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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

FILED/ACCEPTED

NOV 20 2009

Federal Communications Commission
Office of the Secretary

In the Matter of	)	
	)	
Request by the TETRA Association	)	
For Waiver of Sections	)	File No. _____
90.209, 90.210 and 2.1043 of the	)	
Commission's Rules	)	
	)	

REQUEST FOR WAIVER OF SECTIONS 90.209, 90.210 AND 2.1043

The TETRA Association (the "Association"), by its attorneys, hereby requests a waiver of Sections 90.209, 90.210 and 2.1043 of the Commission's rules.[1] A waiver will allow TErrestrial Trunked RAdio ("TETRA") technology, widely used around the world as the next generation standard for digital mobile radio technology, to be used in the United States. There is a demonstrable need in the United States for use of the TETRA standard. While a number of manufacturers stand ready to produced TETRA-based devices in this country, a waiver of the Federal Communication Commission ("FCC") rules is necessary to make this technology available.

The Association therefore seeks a waiver of the following rules:

- The Association requests a waiver of Section 90.209(b)(5), authorizing operations at an occupied bandwidth of up to 21.5 +/- 0.5 kHz;
- The Association requests a waiver of the rules governing emissions masks B, C, and G in Section 90.210 to allow for up to 5dB excursions, as discussed below; and
- The Association seeks a waiver of the Commission's permissive change rules to allow TETRA manufacturers who have received interim equipment authorizations

[1] 47 C.F.R. § § 90.209. 90.210 and 2.1043.

using a modified TETRA standard to upgrade to the TETRA standard without requiring a new application or FCC ID.

I. Background

In 1994, the TETRA Association was formed to promote the use of the TETRA technology being developed at that time by the European Technical Standards Institute ("ETSI"). The Association also established from the beginning an interoperability testing and certification regime to ensure a highly competitive supply of equipment and to provide users with the confidence to purchase equipment from multiple vendors. Since 1994, the Association has grown and now represents more than 150 organizations from 37 countries that are involved in the development, deployment and use of the TETRA standard.

In the last decade, TETRA has become firmly established as the technology of choice for digital land mobile radio throughout Europe. Asia, South America, Australia and Africa.[2] By industrial sector, TETRA infrastructure is used most by transportation companies, public safety, and utilities, all of which rely upon it for fast and reliable voice and data communications.

One of the Association's first tasks was to work with users and regulators to establish harmonized spectrum throughout Europe to enable users to move freely across borders using common equipment. Since then, a number of frequency bands have been agreed upon for the use of TETRA technology.[3]

TETRA is a digital, trunked radio technology that operates with Time Division Multiple Access ("TDