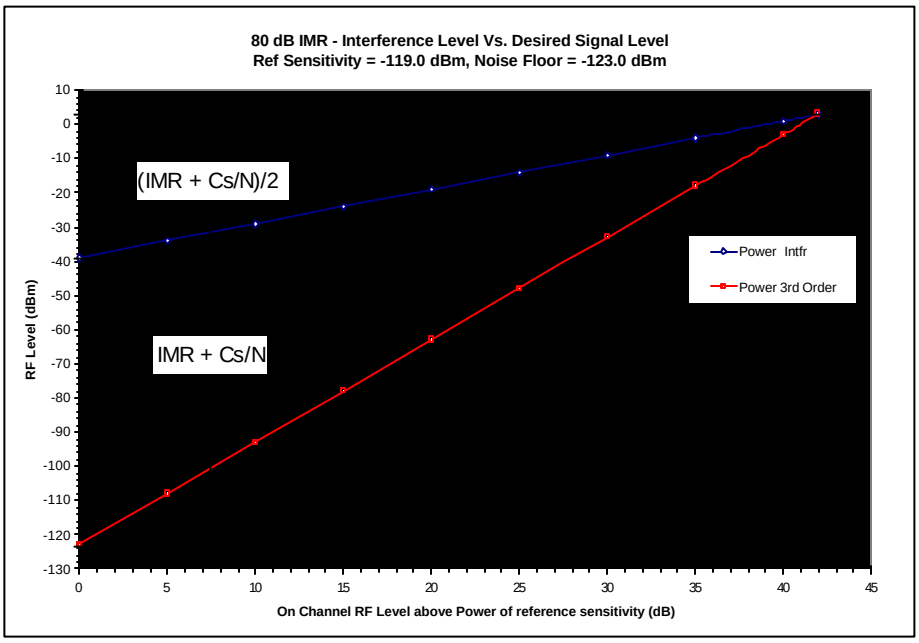


Figure 10 IMR Performance

In Figure 10, the reference sensitivity for 12 dB SINAD is -119 dBm, Cs/N is 4 dB and the IMR is 80 dB. The noise floor calculates to be -123 dBm. The IIP^3 is 1.5*x*(84) or 126 dB above the noise floor (+3 dBm). The individual power level from two equal interferers that produce an IM response on frequency is 42 dB below the IIP^3, -39 dBm.

To review, using the TIA IMR test methodology, consider the previous example. The -119 dBm produces a 4 dB Cs/N that creates the 12 dB SINAD reference sensitivity. The signal is boosted by 3 dB (-116 dBm) and the equal signal level interferers increased until 12 dB SINAD is again reached. This indicates that now a 4 dB Cs/(I+N) has been reached but the desired is now -116 dBm. Thus the composite noise floor is -120 dBm, consisting of -123 dBm from the receiver noise floor and -123 dBm, the equivalent noise from the intermodulating signals. The difference between the original signal (-119 dBm) and the level of the IMR signals (-39 dBm) is the IMR performance of the

receiver (80 dB). Note that at higher signal levels, the receiver' s own noise floor becomes insignificant and the ratio is merely the difference between the desired and the IMR signals required producing 12 dB SINAD. This explains why the slope in Figure 9 tends to flatten out in the region where the receiver noise floor is significant.

If the desired signal for the example 80 dB IMR receiver is 20 dB above reference sensitivity, -99 dBm, then the difference between the IMR sources and IIP^3 is 102 dB. The level of 2 equal signal IM generating sources 102/3 = 34 dB below the IIP^3. (+3 dBm - 34 dB = -31 dBm). Thus for this example the IMR is now -31 dBm - (-99 dBm) = 68 dB, not 80 dB! In this case the two IMR signals produce an equivalent noise of -102 dBm. The receiver' s own noise floor of -123 dBm is insignificant. What is important to note is that even at -99 dBm, the performance is only equivalent to the static reference sensitivity. This phenomenon supports the recommendation for deploying higher IMR receivers when the victim receiver can be close to the source that can produce IMR.

8 RECEIVER SPURIOUS RESPONSES

Receivers can have spurious responses to strong single signals, typically in excess of -50 dBm, which are on frequencies other than the desired receive frequency. Examples include the 1st IF image response, the 2nd IF image response, and any harmonics of the local oscillator mixing with any harmonics of the undesired signal.

Using the typical receiver in Figure 11, if the IF frequency is 11.7 MHz, and the desired signal is 460.0000 MHz, the Local Oscillator must be either 11.7 MHz above or below to cause an 11.7 MHz signal to be generated in the mixer. If the LO is below by 11.7 MHz (448.3 MHz) or above (471.7 MHz) proper operation can occur. With wider preselectors, the image frequency can easily fall within the passband of the preselector. To reduce the possibility of this occurring, the IF frequency should be greater than the preselector' s bandwidth. Figure 11 shows how this can occur.

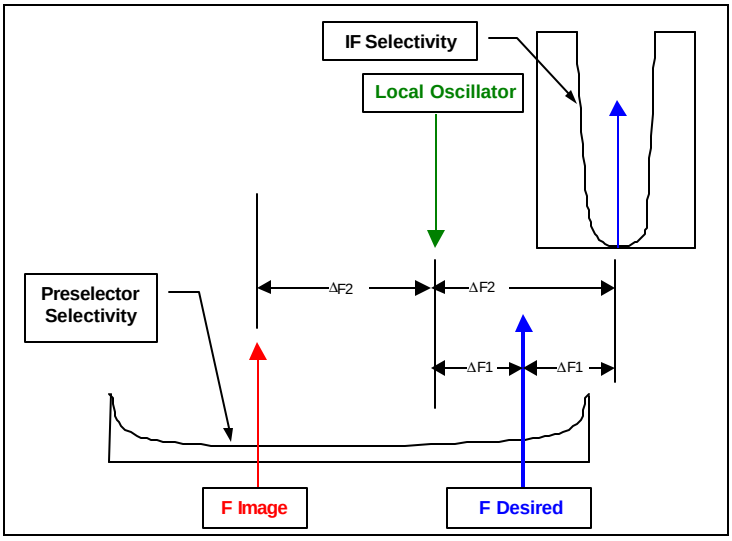


Figure 11 Typical Receiver with a Wide Preselector Passband

The spurious responses of a receiver can cause significant degradation to the desensitization properties of the receiver, on the order of 20 dB in some cases. In most cases, when the interfering signal is due to a base radio with high OOB Emission, the desensitization performance is dominated by that noise floor rather the spurious responses.

9 DETERMINING THE SOURCE OF INTERFERENCE

9.1 TEST EQUIPMENT REQUIRED

1. Spectrum analyzer.
2. Low noise RF amplifier.
3. Step attenuator (pad).
4. Cavity, bandpass filter that has a bandwidth (±3 dB) of at most 300 kHz, an insertion loss of at most 2 dB and that can be tuned to the desired channel.
5. Antenna for the frequency band in question.
6. Subscriber unit that can be connected to a coaxial cable.
7. Motorola Radio Service Software (RSS), or equivalent, loaded on a suitable PC laptop computer to read receive signal strength; if applicable. This capability may not exist for all radios in which case one must listen to the radio' s speaker and judge the quieting level.

9.2 EVALUATION PROCEDURE FOR INTERFERENCE TO SUBSCRIBER UNITS

The interference evaluation process begins by visiting the affected location, setting up the subscriber unit and connecting the test equipment as shown in Figure 12 below:

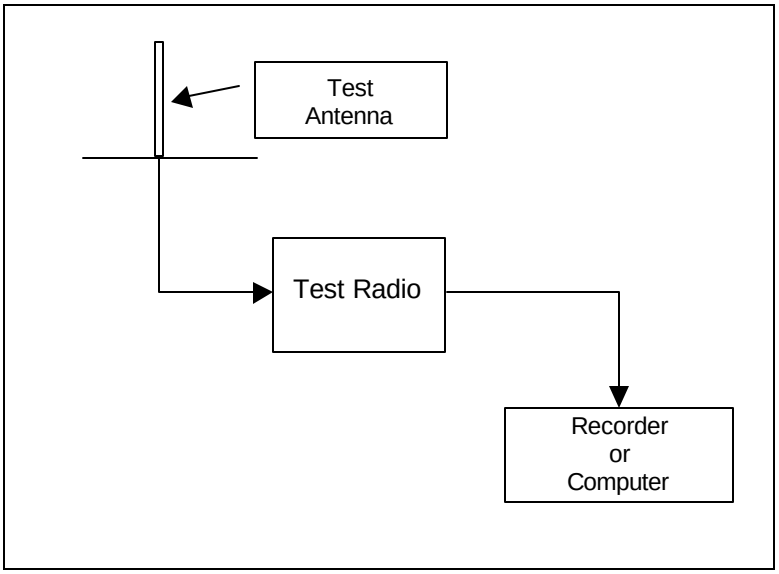


Figure 12 Initial Evaluation

Tune analog units to the appropriate RF channel, and observe the recovered audio quality by recording about two minutes of the audio while slowly driving the test vehicle around in at least a 100-foot circle. The audio should have noticeable degradation compared to the normal reception expected in the general area. After the recording has been made, replay it several times to become familiar with the type of audio degradation that is occurring.

If the subscriber unit uses digital modulation, and the Radio Service Software (RSS) package includes a signal quality metric, it may be more appropriate to record the data from that output on a computer for analysis.

Next, connect the spectrum analyzer to the antenna as shown in Figure 13:

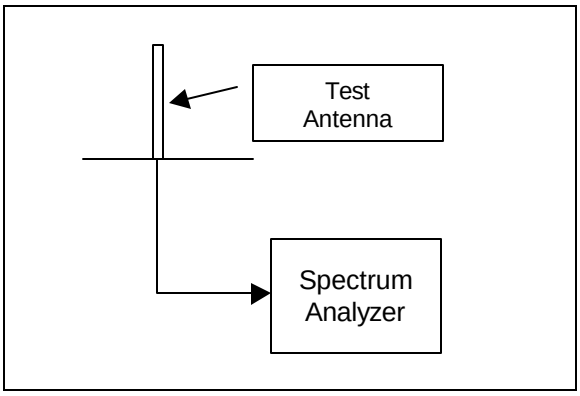


Figure 13 Evaluation with Spectrum Analyzer

Record all signals in the frequency bands that are above (stronger than) -50 dBm. Pay particular attention to those above -40 dBm, as they are the most likely to cause problems, particularly if there are several of them within a few MHz of the desired frequency. A rough guideline is to suspect receiver front-end overload if the total instantaneous peak RF power being delivered to the receiver is in excess of -20 dBm.

In order to correctly measure the power of any RF signal with a spectrum analyzer, it is necessary to use a resolution bandwidth in excess of the maximum spectral distribution of RF energy expected. For analog FM signals, this is typically 10 kHz. For narrowband digital modulation formats, this may be up to 30 kHz, and as much as 1.25 MHz for CDMA transmissions. The reason for this is so that the entire signal will be measured at the same time. The best procedure is to adjust the analyzer frequency span range until the desired signal is centered in the display screen and occupies about 20 percent of the width of the display. Then start at a 1 kHz resolution bandwidth and increase it until there is no further increase in the maximum amplitude shown on the display.

Be aware that multiple RF signals of any modulation format will occasionally add in phase, so that four signals each at a level of -25 dBm will have a total peak instantaneous power that is another 12 dB higher, or -13 dBm.

If there are no strong signals, then the cause is either man-made noise, or co-channel interference from another user on the desired frequency. The difference can be resolved by connecting the equipment as shown in Figure 14:

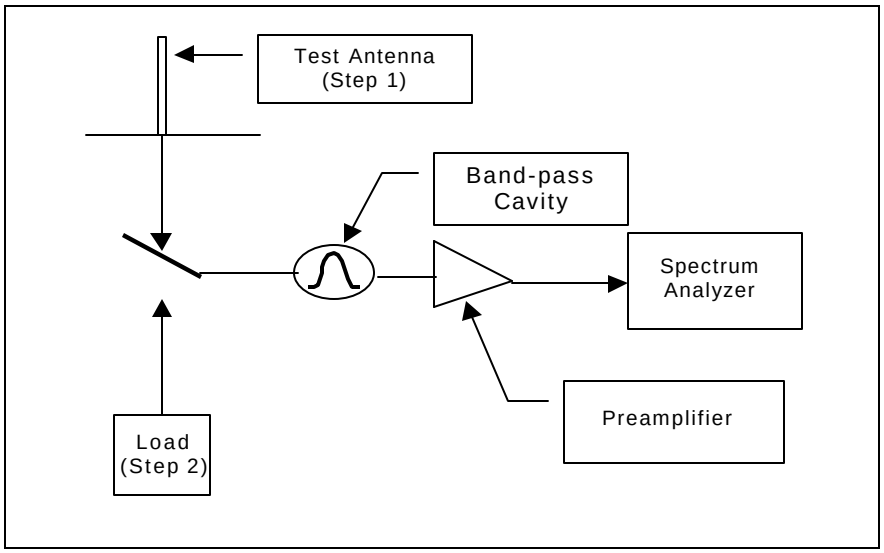


Figure 14 RF Noise Measurement Setup

Using a resolution bandwidth no wider than 3 kHz and a frequency span no greater than 3 times the desired RF channel bandwidth, measure the noise present on the channel, then connect a 50 ohm load in place of the antenna. The noise level should decrease less than 1 dB if there is no noise or interference present. If there is a noticeable reduction, note the amount, then reconnect the antenna, and note the spectral content of the noise. If it is not restricted to the desired channel (Figure 15), then it is most likely either from broadband digital services like CDMA systems or from non-RF sources such as power lines, neon signs, ignitions, and the like. If the noise is shaped to fit the channel (Figure 16), or a single frequency carrier appears in the channel, then co-channel interference is the cause.

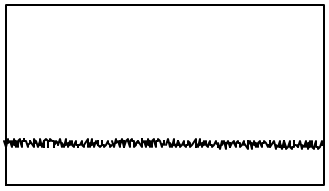


Figure 15 Broadband Noise

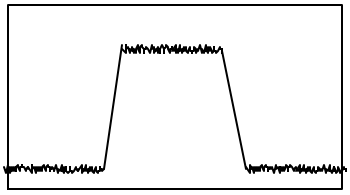


Figure 16 Digital Modulation

If there is only one strong signal present, and it is the desired one, then the cause is one of simple receiver overload. The symptoms are a very high desired signal strength, typically in excess of -30 dBm, with some degree of audio distortion. This is rare, but if it occurs, the only solutions are to move the subscriber unit farther away from the transmitter site, place an attenuator in the receiver' s antenna line or reduce the transmit effective radiated power.

If one or more strong signals are present record about two minutes of audio or data on the desired channel using the configuration shown in Figure 17. Listen carefully to the audio recording several times to get familiar with the recovered audio quality.

If the subscriber unit uses digital modulation, compute the average signal strength and signal quality for the entire recording of digital data. Next, add a 5 dB pad in the line between the antenna and the subscriber unit as shown in Figure 17 below:

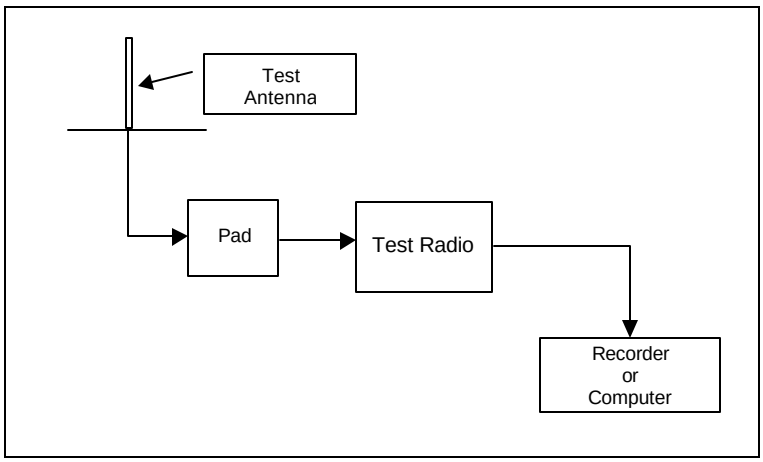


Figure 17 Intermodulation Test

Record another two minutes of audio or data while driving the exact same route as in step 1 and note the differences from the non-attenuated readings. The received signal strength should have been reduced by 5 dB, but if the audio or signal quality ***improved*** noticeably, then the root cause is a high order intermodulation product being generated in the receiver.

Subscriber units using digital modulation will clearly show the reduction in received signal strength while simultaneously indicating the improved signal quality. This type of response usually results from two or more strong signals at the receiver input.

If the received signal strength decreases by 4 dB or less when the 5 dB pad is switched in, the cause is receiver front end overload, resulting from one or more extremely strong signals anywhere in the frequency band. The reason for this is that one of the amplifier stages in the receiver is being driven into saturation by the extremely strong input signals. This effectively reduces the gain of that stage for all signals passing through it. When the strong signals are attenuated by 5 dB, the saturation is reduced, and the effective gain of the amplifier stage increases, so the measured signal strength decreases less than 5 dB. If the audio quality or signal quality remains unchanged when the 5 dB pad is switched in, then the problem is either due to receiver local oscillator noise, or received RF noise from nearby transmitters.

If there are no strong signals closer than 500 kHz away from the desired channel, the cavity filter can resolve whether the receiver is at fault, or the interference is being radiated on frequency from the nearby transmitters. First, connect the external antenna to the analog subscriber unit as shown in Figure 9. Record about two minutes of audio or data on the desired channel. Listen carefully to the audio recording several times to get familiar with the recovered audio quality.

If the subscriber unit uses digital modulation, compute the average signal strength and signal quality for the entire recording of digital data.

Next, connect the antenna through the cavity filter as shown in Figure 18 below:

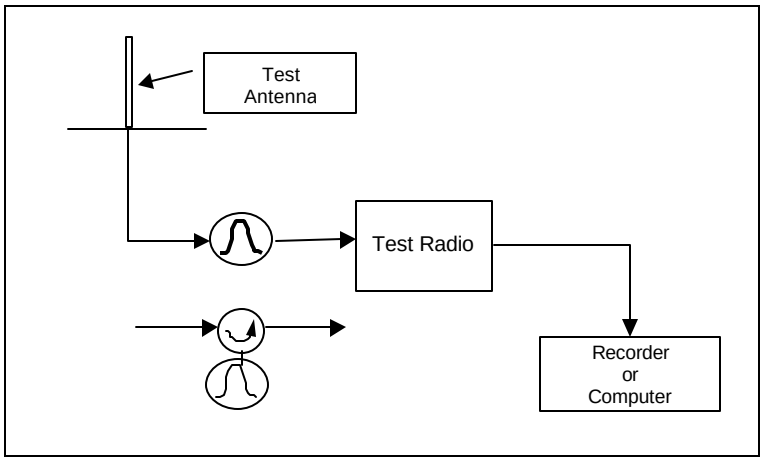


Figure 18 Sideband Noise Determination

Record another two minutes of audio or data on the desired channel. Again listen carefully to the audio recording several times to become familiar with the recovered audio quality. Average the data recorded from digital subscriber units. If the audio quality or average signal quality has improved, the problem is a result of receiver performance limitations.

If it remains about the same, the problem is a result of unwanted RF power being radiated on the desired channel.

It is a special case if any strong signals are less than 300 kHz away from the desired channel. If there are, they are under suspicion right away, especially if they are iDEN signals. A high Q notch filter is needed to perform the above procedure instead of a cavity bandpass filter. This can be achieved by using a bandpass cavity and circulator.

If the above procedures have determined that the problem lies with nearby transmitters, the usual procedures for identifying the exact one or ones apply: If the transmitters are on continuously, shutting them down one at a time can isolate the offender. As this is unpopular with the system operators, a less intrusive method that can be applied if the transmitters are not continuously keyed is to observe the timing of the interference compared to the activity of the nearby transmitters as observed on the spectrum analyzer display.

10 800 MHz BAND EXAMPLE INTERFERENCE SCENARIOS

In most band plans (except Low Band and High Band) there are transition points where the base transmit block of frequencies are adjacent to the base receive block of frequencies. High band and Low band do not follow this due to their earlier development before mobile relay became the dominant type of system deployment. Across this transition there is the potential for base station T to base station R interference in one direction and mobile T to mobile R in the other direction. Within the blocks there is potential for the classic near/far interference scenarios. This can occur as base – mobile interference or mobile – base interference. Recently the frequency of occurrences in the 800 MHz band has become more common, as illustrated in Figure 19.

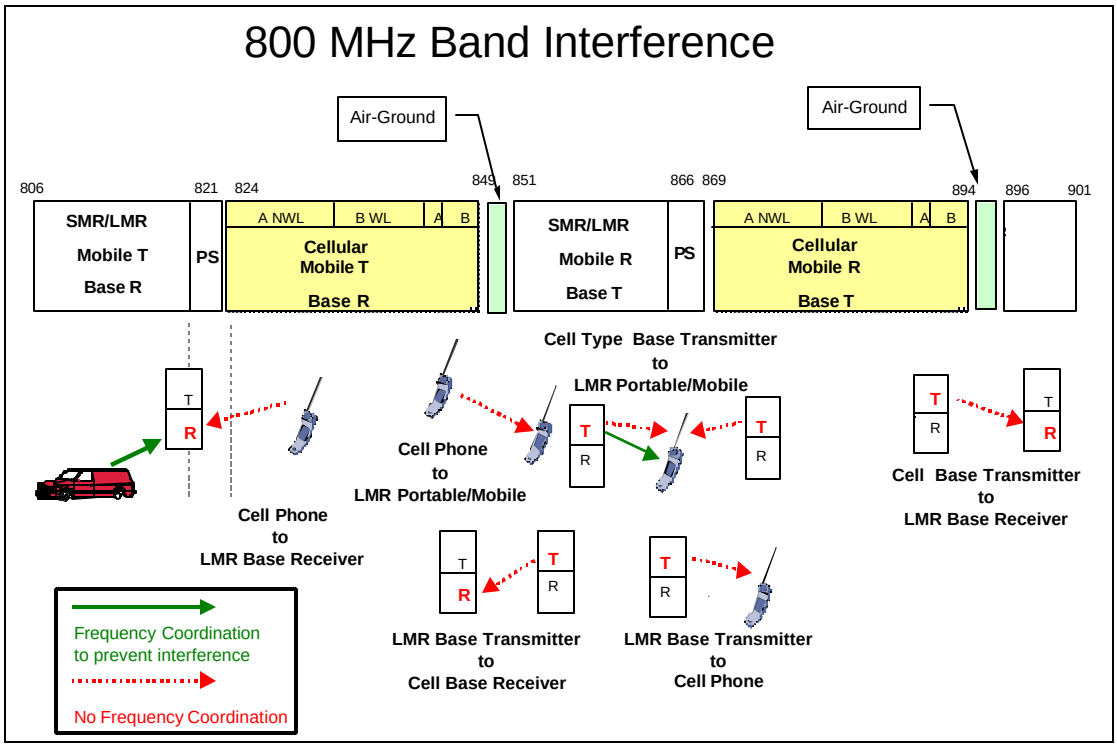


Figure 19 800 MHz Band Interference Scenarios

The following examples (Transmitter to Receiver Cases) will be individually diagrammed, with a table like Figure 20 to show the factors that can create interference, and methods to minimize or prevent that interference.

The logic of the example groupings is that a number describes the type of interference, e.g. Base to Subscriber, but there are different situations because of band breaks or how the systems are deployed.

1 A) LMR[4] Base to LMR Subscriber
  B) SMR Base to LMR Subscriber
  C) Cellular Carrier Base to Public Safety Subscriber
2 LMR Base to Cellular Phone
3 Cellular Base to 900 MHz Base
4 LMR Base to Cellular Base
5 Cellular Subscriber to LMR Subscriber
6 A) LMR Subscriber to LMR Base
  B) Cellular Subscriber to LMR Base

Source of Interference Transmitter Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital
Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			
Victim of Interference Receiver Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital
Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			
Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

Figure 20 Generic Interference Scenario Table

For each example, only the table sections appropriate for that interference scenario will remain legible. Those not appropriate will be darkened. For understanding the table, the rows contain the important information. The columns are not related to each other, other than representing the specific variables being considered in each raw by remaining unshaded.

[4] LMR is Land Mobile Radio

There are two considerations as far as the band is concerned. The cellular band is specifically identified and treated differently than the LMR/SMR band, which includes the exclusive public safety (NPSPAC) portion of the band. For cellular, there are currently three different types of modulations deployed. They include analog, which is referred to as AMPS or NAMPS. AMPS is the original 30 kHz channel bandwidth assignments while NAMPS is a Motorola narrowband version that limits the channel bandwidth to 10 kHz. The Time Division Multiple Access (TDMA) is the 3:1 - 30 kHz channel bandwidth version. Code Division Multiple Access (CDMA) is the 1.23 MegaChip version currently being deployed across markets in the United States. Typically combinations of these modulations can be deployed at any given site. Each cellular carrier selects what they wish to deploy.

In the LMR/SMR band there is currently only analog and some digital, with the digital being principally deployed in the Public Safety band as Project 25 (P-25) systems. However, Nextel has deployed iDEN systems throughout the LMR/SMR band.

Different systems use different transmitter combining techniques. Because LMR systems are narrow band, they typically use Hi-Q cavity combiners, while SMR's frequently uses broadband hybrid combiners to allow frequent frequency changes without requiring site visits.

The Multiple transmitter indication is there to identify where intermodulation products are the easiest to generate.

The duty cycle indicates whether the transmitter(s) are continuous as cellular type deployments require or intermittent as typical of LMR systems use. Note that when a trunking system is involved, the control channel may be continuous while the voice channels are intermittent.

Power Control applies primarily to subscriber units. When power control is available, the subscriber unit limits its output power based on information from the base site. This requires a full duplex path so that the feedback information is constantly updated. For the base station to use power control requires that only a single path be used per base station or that "smart antennas" allow ERP controlled full duplex paths to individual units. This is possible for "interconnect" type calls but isn't possible for dispatch as most of the units are only monitoring the "channel".

The isolation indicated as either High or Low refers to the typical losses involved. There are two different methods used to calculate site isolation. The simplest is to use the port-to-port isolation between the input to one antenna to the output of the other antenna (see the Site Isolation Section 11). The other is to use a propagation model and adjust for the specific antenna gains and propagation losses. The reason for differentiating them is that for the typical scenario being discussed, there is typically between 70 & 75 dB of port-to-port isolation to subscriber units operating in relatively close proximity of the site. Note that the port-to-port isolation eliminates the antenna gains. This makes estimating the effect of OOB emissions much easier. If the OOB emission is -50 dBm, then 70 dB of isolation would produce a -120 dBm interferer at the output of the victim's antenna. However when base-to-base interference is being analyzed, the paths are typically point to point and the antenna gains and minimal free space losses can dramatically reduce the amount of attenuation experienced by the OOB emission. The recent increased usage of "stealth" sites with very short towers has caused a reduction in the amount of site isolation available.

Antenna types are important due to potential directionality.

The victim receiver flag for IM performance is based on the recommendation that 75 dB IMR be a minimal specification. Portable antennas allow some reduction in this requirement as the loss of efficiency acts like an attenuator to potential IM.

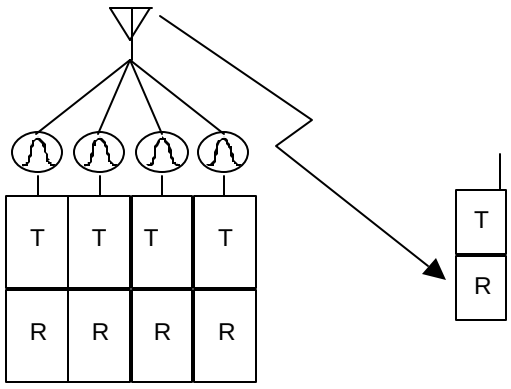
The filtering refers to what can be done at the receiver. Components that are already on frequency cannot be filtered at the victim receiver; they must be filtered at the source. However IM products can be filtered before reaching the active stages of a receiver.

Lastly, the issue of frequency coordination is highlighted. This is an extremely important but not well understood aspect of interference potential. Frequency coordination normally requires that someone (a frequency coordinator) evaluate the use of different candidate frequencies in various defined service areas and then recommends the candidate frequency that doesn't cause interference, or is the best choice from a poor selection. This normally involves evaluating only co-channel usage, but is being expanded to include adjacent channel interference potential. The frequencies are licensed based on the specific site and the ERP being used (referred to as site licensed). SMR's and cellular carriers have special circumstances where they can use any of their inventory of frequencies anywhere in their defined service area, subject to some co-channel reuse limitations where others may be licensed on the same frequencies. As a result, there is no available database of which and where their frequencies are deployed (referred to as area licensed). This allows them the capability of rapidly changing their frequency plan to allow new sites to be deployed thereby adding capacity. A frequency plan covers a wide are a and may be coordinated nationwide. A single change can ripple across the entire system, making exceptions more difficult.

The types of coordination are also listed. In some cases a guard band is provided to take the place of frequency coordination. It is implied that when a different band is used, the requirement for frequency coordination is eliminated. Unfortunately, with the wide band and high OOBE of some of the more complex modulations, this assumption is not longer true. The wide band OOBE is radiated into the adjacent or guard band and must be dealt with to minimize interference potential. Cellular type systems utilize frequency reuse plans. This allows a structured starting point for doing internal frequency coordination. The key point is that they are primarily concerned with their own intra-system interference. This type of frequency planning (interference limited) is based on the fact that when the interference gets strong enough, the system will be able to provide an alternative resource that isn't being interfered with.

The other two references under frequency coordination refer to whether or not the frequencies are close (a small frequency offset) or whether units can get into close physical proximity.

10.1 CASE 1A, LMR BASE TO LMR SUBSCRIBER



Source of Interference Transmitter Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			

Victim of Interference Receiver Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			

Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

Figure 21 Case 1A LMR Base to LMR Subscriber

This is a very common scenario where a subscriber unit can be very close to a site that generates interference. In this case, the transmitters have Hi-Q cavities to limit the OOBE. The frequency coordination should have eliminated co-

channel and adjacent channel interference. If the receiver has an IMR specification of ≥75 dB this scenario would normally be interference free. However, it the undesired IM sources are considerably stronger than the desired signal, the IM "Noise" can prevent the required C/(I+N) from being realized.

However there are some situations where intra site interference can occur for users of that site when they are in close proximity. Figure 21 doesn't show the base receive site configuration. If there is low isolation between the base Transmit and base Receive combiners, then when two subscribers in close proximity to the site transmit a temporary lockup scenario can occur.

Consider the simple two-transmitter/receiver configuration shown in Figure 22. When the subscribers are close to the site, they produce strong signals that can enter the transmitter antenna system. Here the difference in frequencies cross modulate at a loose connector producing the necessary products which are re-radiated to keep the receivers satisfied that they are seeing the correct CTCSS tone or Trunking Connect Tone. When one subscriber de-keys, the cross modulation generates an on frequency interferer that continues to repeat the weak interferer with the other users audio. It is not until the second subscriber de-keys that the lockup will be released.

This can only be resolved by isolating the Transmit and Receive systems, e.g. by vertical antenna separation, and making sure that there are no extraneous locations for this IM to occur. This can also occur externally on the site, such as on rusted tower bolts, etc. For trunking, the use of transmission trunking forces the repeater to also immediately dekey thereby preventing this phenomenon.

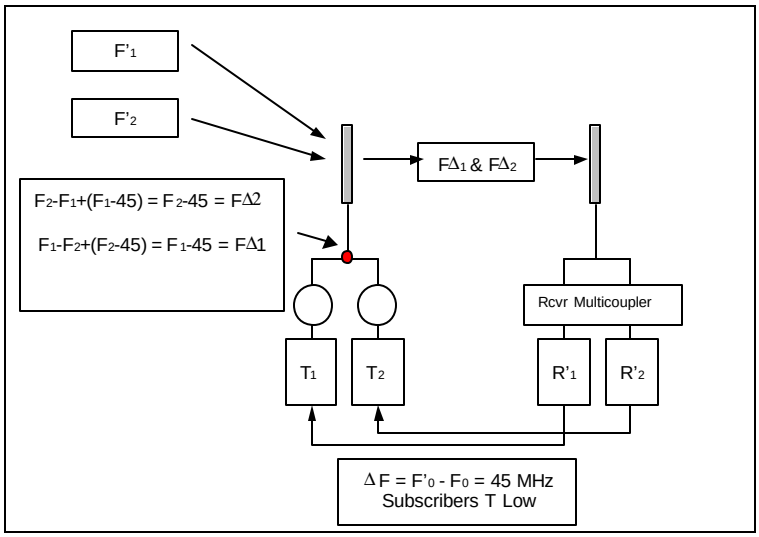
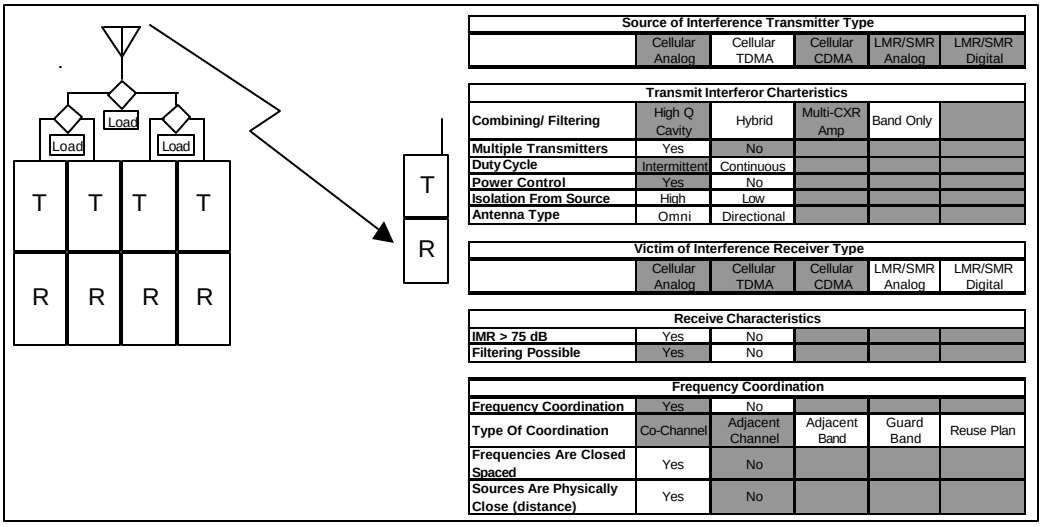


Figure 22 Intermodulation Example

10.2 CASE 1B, IDEN SITE TO LMR SUBSCRIBERS

In Case 1B, the interferer is an iDEN site deploying multiple transmitters as shown in Figure 23. This is a high potential interference scenario due to the fact that the transmitters are hybrid combined and therefore only have limited in-band filtering. The carriers are continuously keyed and subscribers can get in close proximity both in frequency and space with no frequency coordination.

The worst case involves combinations of frequencies that cause on-frequency receiver IM products. This is especially detrimental to receivers with low IMR specifications. If there is sufficient desired signal strength, inserting an attenuator in front of the receiver will reduce both the desired and undesired signals but the IM product of the multiple undesired signals will be suppressed more than the desired signal is attenuated. A building acts much as an attenuator. Building attenuation will reduce the desired by a given amount amount, but it also reduce the IM^3 product by three times the building attenuation, allowing the desired to achieve a usable C/(I+N).



Source of Interference Transmitter Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			

Victim of Interference Receiver Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			

Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

Figure 23 Case 1B, SMR iDEN Site to LMR Subscriber

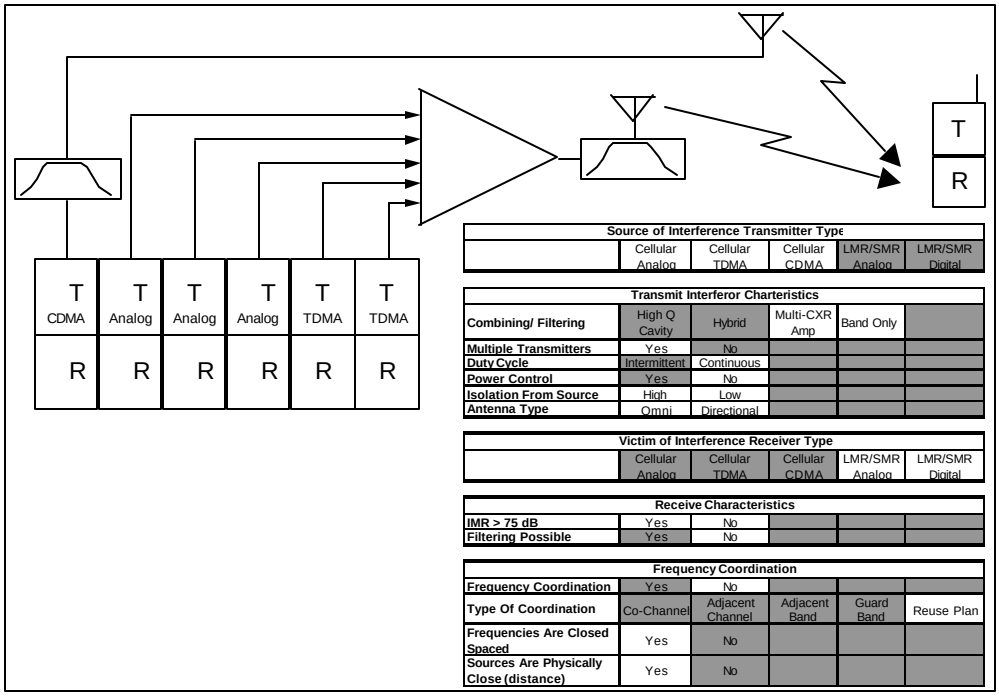
The coordination and reassignment of frequencies deployed at a particular site can eliminate the IMR, allowing the situation to be resolved.

10.3 CASE 1C, CELLULAR CARRIER TO PUBLIC SAFETY SUBSCRIBER

Case 1C is similar to the other Case 1 scenarios except that the interference emanates from transmitters in an adjacent band (Figure 24). The symptoms are similar to the other Case 1 scenarios as this produces coverage holes around the offending site. Due to pressures for minimizing antenna sites, many of the cellular carriers are co-locating. This greatly increases the potential for IMR due to the extremely high number of frequencies involved. The interference potential is increasing as cellular abandons analog for the digital transmitters with higher OOBE and eliminates Hi-Q cavities, deploying multi-carrier transmitters with only band filtering.

This scenario is especially destructive with older portables with 65 dB IMR specifications and preselectors that are designed for International in addition to Domestic distribution. That is because the International band for LMR extends 1 MHz into the Domestic cellular band. This situation is further aggravated if the portables utilize vehicular adapter consoles as this eliminates the portable antenna inefficiency and may even have mobile gain antennas.

Under these circumstances, 5th order IM becomes commonplace. It is not unreasonable for a 20 channel trunked system that has units that operate within ¼ mile of a combined carrier site to have over 1000 IM products distributed randomly over the various frequencies in the 866 - 869 MHz band. For this case, the highest receiver IM performance is mandatory!



Source of Interference Transmitter Type	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			

Victim of Interference Receiver Type	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			

Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

Figure 24 Case 1C, Cellular Carrier Base to Public Safety Subscriber

The Case 1 scenarios all have a similar pattern of interference, wherein the interference potential is maximized where the desired signal is weakest while the interferers are the strongest. This is the classic Near/Far problem (discussed earlier in this document). A typical system wide scenario might look something like Figure 25 with the LMR base in the center. In this case, both Base to Mobile and subscriber-to-subscriber interference is portrayed. Only consider the size of the red zones around interfering sites at this time. The green distribution will be discussed later.

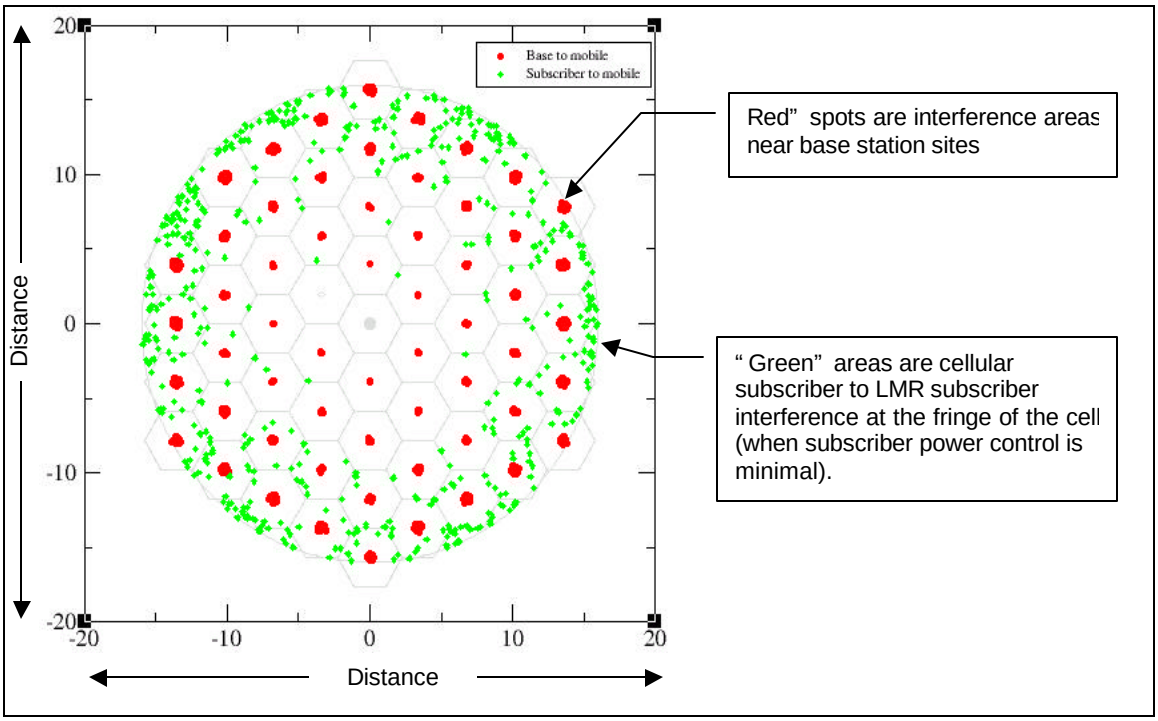
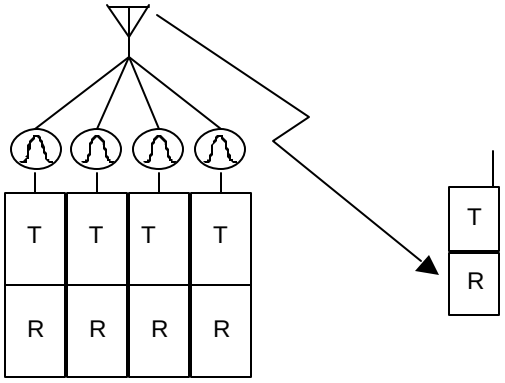


Figure 25 Base to Mobile and Mobile-to-Mobile Interference Pattern

10.4 CASE 2, LMR BASE TO CELLULAR PHONE

Case 2 essentially is the opposite direction from Case 1, where the LMR base station creates coverage holes around its sites for cellular subscribers (Figure 26). Although this case could cause limited interference, it is unlikely due to the fact that the stations are well filtered and the cellular subscribers have alternate sites to be handed over to in case of IMR type interference. Only Public Safety stations operate in the 866 -869 MHz band so their deployment density is quite low compared to the cellular deployment. Also, the LMR transmitters have an internal filter that provides protection above 869 MHz and the HI-Q cavities also limit any OOB emissions.



Source of Interference Transmitter Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			

Victim of Interference Receiver Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			

Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

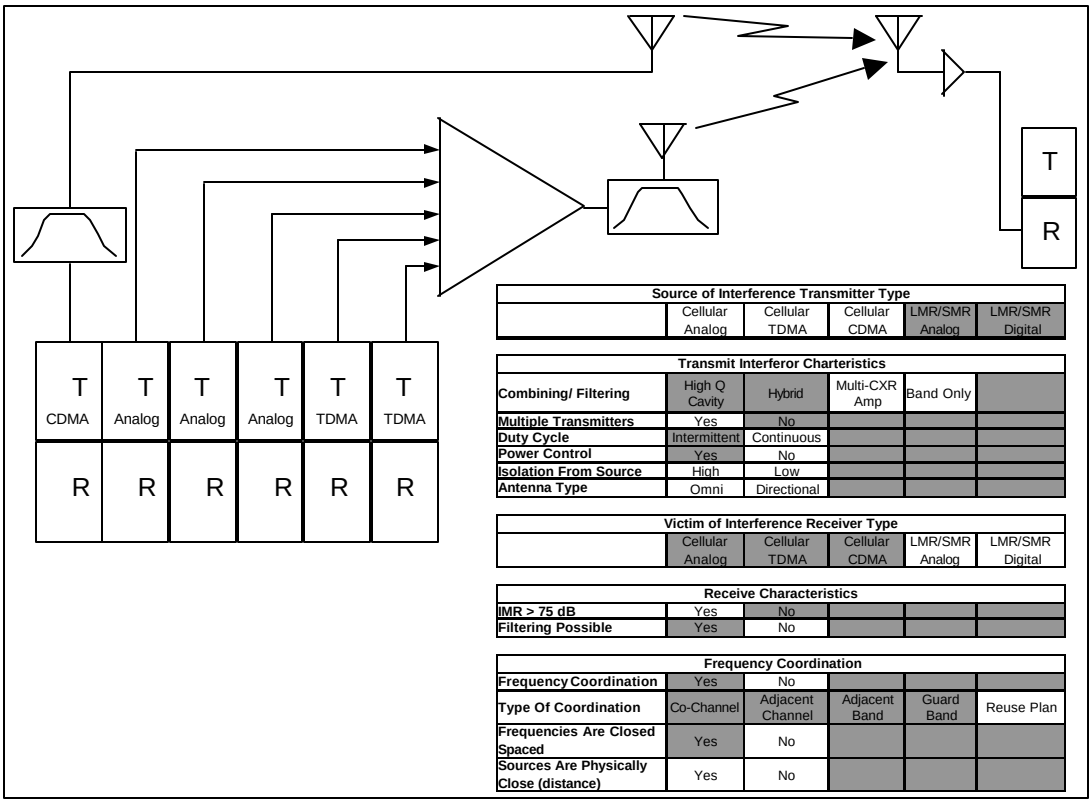
Figure 26 Case 2, LMR Base Station to Cellular Phone

10.5 CASE 3, CELLULAR BASE TO 900 MHZ BASE

Case 3 is the only 900 MHz scenario that will be evaluated (Figure 27). There are several documented cases of this type of interference, primarily caused by the Cellular B carrier. The high OOBE of the various modulations and combinations of modulations along with only band filtering can produce a fairly high noise floor. In this case the noise is amplified by the gain of the transmit antenna and also the receive antenna. Because it is base-to-base interference, the paths often have only free space losses associated with them. At 900 MHz the free space loss between dipoles at 1 mile is 91 dB, but this is reduced by as much as 23 dBd of antenna gains. Thus the isolation is less than 70 dB at one mile. However, sites can be closer than one mile and have even stronger interference potential. When CDMA and mixtures of analog or narrow band analog are present, the potential of IM increases. There is potential IM in the cellular antenna structure that would prevent any filtering at the 900 MHz LMR site from being effective. If CDMA is deployed, then there is also the potential of multiple sources of interference being received. When coupled with high performance TTA' s (Tower Top Amplifiers) to compensate for low power 900 MHz products, the probability of interference is increased.

The configuration shown in Figure 27 is very important. Note that the CDMA is on a separate antenna from the narrow band modulations. If they were combined, the resulting IM of the CDMA with the narrow band carriers can create a very strong and wide noise source. Therefore the combining of wide band and narrow band signals in a linear amplifier is not recommended and should be avoided!

Interference from nearby Paging transmitters operating without cavity filtering is also a frequent source of reduced coverage for 900 MHz base receivers. Excess reserve gain in the TTAs on sites with high ambient noise levels will also reduce coverage.



Source of Interference Transmitter Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			

Victim of Interference Receiver Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

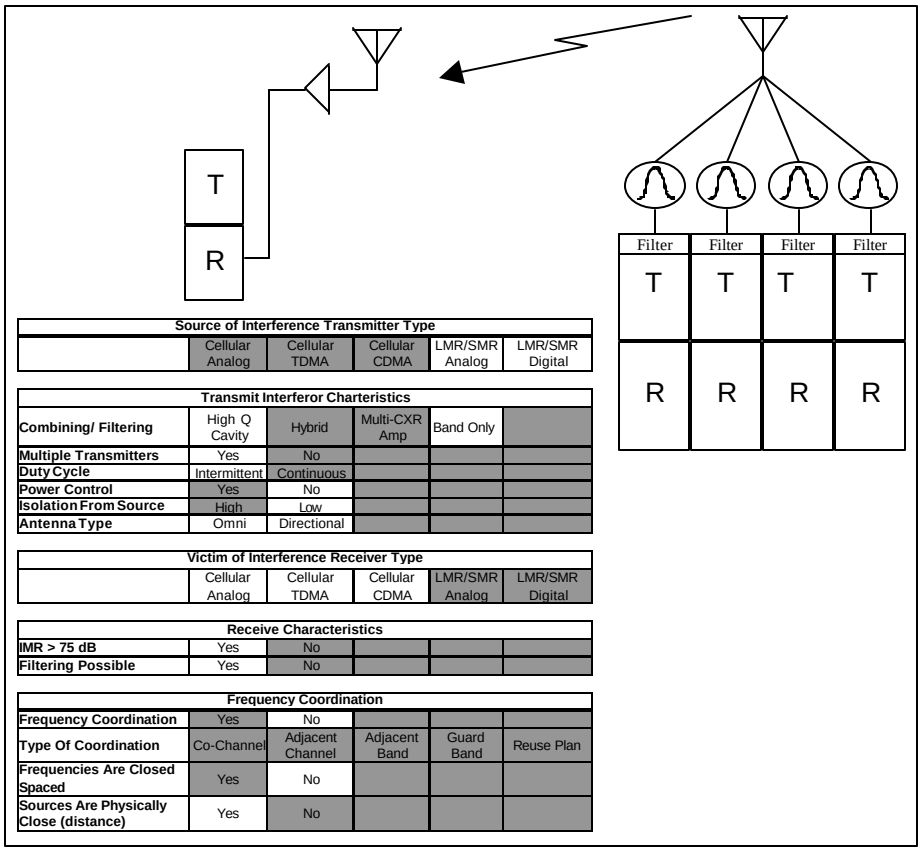
Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			

Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

Figure 27 Case 3, Cellular Transmitters to 900 MHz Base Receivers

10.6 CASE 4, LMR BASE TO CELLULAR BASE

Case 4 has LMR base stations causing potential interference to Cellular Base station receivers (Figure 28). There is little likelihood of this because there is a 2 MHz guard band between the LMR band and the cellular band. Motorola LMR base stations are heavily filtered and provide over 50 dB of suppression at the high end of the base receive band as shown in Figure 29. This coupled with Hi-Q cavity filters should suppress OOB emissions adequately to prevent cellular base stations from being interfered with. Even if they were interfered with, the density of LMR base stations is quite low compared to cellular base stations. The cellular system's ability to hand over subscribers to other resources make this type of interference even less likely.



Source of Interference Transmitter Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Transmit Interferor Charteristics					
Combining/ Filtering	High Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	Yes	No			
Duty Cycle	Intermittent	Continuous			
Power Control	Yes	No			
Isolation From Source	High	Low			
Antenna Type	Omni	Directional			

Victim of Interference Receiver Type					
	Cellular Analog	Cellular TDMA	Cellular CDMA	LMR/SMR Analog	LMR/SMR Digital

Receive Characteristics					
IMR > 75 dB	Yes	No			
Filtering Possible	Yes	No			

Frequency Coordination					
Frequency Coordination	Yes	No			
Type Of Coordination	Co-Channel	Adjacent Channel	Adjacent Band	Guard Band	Reuse Plan
Frequencies Are Closed Spaced	Yes	No			
Sources Are Physically Close (distance)	Yes	No			

Figure 28 Case 4, LMR Base to Cellular Base

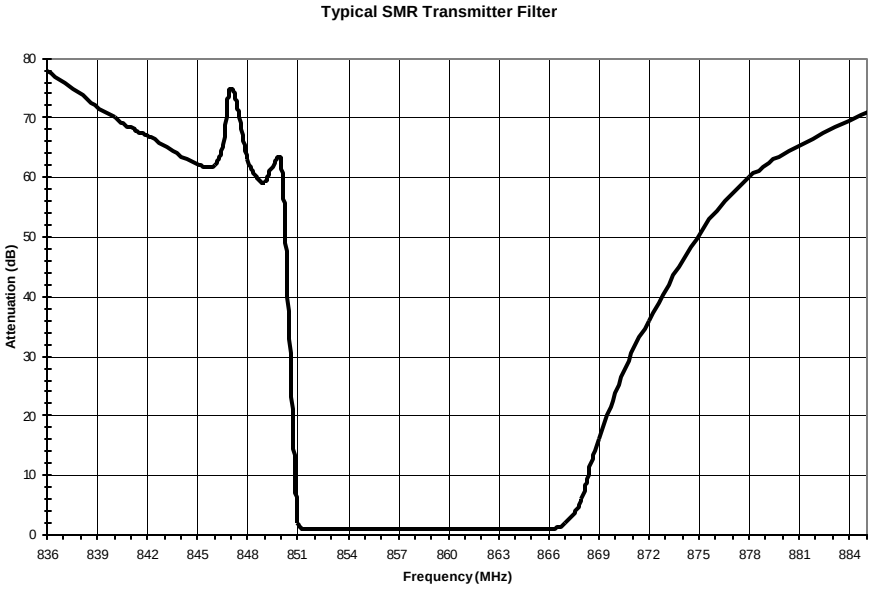
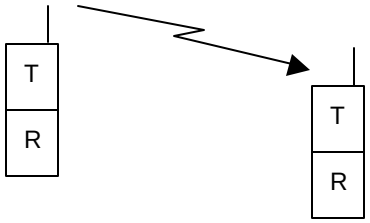


Figure 29 Typical Motorola iDEN Base Station Internal Bandpass Filter

10.7 CASE 5, CELLULAR SUBSCRIBER TO LMR SUBSCRIBER

Case 5 is where Cellular Subscriber units can interfere with LMR subscriber units (Figure 30). There are several mechanisms that need to be discussed. First there is the direct subscriber-to-subscriber interference. Here the high allowable OOBE of cellular subscriber units can cause localized interference around those units when the cellular units are far from their sites (power control doesn' t limit the power output) and the LMR unit is far from its desired signal. Figure 21 shows this as the light green blotches associated with the fringe of the cell sites.

The use of CDMA subscriber units is more worrisome as multiple units can be transmitting simultaneously on the same wideband frequency. Often a large population of cellular users coincident with a major public safety event can occur. Now the large population of subscribers in close proximity both in frequency and distance can increase the potential for interference. In addition, if the public safety event is close to a cellular site and a large population of cellular subscribers occurs, then there is also the opportunity for receiver IM to occur. In a well documented case in Canada, intermittent interference occurred to the direct mode of fire fighter portables.



Interference Scenario					
Source on Interference					
Interference Source Transmitter Type	Cellular			LMR / SMR	
	Analog	TDMA	CDMA	Analog	Digital
Combining / Filtering	Hi Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	YES*	NO			
Duty Cycle	Intermittent	Continuous			
Power Control	YES	NO			
Isolation from Source	High	Low			
Antenna Type	Omni	Directional			
Victim					
IMR > 75 dB	YES	NO			
Filtering Possible	YES	NO			
Frequency Coordination					
Frequency Coordination	YES	NO			
Type of Coordination	Co-Chan	Adj-Chan	Adj-Band	Guard Band	Reuse Plan
Frequencies are close spaced	YES	NO			
Sources are physically close (distance)	YES	NO			

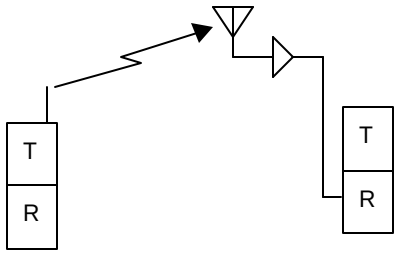
Figure 30 Case 5, Cellular Subscriber to LMR Subscriber

10.8 CASE 6, SUBSCRIBER TO LMR BASE

Case 6 involves interference from subscriber units to LMR base receivers (Figures 31 & 32). Again this is a classic Near/Far scenario. Receiver voting in the LMR system is the best defense for this type of interference, recognizing that for analog systems strong interference can be misinterpreted as a desired signal. Proper use of sub-audible codes can mitigate the undesired voting potential with the voting offering the decreased likelihood that multiple interfering scenarios occur simultaneously.

Case 6A involves the in-band LMR case. In many systems, TTA' s are used to increase sensitivity for fringe talk-in. However, this also increases the susceptibility to interference. A special case is where the LMR subscriber is a control station. This can produce the example of system cross talk and temporary lockup previously described. The area of maximum impact is a reduction in the base talk-in coverage.

Case 6B is the cellular case. Here subscriber units have power control so they would have minimal impact if the cellular site and LMR sites are co-located.



Interference Scenario					
Source on Interference					
Interference Source Transmitter Type	Cellular			LMR / SMR	
	Analog	TDMA	CDMA	Analog	Digital
Combining / Filtering	Hi Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	YES*	NO			
Duty Cycle	Intermittent	Continuous			
Power Control	YES	NO			
Isolation from Source	High	Low			
Antenna Type	Omni	Directional			
Victim					
IMR > 75 dB	YES	NO			
Filtering Possible	YES	NO			
Frequency Coordination					
Frequency Coordination	YES	NO			
Type of Coordination	Co-Chan	Adj-Chan	Adj-Band	Guard Band	Reuse Plan
Frequencies are close spaced	YES	NO			
Sources are physically close (distance)	YES	NO			

Figure 31 Case 6A, LMR Subscriber to LMR Base

Interference Scenario					
Source on Interference					
Interference Source Transmitter Type	Cellular			LMR / SMR	
	Analog	TDMA	CDMA	Analog	Digital
Combining / Filtering	Hi Q Cavity	Hybrid	Multi-CXR Amp	Band Only	
Multiple Transmitters	YES*	NO			
Duty Cycle	Intermittent	Continuous			
Power Control	YES	NO			
Isolation from Source	High	Low			
Antenna Type	Omni	Directional			
Victim					
IMR > 75 dB	YES	NO			
Filtering Possible	YES	NO			
Frequency Coordination					
Frequency Coordination	YES	NO			
Type of Coordination	Co-Chan	Adj-Chan	Adj-Band	Guard Band	Reuse Plan
Frequencies are close spaced	YES	NO			
Sources are physically close (distance)	YES	NO			

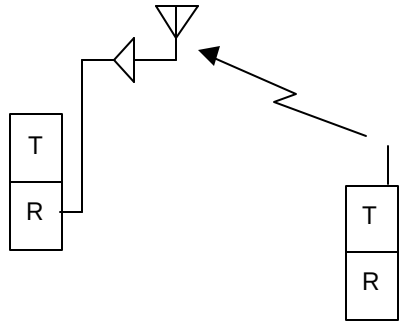


Figure 32 Case 6B, Cellular Subscriber to LMR Base

The use of macro diversity (voting) is the best tool for the prevention of this type of interference.

Figure 33 depicts a special case where the cellular system and LMR system are co-located. This essentially minimizes the size of the reduced coverage. If a LMR site were at the junction of three cells, then the potential for multiple interferers transmitting at maximum output power would produce a much worse case. Fixed cellular units, similar to LMR control stations are also a potential problem. In this case the small red diamonds represent the cellular type deployment of sites.

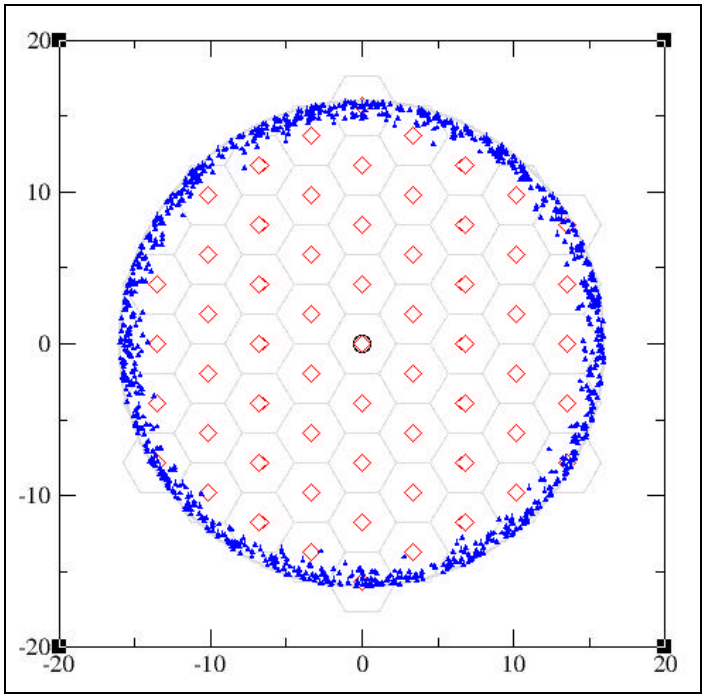


Figure 33 Co-Located Cellular System and LMR System

11 SITE ISOLATION

As described earlier, there are two ways of predicting the losses between a base station and a subscriber unit at close distances. The antenna patterns aren't completely formed and in many cases there are little to no obstructions to increase the losses.

Numerous investigations have been made. Dr. Garry Hess reported on this in his books, and numerous measurements have been made while investigating interference cases.

Figures 35, 36 and 37 show the results of measurements made in the Motorola Schaumburg parking lot many years ago. Note that except for the very low antenna case, all the port-to-port isolation measurements produced ≥65 dB of path loss [isolation] for omni directional antennas. The near/far field transition occurs at ~36 feet. This particular pattern is very important as lower antenna heights are being deployed and this lowers the anticipated site isolation by eliminating the additional isolation produced by the transmit antenna pattern.

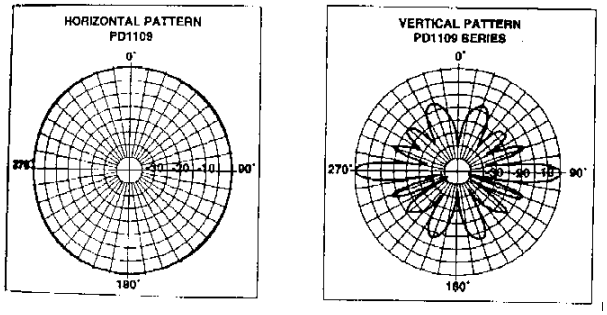


Figure 34 PD 1109 Antenna Pattern.

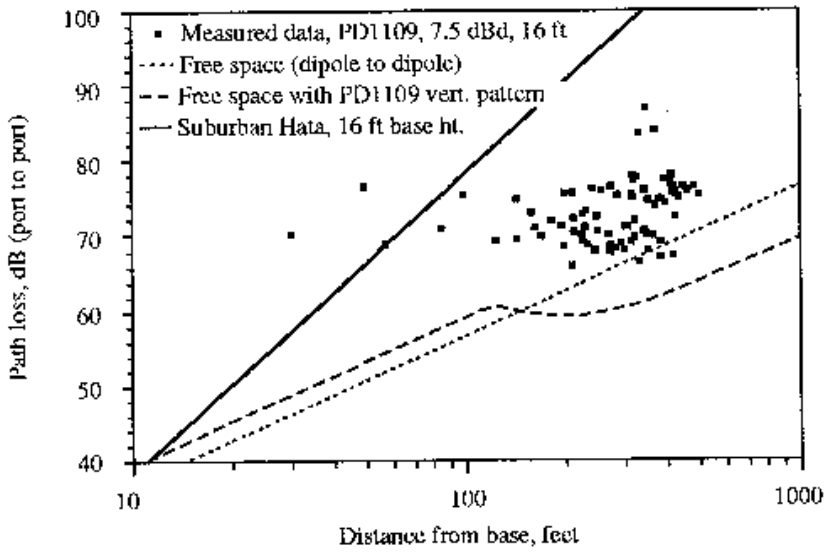


Figure 35 PD1109 @ 16 Ft Above Receive Antenna

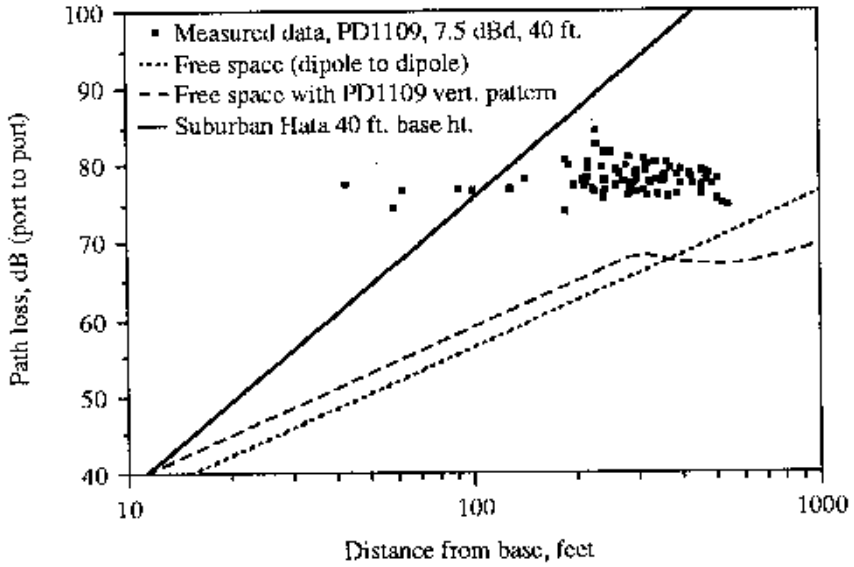


Figure 36 PD1109 @ 40 Ft Above Receive Antenna

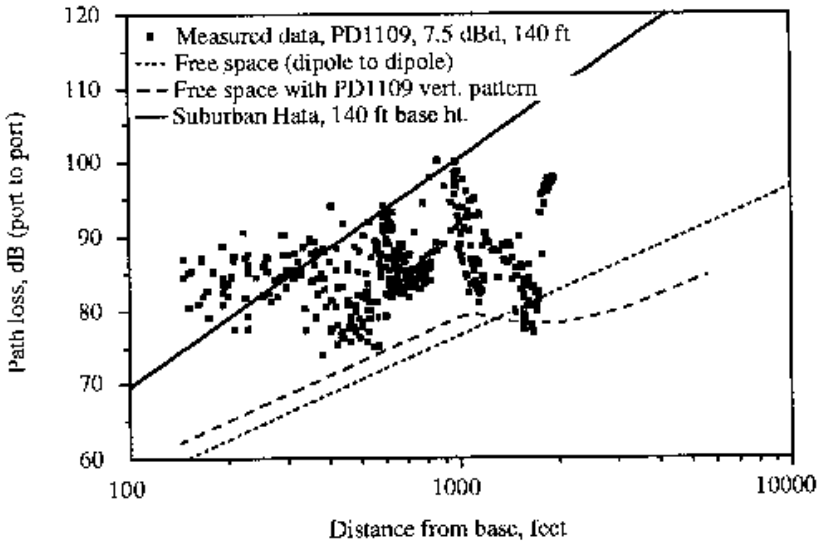


Figure 37 PD1109 @ 140 Ft Above Receive Antenna

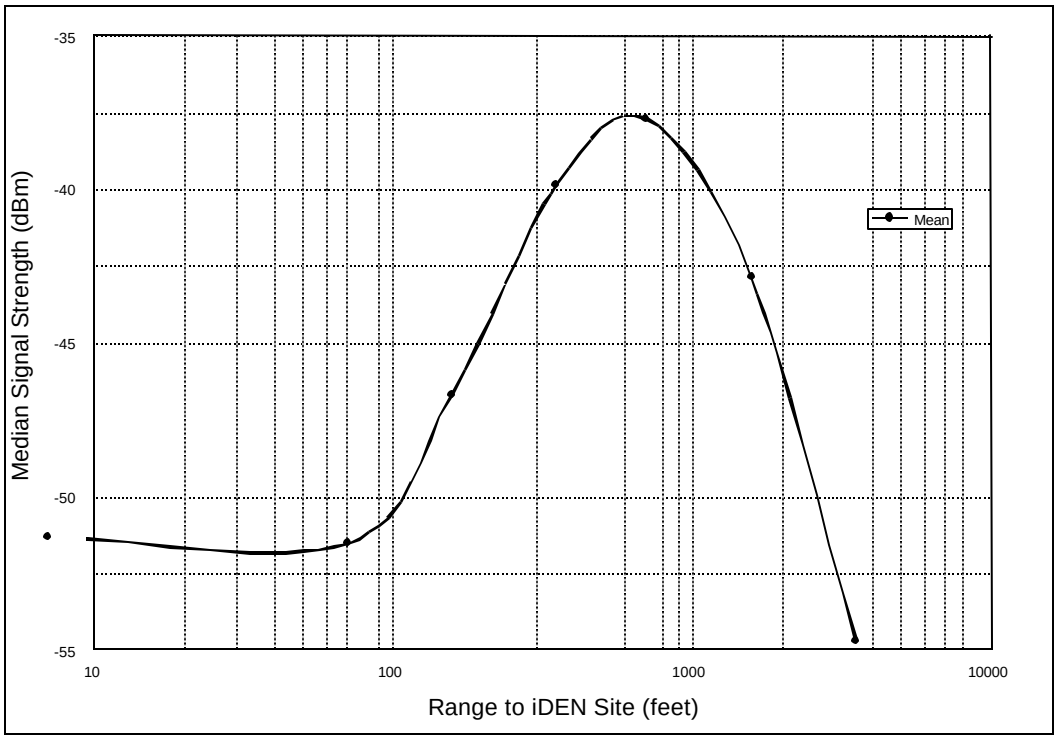


Figure 38 Median Signal Strength Model for Measured iDEN Sites

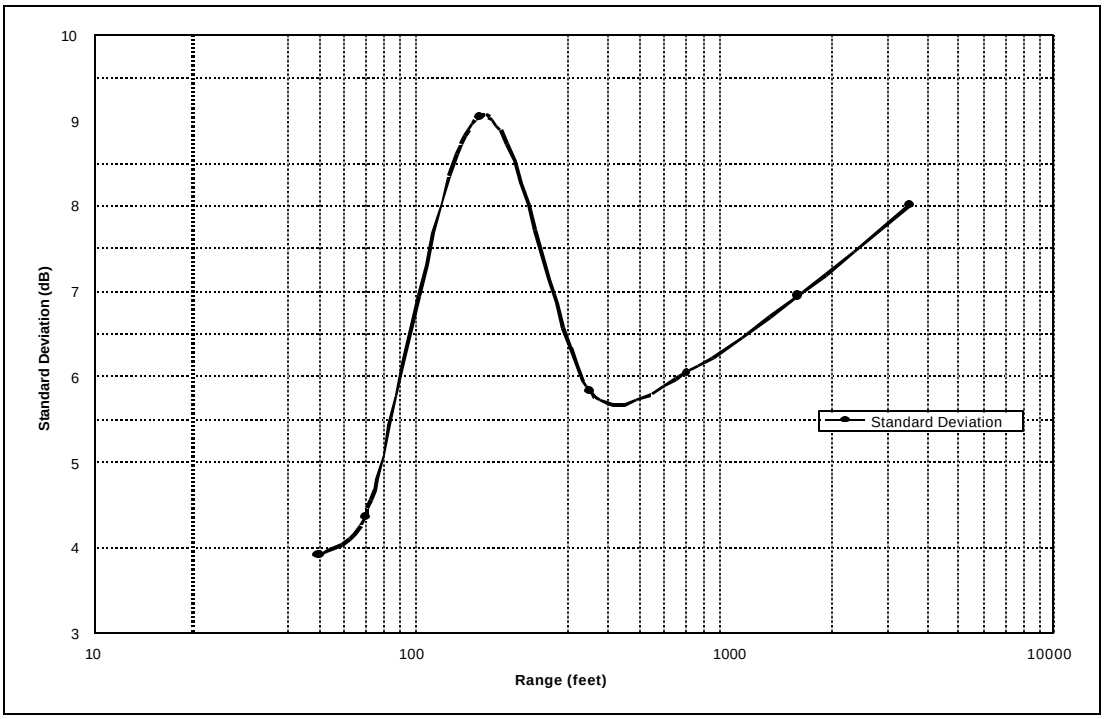


Figure 39 Standard Deviation of Received Power from iDEN Sites vs. Range (measured)

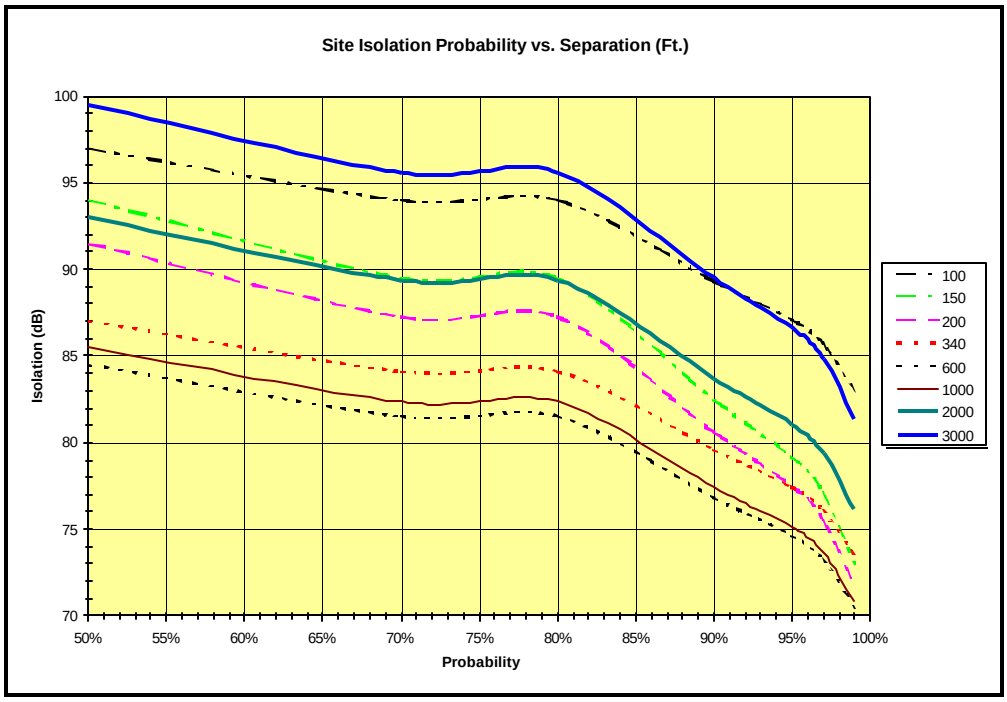


Figure 40 Calculated Probability of Site Isolation

Compare this to a simple spreadsheet model. This allows a coarse look at the port-to-port isolation (Figure 41). The scenario consists of a tower 100 feet tall, a 105° sectored antenna with 11.8 dBd gain, and an arbitrary 10 dB of clutter loss. The primary point to note is that the isolation is greater than 75 dB and that the general shape of the graph is quite similar to the standard deviation of field measurements (Figure 39). The standard deviation is highest in the region closest to the base of the tower, as this is where nulling of the antenna sidelobes occurs. Since there were many different types of antennas involved in the data, the largest variations occur in this region.

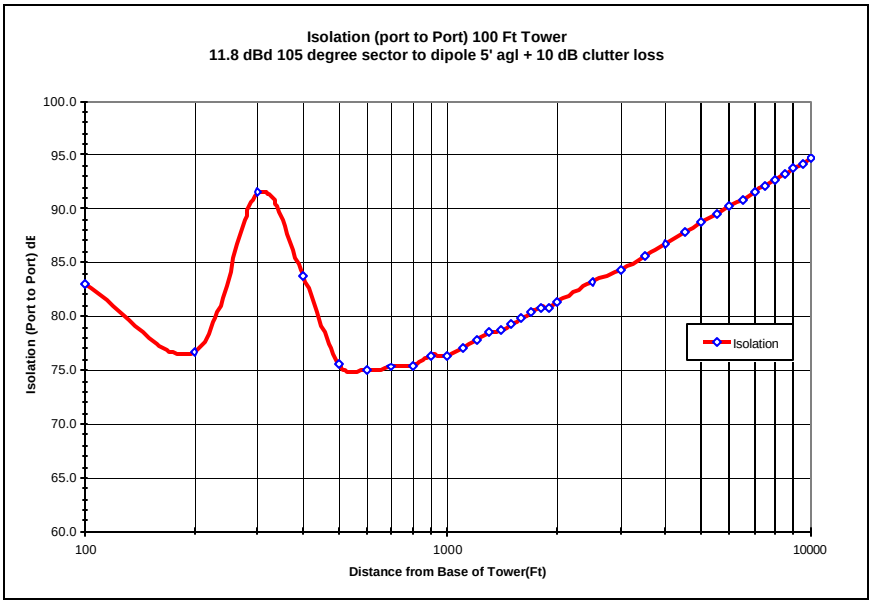


Figure 41 Port-to-Port Isolation

12 RESOLVING INTERFERENCE

The following sections describe actions that can be taken to minimize Radio Frequency Interference (RFI) between systems operating at 800 MHz within the same geographical location. These guidelines are general in nature and these same techniques and philosophies can be applied to most any systems experiencing RFI. Thorough testing will determine actual causes (in some cases, multiple causes) and sources of interference that the system is experiencing. Therefore, thorough testing should precede and follow the application of any solutions proposed below to determine the appropriate actions required and the effectiveness of the deployed solution.

12.1 RECOMMENDED RESOLUTION PROCESS:

1. Identify performance issue as RF Interference.
2. Identify potential source(s) of the interference.
3. Contact other system operators to cooperatively identify the interference issue. The correct and accurate assessment of the interference mechanism is critical to developing an action plan that will rectify the situation.
4. FCC rules stipulate that the two system licensees must work cooperatively to resolve any reports of interference.
5. Implement required changes.
6. Monitor performance.
7. Maintain communications with other operators as the site/system evolves.

12.2 METHODS TO REDUCE INTERFERENCE OF SPECIFIC TYPES

12.2.1 POSSIBLE ACTIONS TO REDUCE THE EFFECTS OF TRANSMITTER SIDEBAND NOISE:

- Change frequencies to increase frequency spacing between the channels.
- Lower transmitter power as much as possible. This can reduce coverage and move traffic to surrounding sites if there is sufficient coverage overlap. The resulting reduction in carried load may allow a reduction in the number of transmitters that will also reduce the noise floor rise due to transmitter sideband noise.
- Increasing the center of radiation on the undesiredtransmit antennas > 80' AGL will increase the local path loss to the affected units and reduce the noise floor rise due to antenna discrimination.
- Increase desired signal level. This may be accomplished by increasing desired ERP (more power or higher gain antennas) or adding desired sites.
- Co-locating sites will maximize the desired signal strength where the undesired energy is strongest.
- Change antennas in an attempt to reduce the undesired signal level in the immediate area of a site. This may be a change of pattern, the removal of down-tilt, less energy in lower lobes or higher gain (narrower vertical beamwidth).
- Use cavity combiners instead of hybrid combiners. Use only when the recommended tests have demonstrated that cavities will help. Note that some auto-tune cavity combiners may not work properly with iDEN' s Quad-QAM modulation.
- Escalate the construction of new sites in surrounding areas to allow further reduction in ERP.
- Swap frequencies or segregate spectrum. These alternatives would require FCC approval.

12.2.2 POSSIBLE ACTIONS TO REDUCE THE EFFECTS OF PORTABLE RECEIVER IM

- Increase desired signal strength by adding sites or changing antennas.
- Avoid using portables with an IM specification < 75 dB. Portables with higher IM specifications are much more immune to IM interference.
- Design systems for in-building coverage. This will present higher desired signal levels "on-the-street", overriding IM interference where it is more likely to occur - on the street near low sites. (The undesired signal strengths are typically attenuated inside buildings and the strength of the IM mix is typically insufficient to interfere with the desired signal.) This may allow portables with lower IM specifications (i.e. IM ≤ 70 dB) to be utilized.
- Determine the frequencies being used by each operator. Attempt to coordinate to prevent creating third and fifth order Intermodulation (IM) products. Change the receive and transmit frequency plan so that IM products do not fall on receive channels.
- Reduce the ERP of the undesired transmit channels as much as possible. A 1 dB reduction in ERP will reduce 3rd order products by 3 dB and 5th order products by 5dB. This reduction in ERP is likely to reduce the number of transmitters that can contribute to mixes as the traffic is offloaded to surrounding sites.
- Change portable antennas. Reduce portable antenna gain if there is sufficient desired signal. Each 1 dB reduction in gain will reduce 3rd order products in the receiver front-end by 3 dB and 5th order products by 5 dB.
- Use voting receivers to minimize the impact of portable interference to base receivers.
- Sweep the transmit antenna system or check the tuning on the combiners to reduce transmitter generated IM.
- Swap frequencies or segregate spectrum. These alternatives would require FCC approval. Consolidated spectrum would tend to create tightly clumped IM products. Existing interlaced frequency allocations spread out the IM products across much of the band.

12.2.3 POSSIBLE ACTIONS TO REDUCE THE POSSIBILITY OF INTERFERENCE IN THE FUTURE

- Maintain constant communication between license holders to coordinate frequency deployments and system expansion plans and actions.
- Co-locate sites whenever possible.
- Swap frequencies to remove interlaced frequency assignments - requires FCC approval.
- Segregate frequencies into sub-bands and either minimize use of frequencies at sub-band edge or establish guard bands between sub-bands.

12.3 INTERFERENCE REDUCTION METHODS

The following section describes various methods for minimizing or eliminating interference. Most often, the interference is not totally eliminated, it is just reduced to levels that where acceptable communications can be maintained.

Multiple methods must often be employed. One method may reduce a certain kind of interference and then a different type of interference may then be revealed. Only thorough testing will completely characterize the interference types that are occurring in any given situation. The "best" solution for any given case will depend on many factors including the individual circumstances of the location. What worked in one case may not work as well in another case. For example, a change of frequencies in one case may not be possible in another case.

These solutions are offered as a menu of possible choices. The optimal applications of the various solutions will be determined by the details of each and every situation.

12.3.1 CHANGE FREQUENCY PAIRS

Changing frequencies is a relatively easy way to avoid both Side Band Noise (SBN) and Intermodulation (IM) interference if this flexibility exists in any given case. Changing frequencies in a frequency reuse system has multiple effects that ripple across many sites if not the entire service area.

Increase the frequency spacing between channels to address sideband noise issues. Moving one or more close spaced frequencies can reduce the amount of sideband noise that can fall on nearby channels. Frequency spacings of 150 KHz or greater permits the use of filtering on the transmitter. Greater frequency spacings generally offer increased protection.

Changing transmit frequencies involved in an IM product can be used to move the mix to a channel that is not used in the area or to a frequency that is more immune to the IM product. Receiver frequencies can be moved from channels where IM mixes occur.

In some cases an exchange of frequencies is another possibility where and when this is permitted. Ideally, a segregation of frequency utilization into sub-bands offers much more protection as compared to situations where frequencies assignments are interlaced. IM may be generated, but it is more likely to be within ones own sub-band where the system design can mitigate it. IM products generated at the source and outside the sub-band can be filtered.

12.3.2 REDUCE ERP OR SIGNAL STRENGTH OF THE UNDESIRED SIGNAL

One way to reduce interference is to reduce the signal strength of undesired signals. This may be difficult at times as the amount of reduction required may be sufficient as to negatively impact communications on those channels. But when possible, this can be effective solution.

In some cases the reduction may be aimed solely at the sideband energy on a given channel or set of channels. In other cases, a reduction in the radiated power of the main carrier is required.

Adding filters (typically RF cavity filters) between a transmitter and the antenna may by used to reduce the energy radiated in channels separated from the transmit frequency. Cavity filters typically offer little reduction within 150 kHz on either side of the carrier frequency. Cavity filter will typically offer more protection at greater frequency separations. Ceramic autotune cavity filers and combiners provide higher Q filters while offering more flexibility to change frequencies when needed. Note that some autotune cavities may not function with iDEN modulation.

Lowering transmitter ERP can help control both sideband noise levels as well as the power in an IM mix. Due to the nature of IM interference, a 1 dB reduction in ERP on frequencies involved in a 3rd order mix can reduce the IM product level inside a portable receiver front-end by 3 dB. For 5th order mixes, a 1 dB reduction can reduce the IM level by 5 dB. A 1-2 dB reduction in transmitter ERP may be enough to reduce the IM levels to acceptable levels. A reduction in transmit ERP may reduce the size of a cell and the traffic carrying capacity of that cell. A drop in offered load may also allow one or two transmitters to be turned off, thereby decreasing the interference potential of the cell.

ERP can be simply reduced by reducing the transmitter power. This change affects the entire cell. A more selective way to change the ERP to specific location is to change the antenna gain pattern. The area where a reduction is desired may be a specific spot or it may be the area within a certain distance of the site. Reducing antenna gain , reducing down-tilt, or using an antenna with greater lobe reduction or using a different gain antenna can all be used to reduce the signal strength near a site where there is an abundance of signal strength.

There are several more creative ways to reduce IM interference by reducing the levels of the signals involved in the process. A portable with increased immunity against the IM products is one of the best methods of protecting oneself from IM interference no matter what the sources are. Such a portable generally has better all around performance and the added expense is well worth the investment, especially given the growth in wireless and the increased chances of operating near other wireless devices. A portable with an IM spec of 75 dB or greater is sufficient protection against almost all IM in studied and expected scenarios. Receiver specification improvements typically require an increase in battery drain to provide enhanced IM performance. That is why mobile installations tend to have better IM performance than portables.

Oddly enough, using a lower gain antenna on a portable that is experiencing IM interference is one way to lower the amount of undesired signal reaching a portable receiver' s front-end. This lowers the desired signal a few dB but reduces the IM products by the order of the product. This can be an effective solution when there is sufficient desired signal strength and the interference is due to front-end overload. Note that a lower gain antenna may reduce the portables' effective range in other situations.

Another method of decreasing the impact of an undesired signal to increase the distance between the source and target. Path loss increases logarithmically with distance. Distance also changes the amount of gain in the antenna pattern. The potential for interference is noticeably reduced when sites are above 80' above ground level (AGL). Raising the center of radiation of transmit antennas can eliminate interference. Zoning rules and atheisticare forcing antennas to lower levels and there may be "stealth" sites behind store-front facades and many more sites below 80' AGL. A more conventional tower or building installation provides increased protection from RFI. Note that increasing demands for wireless services is a factor in more sites that are heavily loaded and frequency reuse is enhanced when theses sites are deployed below tree top or building top levels.

Lowering the ERP' s and reducing the number of transmitters on any one site may shrink the coverage area of a given cell and off load traffic to surround cells. Adding additional cells (otherwise known as cell splitting) adjacent to the cell is one way to accommodate these reductions while maintaining offered service levels.

Sweeping sites to find transmitted IM (IM) is required regularly to insure legal operation. Reducing transmitted IM levels and maintaining low radiated IM levels is an effective method to reduce the possibility of interference of this type.

12.3.3 INCREASE ERP OR SIGNAL STRENGTH OF DESIRED SIGNAL

A number of methods exist for reducing or eliminating interference by increasing the desired signal level. This method can override many forms of interference including both Sideband noise and receiver IM.

It is fairly common now for users of wireless communications systems to desire or demand coverage inside buildings. Many two-way radio users conduct business indoors and therefore need inside coverage. The mobility of portables requires in-building coverage. Public Safety users often have to enter buildings to perform their critical life-preserving activities. Providing in-building coverage will require more sites or equipment but it will also provide protection against many forms of interference. Many of the interference problem areas can be found near other sites while on the street. The little extra building loss usually reduces the interference down below troublesome levels. This is especially true for the case where IM is occurring in the portable's receiver. Every dB of attenuation to the undesired produces a 3 times or 5 times reduction in the level of any IM product.

Increasing the transmitter power on desired frequencies can improve the downlink performance by overriding the interference. The ERP can also be raised into a particular area by changing the antenna pattern or by increasing antenna gain. Increasing the antenna height above ground level on the desired transmitters can also increase the level of the desired signal.

Adding additional sites on the desired channels is another available option. This has the added benefit of increasing coverage inside buildings.

Deploying Bi-Directional Amplifiers (BDA) or channelized repeaters are also possible ways to improve coverage into specific areas that would benefit from enhanced coverage. However, BDA's can be a source of interference so their deployment needs to be well engineered.

The co-location of transmitter sites ensures that the desired signal is stronger on-channel than any interfering signal. This may not always be possible when mixing systems of different types such as high density cellular on many low sites and a lower density two-way radio system on a few high sites. This option reduces talk-out interference but it can increase talk-in interference, requiring "voting" receivers to minimize this effect.

Mentioned above, the use of a portable with higher performance specifications is another way to reduce the probability of interference. The specifications of interest are the selectivity and IM performance of the radio. Radios with specifications in this areas > 70 dB are needed to offer reasonable protection for use in typical environments where there high levels of desired RF. Increased protection is offered by improved specifications.

Increasing the signal strength of the desired signal is a highly effective method for minimizing interference and these choices should be considered as alternatives in most cases.

12.3.4 LONG TERM AVOIDANCE

Longer term strategies for minimizing or eliminating inference may involve an exchange of frequencies or a segregation of frequencies to move the operations of any given system to its own spectrum allocation. This will usually require some approval by the FCC and possibly some coordination with one or more designated coordinating bodies.

Swapping one or more frequency pairs may provide an opportunity to address an individual case or set of cases throughout a small area.

Segregating frequencies would separate distinct service types into different sub-bands and offer higher each service a higher level of protection against interference. There may be some interference if the sub-bands are located next to each other but the interference in such cases would easier to predict, identify and create an engineered solution when it does occur.

APPENDIX P
DTV TRANSITION

APPENDIX P

DTV TRANSITION

Frequency Availability through the DTV Transition

On August 14, 1996, the FCC released a *Sixth Further Notice of Proposed Rule Making* in the digital television (DTV) proceeding. A portion of the spectrum recovered from TV channels 60-69 when DTV is fully deployed "could be used to meet public safety needs."[1] By Congressional direction in the Balanced Budget Act of 1997, the FCC reallocated 24 MHz of spectrum to Public Safety services in the 764-776 MHz and 794-806 MHz bands. The statute required the FCC to establish service rules, by September 30, 1998, in order to start the process of assigning licenses. The rules that the FCC established by September 30, 1998, "provided the minimum technical framework necessary to standardize operations in this spectrum band, including, but not limited to: (a) establishing interference limits at the boundaries of the spectrum block and service areas; (b) establishing technical restrictions necessary to protect full-service analog and digital television service during the transition to digital television services; (c) permitting public safety licensees the flexibility to aggregate multiple licenses to create larger spectrum blocks and service areas, and to disaggregate or partition licenses to create smaller spectrum blocks or service areas; and (d) ensuring that the new spectrum will not be subject to harmful interference from television broadcast licensees" [2].

In April 1997, the FCC assigned a second 6 MHz block of spectrum to each license (or permit to construct) holders of full power, analog, television broadcast station (NTSC) in order to construct a digital television station (DTV). Secondary low power television stations (LPTV), secondary translators and boosters (TX), mutually exclusive applications for new stations, and application filed after a cut-off date did not receive a second 6 MHz allotment for DTV. The FCC established about a 10 year timeline for those stations with a DTV assignment to construct a DTV station, cease NTSC transmissions, and return one of the two 6 MHz blocks of spectrum to the FCC. Target date for the end of analog television (NTSC) transmission was set for December 31, 2006.

Congress provided several market penetration loopholes (>85% households served, all 4 major networks converted, etc) allowing NTSC operations to continue past the December 31, 2006 date. While there are over 100 NTSC full power stations in this band, there are also about 12 DTV assignments. The DTV assignments might continue operations past the December 31, 2006 date for two reasons. 1) They must find a suitable channel below channel 60 to move to,

[1] Advanced Television Systems and Their Impact Upon the Existing Television Broadcast Service, MM Docket No. 87-268, *Sixth Further Notice of Proposed Rule Making*, 11 FCC Rcd 10,968, 10,980 (1996) (*DTV Sixth Notice*).

[2] FCC 98-191, 1st R&O and 3rd NPRM on WT Docket No. 96-86 Operational & Technical Requirements or the 700 MHz Public Safety Band, para.4.

which may be their own NTSC assignment. They may not be able to find another allocation until other NTSC stations have ceased operations and returned a channel below 60 to the FCC. Or, 2) their license does not expire until after 2006 (most are licensed into 2007 or 2008).

Protection of Public Safety from future TV/DTV Stations

Public safety base and mobile operations must have a safe distance between the co-channel or adjacent TV and DTV systems. This typically means that a co-channel and adjacent channel base and mobile system cannot operate in areas where TV stations already exist. The public safety systems that will operate in the 700 MHz band for some locations in the U.S. and its possessions must wait until the transition period is over and the TV/DTV stations have moved to other channels before beginning operations. In other areas, channels will be available for public safety operations. During the transition period, public safety stations must be acutely aware of the TV allocations for both TV and DTV stations. The FCC wants the number of situations where the public safety licensee has to coordinate its station with the existing TV stations kept to a minimum. The Commission's decisions in the reallocation of spectrum to DTV implemented two requirements which will help public safety systems to protect TV/DTV stations and reduce the number of coordinations. The first requirement is that full power UHF-TV stations can no longer apply for channels 60-69 or modifications in channels 60-69 which would increase the stations' service areas, which creates a known environment for public safety licensees.[3] The second requirement is that since only existing TV station licensees can apply for DTV channels, the applicants and their proposed locations are already known.[4]

[3] *See Reallocation Report and Order*, 12 FCC Rcd 22,969-22,970. Stations with existing channel 60-69 TV construction permits must complete their stations and file for a license by January 2, 2001.

[4] *See DTV Sixth Report and Order*, 12 FCC Rcd 14,739-14,754; *See also* In the Matter of Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service, *Memorandum Opinion and Order on Reconsideration of the Sixth Report and Order* in MM Docket No. 87-268, 13 FCC Rcd 7418 (1998). The 11 DTV allotments are:

STATE	CITY	NTSC TV Ch.	DTV Ch.	ERP (kW)	HAAT (m)
California	Stockton	64	62	63.5	874
California	Los Angeles	11	65	688.7	896
California	Riverside	62	68	180.1	723
California	Concord	42	63	61.0	856
Pennsylvania	Allentown	39	62	50.0	302
Pennsylvania	Philadelphia	6	64	1000.0	332
Pennsylvania	Philadelphia	10	67	791.8	354
Puerto Rico	Aguada	50	62	50.0	343
Puerto Rico	Mayaguez	16	63	50.0	347
Puerto Rico	Naranjito	64	65	50.0	142
Puerto Rico	Aguadilla	12	69	691.8	665

Also, the low power TV stations and translators already on channels 60-69 are secondary and must cease operations if they cause harmful interference when a primary service, like land mobile, comes into operation. The secondary Low Power TV stations already on channels 60-69 cannot apply for the new Class A protection status.

Spectrum Overview

700 MHz Public Safety Band - 24 megahertz of spectrum

TV 61	TV 62	TV 63 Public Safety 6 MHz	TV 64 Public Safety 6 MHz	TV 65	TV 66	TV 67	TV 68 Public Safety 6 MHz	TV 69 Public Safety 6 MHz	806-824 LMR Band

TV Channel 63 TV Channel 64 TV Channel 68 TV Channel 69

764 MHz 770 776 794 MHz 800 806

NB **3 MHz**	**WB** **6 MHz**	**NB** **3 MHz**

NB **3 MHz**	**WB** **6 MHz**	**NB** **3 MHz**

NB = narrowband channels **WB** = wideband channels

The FCC designated 764-776 MHz (TV Channels 63 and 64) for base-to-mobile transmissions and 794-806 MHz (TV Channels 68 and 69) for mobile-to-base communications. In addition, base transmit channels in TV Channel 63 are paired with mobile channels in TV Channel 68 and likewise that base channels in TV Channel 64 are paired with mobile channels in TV Channel 69. This provides 30 MHz separation between base and mobile transmit channel center frequencies. This band plan was suggested because of the close proximity of TV Channels 68 and 69 to the 806-824 MHz band, which already contains the transmit channels for mobile and portable radios (base receive).

Mobile transmissions are allowed on any part of the 700 MHz band, not just the upper 12 MHz. This will facilitate direct mobile-to-mobile communications (*i.e.*, not through a repeater) that are often employed at the site of an incident, where wide area communications facilities are not available or desired. Allowing mobile transmissions on both halves of a paired channel is generally consistent with FCC rules governing use of other public safety bands.

Non-uniform TV Channel Pairing

There are currently geographical areas where, either licensed or otherwise protected full-service analog or new digital, television stations are currently authorized to operate on TV Channels 62, 63, 64, 65, 67, 68, and 69.[5] During the DTV transition period, an incumbent TV station occupying one or more of the four Public Safety channels (63, 64, 68, 69) or the three adjacent channels (62, 65, 67) may preclude pairing of the channels in accordance with the band plan defined above. Therefore, to provide for cases where standard pairing is not practicable during the DTV transition period, the FCC will allow the RPCs to consider pairing base-to-mobile channels in TV Channel 63 with mobile-to-base channels in TV Channel 69 and/or base-to-mobile channels in TV Channel 64 with mobile-to-base channels in TV Channel 68. Because such non-standard channel pairing may cause problems when the band becomes more fully occupied, the FCC expects the RPCs to permit such non-standard channel pairing only when absolutely necessary, and the FCC may require stations to return to standard channel pairing after the DTV transition period is over. <u>However, the FCC will not permit non-standard channel pairing on the nationwide interoperability channels in the 700 MHz band because of the need for nationwide uniformity of these channels</u>.

At least three issues must be considered before deciding upon non-uniform channel pairing:

1) Preliminary analysis, looking at current incumbent TV stations, shows few geographic areas where non-uniform pairing allows early implementation of 700 MHz systems. As DTV Transition progresses, and TV stations vacate the band, this situation might change.

2) If interoperability channels must be uniform, operation on I/O channels will be blocked until all incumbent TV stations are cleared, even though General Use channels may be implemented earlier.

3) If I/O channels must follow uniform pairing, and general use & reserve channels can be implemented using non-uniform pairing, narrowband voice subscriber equipment must operate on 3 different channel pairings - 39 MHz (764-767 paired with 803-806 MHz), 30 MHz, and 21 MHz (773-776 paired with 794-797 MHz). Likewise, there will be 3 different channel pairing for wideband channels. No vendors have volunteered to build equipment & systems for non-uniform pairing, yet.

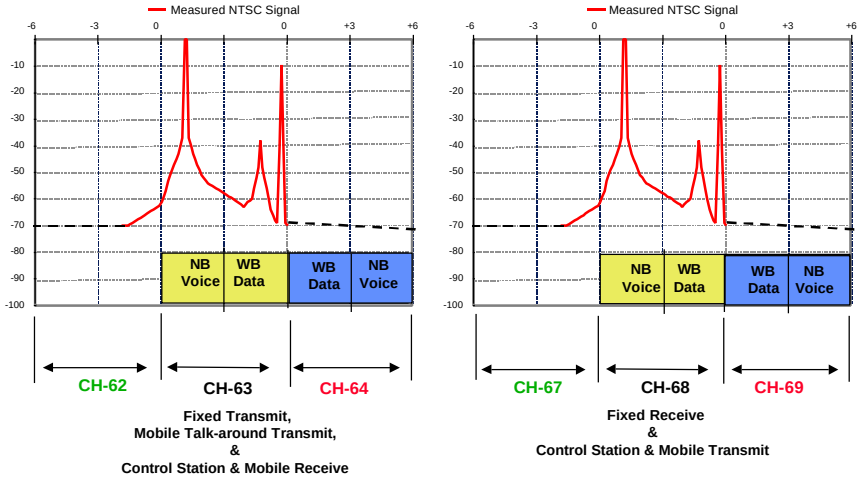
TV/DTV Protection

During the DTV Transition period, public safety must consider all co-channel and adjacent channel TV and DTV stations within about a 160 mile radius.

For public safety channel pair 63/68, public safety must consider six TV/DTV channels - co-channels 63 and 68, as well as, adjacent channels 62, 64, 67, and 69.

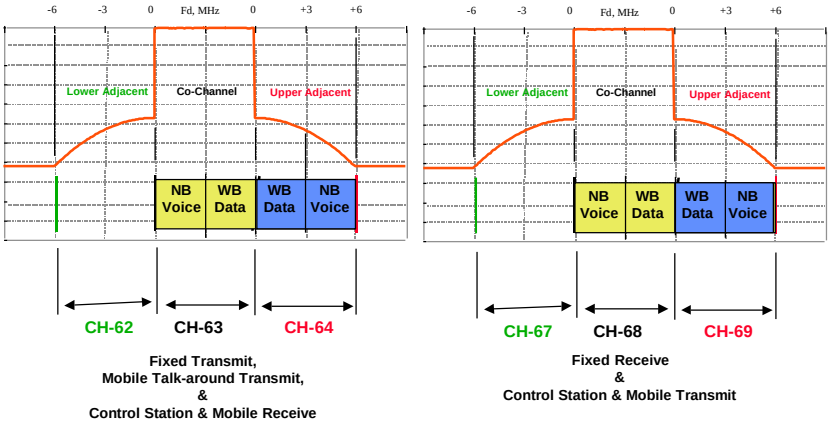
[5] *See Reallocation, Notice of Proposed Rule Making,* 12 FCC Rcd at 14,141, 14,177-78 and 14,182-83.

Measured (off-the-air) Analog TV Signal
vs
700 MHz Public Safety Assignments



HAVE 2 CO-CHANNEL AND 4 ADJACENT CHANNELS
TO CONSIDER FOR EACH 700 MHz PAIRED BLOCKS OF SPECTRUM

DTV Emission Mask
vs
700 MHz Public Safety Assignments



HAVE 2 CO-CHANNEL AND 4 ADJACENT CHANNELS
TO CONSIDER FOR EACH 700 MHz PAIRED BLOCKS OF SPECTRUM

For public safety channel pair 64/69, public safety must consider five TV/DTV channels; co-channels 64 and 69, as well as, adjacent channels 63, 65, and 68.

It may only takes one TV/DTV station to block operations on one, the other, or both public safety channel pairs. For a public safety system at 500 watts ERP and 500 ft HAAT, co-channel TV stations can block a 120 mile radius and adjacent channel TV/DTV stations can block a 90 mile radius.

Since base stations transmitters are located only on channels 63 and 64, LMR mobile only TV/DTV protection spacing on channels 68 and 69 may be shorter than LMR base TV/DTV protection on channels 63 & 64.

TV/DTV Protection Criteria

Public safety applicants can select one of three ways to meet the TV/DTV protection requirements: (1) utilize the geographic separation specified in the 40 dB Tables of 90.309;
(2) submit an engineering study to justify other separations which the Commission approves; or
(3) obtain concurrence from the applicable TV/DTV station(s).

90.309 40 dB D/U Tables

The FCC adopted a 40 dB desired (TV/DTV) to undesired (LMR) signal ratio for co-channel operations and a 0 dB desired/undesired (D/U) signal ratio for adjacent channel operations. The D/U ratio is used to determine the geographic separation needed between public safety base stations and the Grade B service contours of co-channel and adjacent channel TV/DTV stations.[6] The D/U signal ratio is used to determine the level of land mobile signals that can be permitted at protected fringe area TV receiver locations without degrading the TV picture to less than a defined picture quality. In other words, the D/U signal ratio indicates what relative levels of TV and land mobile signals can be tolerated without causing excessive interference to TV reception at the fringe of the TV service area.

Desired and undesired contours are not quite the same thing. Desired analog TV contours are defined as F(50,50), meaning coverage is 50% of the places and 50% of the time. Undesired land mobile or interference contours are defined as F(50,10). For Digital TV, the desired contours are defined as F(50,90), while the undesired land mobile contour are still F(50,10).

Land mobile and analog TV services have successfully shared the 470-512 MHz band (TV Channels 14-20) within a 50 mile radius of eleven major cities since the early 1970's based upon providing a signal ratio of at least 50 dB[7] between the desired TV signal and undesired co-channel land mobile signal (D/U signal ratio) at a hypothetical 88.5 km (55 mi) Grade B service contour and an adjacent channel D/U signal ratio of 0 dB at the same hypothetical Grade B service contour. These separation distances also protected the land mobile systems from interference from the TV stations. In 1985, recognizing that 50 dB D/U was too conservative, the FCC proposed to expand land mobile/TV sharing to other TV channels and proposed that the geographic separation requirements for co-channel operations be based on a D/U signal ratio of

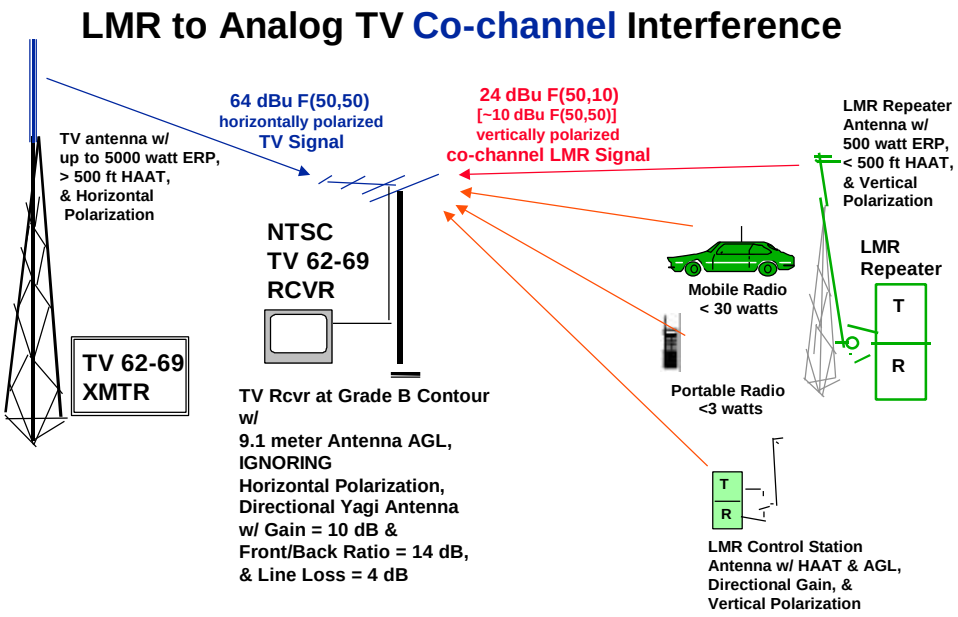
[6] *See Second Notice*, 12 FCC Rcd 17,803.

[7] For TV Channel 15 in New York City, a 40 dB D/U signal ratio is used. *See* 47 C.F.R. §§ 90.307(b) and 90.309 (Table B). A 50 dB protection ratio means that the amplitude of the desired TV signal is more than 300 times greater than the amplitude of the undesired signal at the Grade B service contour. A 40 dB protection ratio means the desired TV signal is 100 times greater.

40 dB rather than 50 dB.[8] That proceeding was put on hold pending completion of the DTV proceeding, which has now been completed. In the 470-512 MHz band, the FCC also relied on minimum separation distances based on the various heights and powers of the land mobile stations (HAAT/ERP separation tables) to prevent harmful interference.

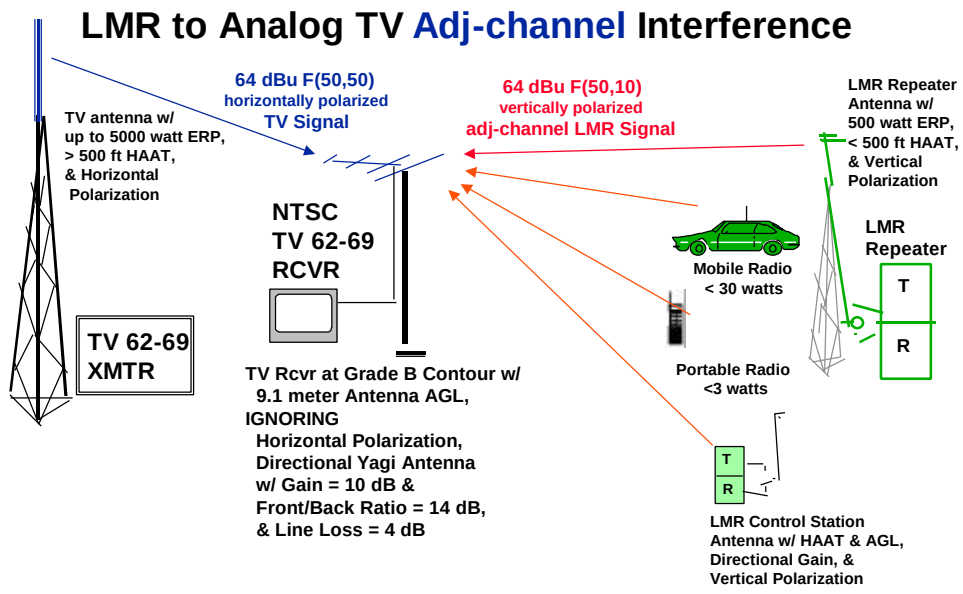
Since this simple, yet conservative, method was successful, the FCC decided to use this same method, the 90.309 HAAT/ERP Separation Tables, to administer LMR to TV/DTV receiver protection criteria for the services in the 700 MHz band.

Co-channel land mobile base station transmitters are limited to a maximum signal strength at the hypothetical TV Grade B contour 40 dB D/U below desired 64 dBu F(50,50) analog TV signal level, or 24 dBu F(50,10).[9] The FCC adopted a 0 dB D/U signal ratio for adjacent channel operations. Adjacent channel land mobile transmitters will be limited to a maximum signal of 64 dBu F(50,10) which is 0 dB D/U below the TV Grade B signal of 64 dBu F(50,50) at the TV station Grade B contour of 88.5 km (55 miles). A typical TV receiver's adjacent channel rejection is at least 10-20 dB greater than this level which will further safeguards TV receivers from land mobile interference.



[8] *See* Amendment of the Rules Concerning Further Sharing of the UHF Television Band by Private Land Mobile Radio Services, GEN Docket No. 85-172, *Notice of Proposed Rulemaking*, 101 FCC 2d 852, 861 (1985) (*UHF-TV Sharing NPRM*).

[9] In terms of miles, if everything else is the same, a 40 dB D/U ratio rather than a 50 dB D/U ratio allows base stations to be located approximately 48.3 km (30 mi) closer to a co-channel TV station. *See* 47 C.F.R. § 90.309, Tables A & B.



The equivalent ratios for a DTV station's 41 dB F(50,90) desired field strength contour are land mobile 17 dB F(50,10) contour for co-channel and land mobile - 23 dB F(50,10) contour for adjacent channel.

The Tables to protect TV/DTV stations are found in Section 90.309 of the Commission's rules. These existing Tables cover co-channel protection based on a 40 dB D/U ratio using the separation methods described in Section 73.611 of the Commission's rules for base, control, and mobile stations, and for adjacent channel stations for base stations based on a 0 dB D/U ratio.

However, the original considerations in 470-512 MHz band under Section 90.309 were different in that mobiles were limited in their roaming distance from the base station (less than 30 miles) and mobiles were on the same TV channel as the base station.

Control and mobile stations (including portables) are limited in height (200 ft for control stations, 20 ft for mobiles/portables) and power (200 watts ERP for control stations, 30 watts for mobiles, 3 watts for portables). Mobiles and control stations shall afford protection to co-channel and adjacent channel TV/DTV stations in accordance with the values specified in Table D (co-channel frequencies based on 40 dB protection for TV and 17 dB for DTV) in § 90.309.

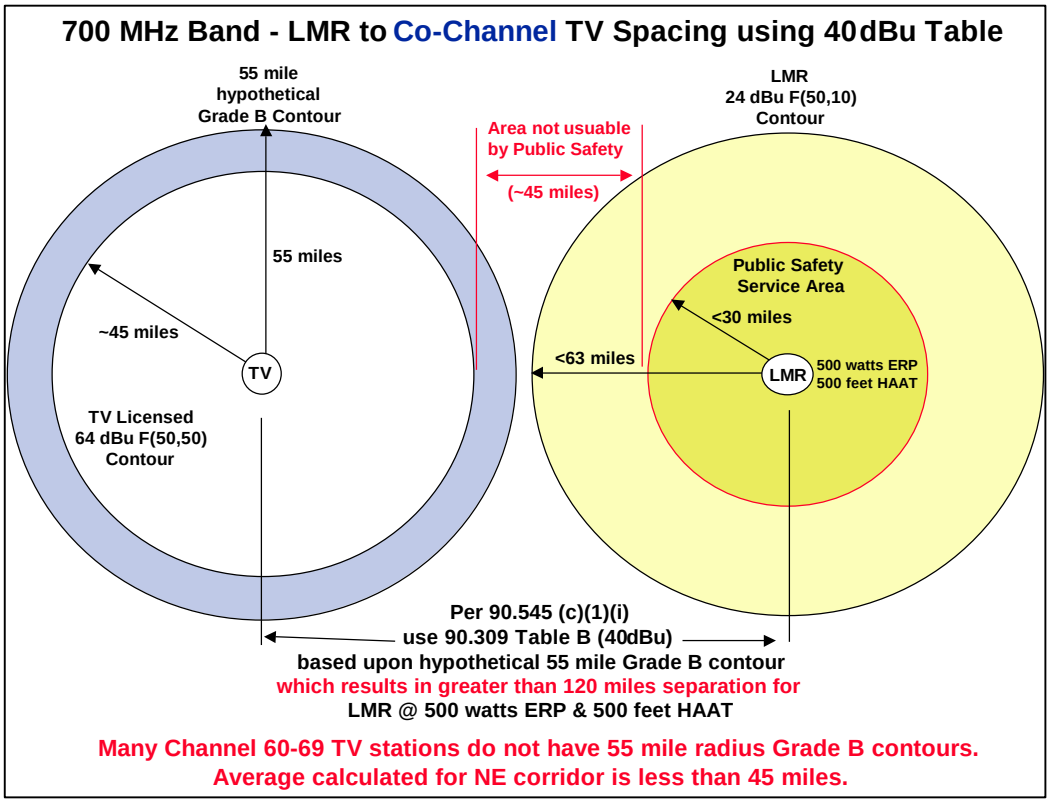
Control stations and mobiles/portables shall keep a minimum distance of 8 kilometers (5 miles) from all adjacent channel TV/DTV station hypothetical or equivalent Grade B contours (adjacent channel frequencies based on 0 dB protection for TV and -23 dB for DTV). This means that control and mobile stations shall keep a minimum distance of 96.5 kilometers (60 miles) from all adjacent channel TV/DTV stations.

Since operators of mobiles and portables are able to move and communicate with each other, licensees or coordinators must determine the areas where the mobiles can and cannot roam

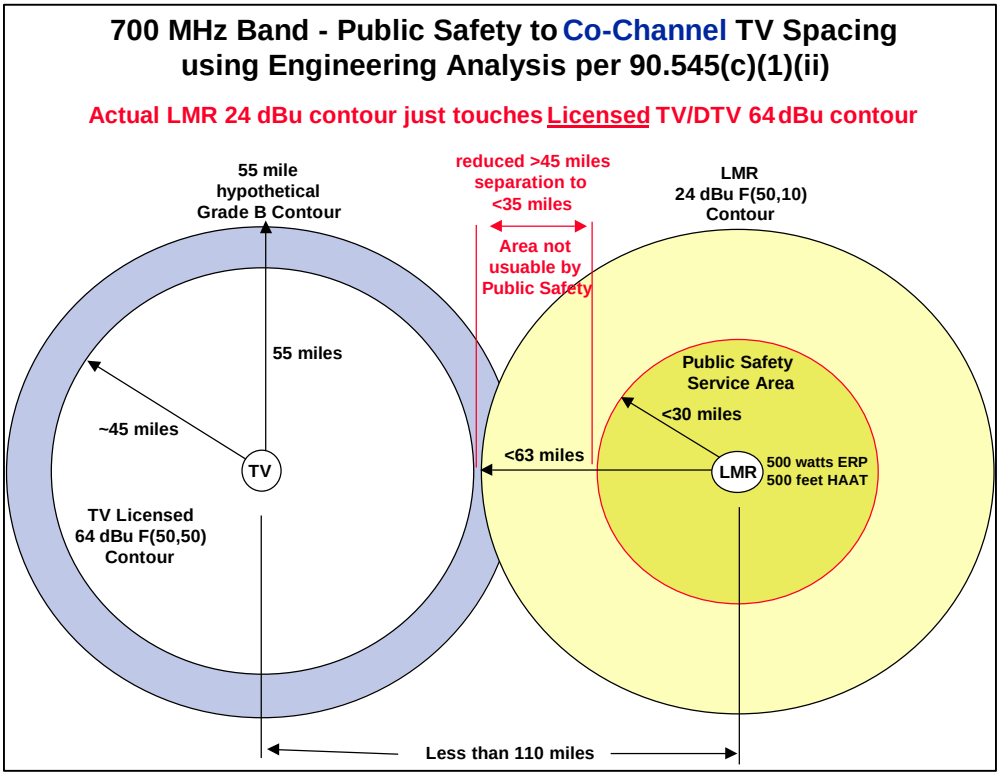
in order to protect the TV/DTV stations, and advise the mobile operators of these areas and their restrictions.

Engineering Analysis

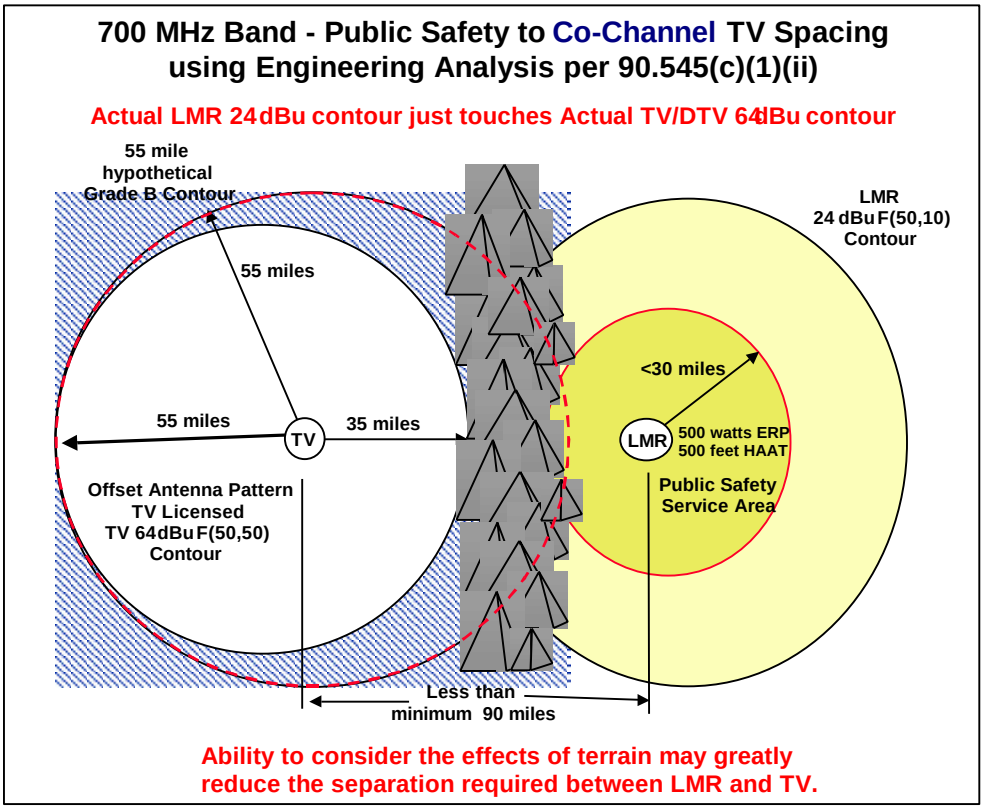
Limiting TV/land mobile separation to distances specified in the 40 dB HAAT/ERP Separation Tables found in 90.309 may prevent public safety entities from fully utilizing this spectrum in a number of major metropolitan areas until after the DTV transition period ends. Public safety applicants will be allowed to submit engineering studies showing how they propose to meet the appropriate D/U signal ratio at the existing TV station's authorized or applied for Grade B service contour or equivalent contour for DTV stations instead of the hypothetical contour at 88.5 km.



This would permit public safety applicants to take into account intervening terrain and engineering techniques such as directional and down-tilt antennas in determining the necessary separation to provide the required protection. Public safety applicants who use the engineering techniques must consider the actual TV/DTV parameters and not base their study on the 88.5 km hypothetical or equivalent Grade B contour. If land mobile interference contour does not overlap the TV Grade B contour (or DTV equivalent), then engineering analysis may be submitted to the FCC with the application.



This method is most useful with lower power TV stations whose Grade B contours are much smaller than the hypothetical 55 mile (88.5 km) Grade B contour or have directional



patterns.

Note that 200 ft AGL limitations on 700 MHz control stations is much higher than the 100 ft AGL limitation used at UHF. Limiting control station antenna height and/or ERP may greatly reduce land mobile to TV contour spacing.

Also, note that analysis for TV/DTV receivers uses 30 ft (10 m) antenna height whereas, analysis for land mobile subscribers uses about a 6 ft (2m) antenna height.

TV/DTV Short-spacing

Public safety applicants will also be allowed to "short-space" even closer if they get the (written) approval of the TV stations they are required to protect. Public safety applicants need to determine the station's intended market area vs its hypothetical Grade B contour area. Alternately, the TV/DTV station may be short-spaced against another TV/DTV station, limiting their area of operation, but does not affect LMR operations.

Instead of each agency negotiating with a TV/DTV station individually, they may want to combine into a single group or committee and negotiate together.

TV/DTV Height Adjustment Factor

In order to protect certain TV/DTV stations which have extremely large contours due to unusual height situations, such as a television station mounted on top of Mount Wilson near Los Angeles, California, the FCC incorporated an additional height adjustment factor which must be used by all public safety base, control and mobile stations to protect these few TV/DTV stations and afford the land mobile stations the necessary protection from the TV/DTV stations. The equation necessary to calculate the additional distance from the hypothetical or equivalent Grade B contour is found in the rules section 90.545(c)(2)(iii).

CANADIAN AND MEXICAN BORDER REGIONS

The FCC typically takes one of two approaches. They either postpone licensing of land mobile stations within a certain geographic distance (*e.g.*, 120 km (75 miles)) of Canada and Mexico, or permit interim authorizations conditioned on the outcome of future agreements. Because international negotiations can take many months or even years to finalize, the FCC took the later approach and adopted certain interim requirements for public safety licenses along the Canada and Mexico borders, providing that the licenses are subject to whatever future agreements the United States develops with the two countries.

Nevertheless, existing mutual agreements with Canada and Mexico for the use of these bands for UHF television must be recognized until further negotiations are completed. The US negotiated an agreement with Mexico of DTV operations near the US/Mexican border in July 1998. The US just negotiated an agreement with Mexico of DTV operations, and limited non-broadcast operations on 746-806 MHz, near the US/Canadian border in September 2000. Existing agreements recognize existing TV and/or DTV allotments and planning factors within a specified distance of the border. The Canadian Letter of Understanding also acknowledges that US plans to use 746-806 MHz for non-broadcast purposes and provides planning criteria (40 dB D/U) to protect Canadian TV/DTV receivers.

Additionally, public safety facilities within the United States must accept interference from authorized channel 60-69 TV transmitters in Canada and Mexico in accordance with the existing agreements. Since the locations of the Canadian and Mexican analog TV assignments and DTV allotments are known, the public safety applicants can consider the levels of harmful interference to expect from Canadian and Mexican TV/DTV stations when applying for a license. Both Canada and Mexico have been informally notified that the Commission has changed its allocated use of TV channels 60-69, and the Commission will discuss the possibility of mutually compatible spectrum use with Canada and Mexico.

APPENDIX U MPSFAC Committee Structure

Agency	Number of Representatives
Michigan State Police	2
Michigan Department of Natural Resources	1
Michigan Department of Public Health	1
Michigan Municipal League	1
Michigan Chapter of the Sheriffs, Association	1
Michigan Charter MACP	1
Michigan Department of Transportation	1
EMS service providers	1
MI. APCO frequency advisor	1
FCCA	1
Fire Department	1

There are also 4 APCO appointed members of the committee representing city (one from Detroit) or county public safety agencies that have a background in either or both of the following:

1. radio frequency systems
2. public safety answering point

MPSFAC MEETINGS

The MPSFAC meetings function in accordance with Roberts Rules of Order.

MPSFAC Routine Duties

- A chairman is elected during the first meeting each year.

- Meetings are scheduled for the 3rd Tuesday each month except July and August; when application need committee action. Applications are to be sent to committee members by the applicant two weeks prior to the meeting. The applicant can obtain the addresses form the MPSFAC secretary. The MSP has acted as the host and provided the secretary for the MPSFAC since it inception about 50 years ago. Presently the secretary is, Harry Warner of the Michigan State Police (MSP). His phone number is 517-336-6623.

- Review application based upon the Region 21 matrix. Review the application(s) for interoperability technical requirements. Further the MPSFAC will review the application(s) for interoperability operational requirements if there is no SIEC

- Deal with appeals/application clarification, consider applicant presentations.

- Interact with applications to determine if the implementation of their systems is in accordance with their applications.

- Maintain coordination with neighboring regional committees and other FCC certified frequency coordinators and their advisors.

- Promulgate other rules and procedures as need to operate efficiently and effectively.
  Further the MPSFAC adjusts it's membership as needed to insure that it is representative of the agencies it serves.

Appendix V
Existing Interoperability Agreements

The Region 21 Planning Committee feels that it would be impractical to gather all of the interoperability agreements that may exist statewide. As soon as agencies begin requesting 700 MHZ frequencies, these documents will have become outdated. Therefore, we have included only existing plans that cover the whole of the State of Michigan. However, as per the Region 21 Plan, applicants are required to provide existing interoperability information and to plan for interoperability for both pre and post 700 MHZ system implementation

The MEPPS channel (155.865) is a statewide channel intended to provide inter-agency mobile communications for police agencies. Fire agency interoperability is provided for by Common Channel (154.295).

MICHIGAN EMERGENCY PUBLIC SAFETY SYSTEM (MEPSS) REGULATIONS

The radio frequency of 155.865 MHz will be used as a mobile emergency channel for mutual aid purposes. Base stations are strategically located throughout the State of Michigan for emergency contact for any mobile unit equipped with the MEPSS frequency. Base stations shall be installed and operated only as approved and recommended by the Michigan Public-Safety Frequency Advisory Committee.

The purpose of the MEPSS System is to implement a uniform, statewide frequency that will insure direct communications with all elements working together in an emergency situation. The system is intended to transform area police departments from a loose collection of independent units into a cohesive, coordinated team.

The MEPSS frequency will not be used within the licensee's normal service area for day-to-day operation. Inclusion of other local government mobile users, such as fire departments, civil defense units, federal agencies and public works departments shall be as recommended by the Michigan Public-Safety Frequency Advisory Committee

REGULATION OF MEPSS

Section I — Requirements of Prime Station Locations

1. 24-hour, 7 day-a-week, established dispatching service.
2. Personnel dedicated to radio dispatching on every shift.
3. Point-to-point communications facilities, either LEIN, radio or both.

Section II - Operating Requirements

1. All established base stations in the MEPSS System shall continuously monitor the MEPSS channel at all times.
2. The MEPSS System shall not be used within a licensee's normal service area for day-to-day operations.
3. Mobile originated traffic shall be confined to interagency coordination.

4. Base station originated traffic shall be confined to coordination of mobile units, except for weekly tests.

5. The MEPSS System shall not be used as an alternate for facilities presently available.

6. Plain language rather than-ten codes shall be used when operating on the MEPSS System.

7. If the entity selected for base operation fails to properly carry out the prescribed responsibilities for maintaining the system operation, the MPSFAC at its discretion may select another base station location to serve the area.

8. A weekly test will be conducted to assure that receivers and transmitters are in good working order. These weekly tests will be conducted on a talk around basis.

9. All operations on the MEPSS channel must be in compliance with Part 90 of the Federal Communications Commission's Rules & Regulations.

Section III - Technical Requirements

1. Prime system stations shall be equipped with a discreet receiver on the MEPSS channel. A scanner-type or dual, front-end receiver will not be accepted. Base station receivers shall not be equipped with a tone filter.

2. Tone squelch will not be used in the system.

3. The base station locations have been selected on the assumption of 90-100 watt transmitters with 3.db gain antennas located 100 feet AGL.

4. System calculations are based on mobile units with standard, 1/4 wave antennas and receivers with .5uv sensitivity.

5. If the entity selected for base operation fails to properly carry out the prescribed responsibilities for proper equipment maintenance, the MPSFAC may at its discretion select another base station location to serve the area.

KEY TO MEPSS SYSTEM MAP

1. Detroit Police Department
(313) 224-4425

2. Wayne County Sheriff (Detroit)
(313)561-5680

3. Monroe County Sheriff (Monroe)
(313) 241~2727

4. Oakland County Sheriff (Pontiac)
(313) 658-4911

5. Macomb County Sheriff (Mt. Clemens)
(313) 469-5151

6. St. Clair County Sheriff/Port Huron Police Department (Port Huron)
(313) 985—8115

7. Sandusky MSP #34
(313) 648-2233

8. Huron County Sheriff (Bad Axe)
(517) 269-6421

9. Genesee County Communications Center (Flint)
(313) 732-9911

10. Bay City MSP #31
(517) 684-2234

11. Livingston County Sheriff (Howell)
(517) 546-2440

12. East Lansing MSP (Operations Office)
(517) 336-6100

13. Ann Arbor Police Department
(313) 994-2911

14. Jackson County Sheriff (Jackson)
(517) 788-4200

15. Branch County Sheriff (Coldwater)
(517) 278-2325

16. Paw Paw MSP #51
(616) 657-5551

17. Berrien County Sheriff (St. Joseph)
(616) 983-7141

18. Battle Creek Police Department
(616) 966-3363

19. Kent County Sheriff (Grand Rapids)
(616) 774-3113

20. Muskegon County Central Dispatch (Muskegon)
(616) 726-6650

21. Ithaca MSP #14
(517) 875—4111

22. Houghton Lake MSP #75
(517) 422-5101

23. Gaylord MSP #73
(517) 732-5141

211. Petoskey MSP #78
(616) 347-8101

25. Cheboygan MSP #72
(616) 627-9973

26. Mecosta County Sheriff (Big Rapids)
(616) 796-4811

27. Mason County Sheriff (Ludington)
(616) 843-3475

28. Benzie County Sheriff (Beulah)
(616) 882-4484

29. Traverse City MSP #71
(616) 946-4646

30. Lake County Sheriff (Baldwin)
(616) 745-4614

31. Alpena MSP #74
(517) 354-4101

32. East Tawas MSP #32
(517) 362-3434

33. St. Ignace MSP #83

KEY TO MEPSS SYSTEM MAP

(906) 643-8383

32. Sault Ste. Marie MSP #93
(906) 632-2216

35. Newbetry MSP #82
(906) 293-5151

36. Manistique MSP #84
(906) 341-2101

37. Munising MSP #91
(906) 387-4550

38. Negaunee MSP #81
(906) 475-9922

39. Gladstone MSP #65
(906) 428-1212

40. Dickinson County Sheriff (Iron Mountain)
(906) 774-6262

41. Stephenson MSP #89
(906) 753-2275

42. Iron River MSP #92
(906) 265-9916

43. Wakefield MSP #87
(906) 224-9691

44. L'Anse MSP #88
(906) 524-6161

45. Calumet MSP #90
(906) 337-2211

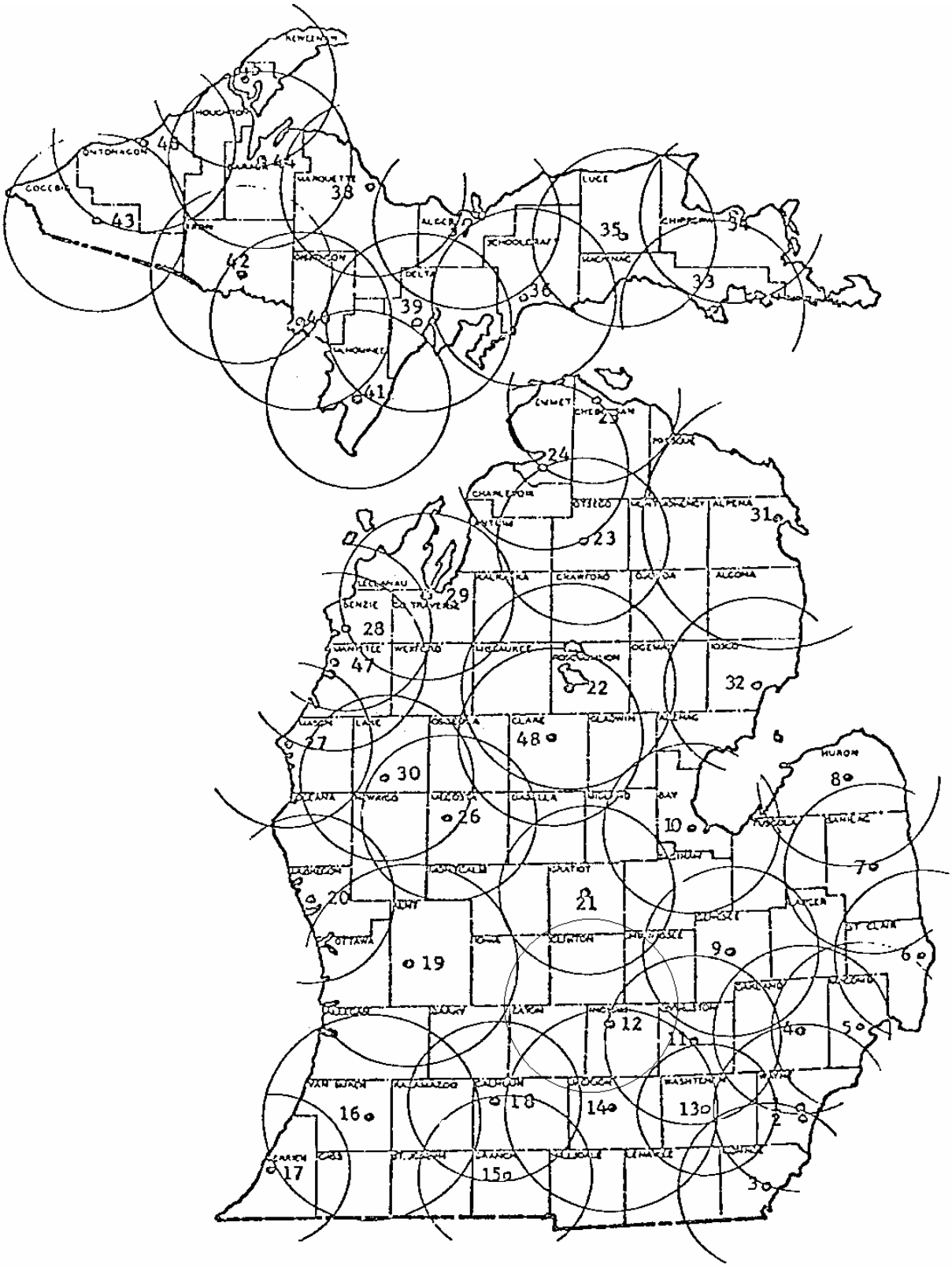
46. Ontonagon County Sheriff (Ontonagon)
(906) 884-4901

47. Manistee MSP #77
(616) 723-3535

48. Clare County Sheriff (Harrison
(517) 539-7166

MICHIGAN EMERGENCY PUBLIC-SAFETY RADIO SYSTEM

PROPOSED BASE STATION LOCATIONS



MICHIGAN PLAN

FOR

OPERATION and MANAGEMENT

of

A STATEWIDE COORDINATING

FIRE COMMUNICATIONS SYSTEM

Operated

on

THE COMMON FREQUENCY

154.295 MHz

FIRE COMMUNICATIONS SYSTEM

The frequency 154.295 MHz has been designated for use exclusively in an interagency fire coordinating system in the State of Michigan.

The system will be a valuable tool, which will help to assure the safety of firemen and fire equipment, and aid in the coordination of multi-jurisdictional responses to emergency situations.

The statewide use of this emergency channel will be used, under sound technical and operational standards, to provide the following major improvements in fire communications:

(1) Provide improved command and control communications to supervisory personnel in situations where fire agencies from multiple jurisdictions are responding to a mutual aid request or other emergency.

(2) Permit direct mobile or portable to mobile or portable emergency communications between fire units from various jurisdictions.

Considerable time and money will be expended in developing and implementing a statewide fire coordinating communications system on 154.29S MHz. The communications system can only achieve its full potential if its day to day use is prudently managed.

The principal objective of the state's management plan is to assure disciplined, controlled use of the radio network so that it will be available in times of emergency to provide the benefits it is intended to provide.

STATE NETWORK GOVERNING BOARD

The entire fire community of the State of Michigan will be served by the emergency fire coordinating communications system on 154.295 MHz. Each agency will have a significant investment in portable or mobile equipment to operate on the channel. Accordingly, over-all responsibility for, and control of, the system is vested in a broadly representative board. Members of the board represent the full -range of types of fire entities, which will be using the system, including a representative appointed from each of the following:

Michigan State Police, Fire Marshal Division Michigan
Natural Resources, Forest Fire Division
Michigan State Firemen's Association
Michigan Fire Chiefs Association
Michigan Fire Frequency Coordinator

OPERATION OF THE SYSTEM

Responsibility for operation and management of the system will be vested in the using fire agencies under detailed-operating procedures established by the governing board.

ESTABLISHMENT OF TECHNICAL STANDARDS

The existing radio networks offer the most optimum emergency channel resource. If an agency's current operation is in the high-band VHF spectrum and existing communications units have compatible configuration, it should be feasible to add the emergency channel to its mobile or portable radios. Participating agencies presently operating on low band VHF or UHF frequencies will have to add to their intercommunications capability on 154.295 MHz.

The desired level of interagency communications on an existing fire or other emergency can be served by either mobile or hand-held radio equipment; however, individual system requirements will dictate the most optimum method for a given system.

Regular testing to assure the technical effectiveness of the emergency network is essential. The nature of such tests and the manner in which they are conducted to be established by the governing board.

ESTABLISHMENT OF OPERATING STANDARDS

The dedication of the frequency 154.295 MHz for use in an interagency fire coordination radio network has set aside a valuable spectrum resource. Rigid control of radio traffic and enforced discipline will be necessary to achieve the goals of the fire service and thus justify the allocation of the frequency. Unnecessary and uncontrolled traffic on the channel would ultimately defeat its intended purpose. Accordingly, a principal objective of the network operating procedure must be to establish means of assuring disciplined and professional use of the system.

In general, the fire coordinating channel can be used in any fire service action requiring communication between units under circumstances where regular radio services are not available.

The fire coordinating radio network is primarily for portable and mobile service. It is principally intended to provide a communications capability among fire units of differing jurisdictions when an emergency arises which renders the regular channels of communication inadequate to provide the comminations capability needed to successfully complete the operation.

In order to preserve the emergency nature of the network, mobile installation must be limited to fire vehicles, in accordance with Federal Communications Commission Rules & Regulations for use of the frequency.

Operating procedures on the channel will follow those procedures outlined in the Associated Public-Safety Communications Officers manual of system operating procedures. Codes are not recommended and are not to be used in radio transmissions of multi-jurisdictional nature.

Where many units are involved in a particular emergency response, individual mobile and portable operators must exercise discretion to avoid overloading the fire coordination channel. Intradepartment transmission must be on that department's regular frequency with transmission on 154.295 MHz limited to only the transmissions required to properly coordinate the department's participation in the emergency response with units of other departments on the scene.

COORDINATION OF REGULATORY AFFAIRS

Like any other fire service communications system a fire communications system operating on 154.295 MHz must be licensed by the Federal Communications Commission and operated in accord with its rules. The entity responsible for day to day operation of the network will be responsible for all licensing and regulatory matters.

Each application for use of the frequency should be submitted first to the frequency advisory committee for Michigan. Detailed technical and operating plans for the network should be submitted to the fire frequency coordinator and the fire coordinating communications governing board.

If the request conforms with the planned use of the frequency, a recommendation will be made to grant the request. The frequency coordinator's recommendation must then accompany the application when it is filed with the Commission.

Michigan Public Safety

FREQUENCY ADVISORY COMMITTEE

(MPSFAC) REGION 21 700 MHz Planning Committee

DIRECT ALL CORRESPONDENCE TO:

Joseph M. Turner, Chairman
2719 State St
Saginaw, MI 48602
(989) 793-7373

REPRESENTING:

Associated Public-Safety Communications Officers, Inc.
Michigan Association of Chiefs of Police
Michigan Sheriff's Association
Michigan Municipal League
State of Michigan

CERTIFICATION OF PUBLIC MEETINGS

ON BEHALF of the members of the Region 21 700 MHz Planning Committee, I hereby certify that all meetings of the Planning Committee were open to the public; that solicitations were made at said meetings to secure comments from members of the public; and that any comments received were duly noted and properly considered during the development of the Region 21 700 MHz Plan to which this certification is affixed.

I ATTEST that proper notification was given to the public. Public notices included, but were not limited to: postings on web sites maintained by the FCC, by the Michigan Chapter of APCO and by the Michigan Public Safety Frequency Advisory Committee; notices sent via the LEIN system, and notices distributed via representatives of the various government units, not for profit agencies, for profit entities and private parties who attended 700 MHz RPC meetings and those persons who attended meetings of the Michigan Public Safety Frequency Advisory Committee. An initial solicitation of individual and parties of interest was distributed on March 28, 2000 (See Exhibit E of the 700 MHz Region 21 700 MHz Plan). The planning process was terminated on March 31, 2006 upon an electronic filing of the plan with the Federal Communications Commission.

I FURTHER ATTEST that the 700 MHz RPC will terminate upon final approval of the 700 MHz Region 21 Plan, but that the 700 MHz RPC members have voted to remain active and make available opportunities for further public comment should there be a need to revise or modify the Plan submitted to the FCC on March 31, 2006. Following approval of the Plan by the FCC, public comment will be accepted for 700 MHz frequency allocations pursuant to guidelines of the Plan as finally approved.

On this 10th day of April 2006, the above comments are certified as true and accurate to the best of my belief and knowledge.

Joseph M. Turner

Joseph M. Turner, Chairman
Region 21 700 MHz RPC
989 793-7373

AGREEMENTS WILL BE ADDED AS THEY ARE RECEIVED

Acronyms Used in the Region 21 Plan

DTV -	Digital Television
ICS -	Incident Command System
MDT -	Mobile Data Terminal
MOU -	Memorandum of Understanding
MPSFAC -	Michigan Public Safety Frequency Advisory Committee
NCC -	National Coordinating Committee
NIJ -	National Institute of Justice
NPSTC -	National Public Safety Telecommunication Council
PSWAC -	Public Safety Wireless Advisory Committee
PW -	FCC designator for Public Safety “Pool” Frequencies
SIEC -	State Interoperability Executive Committee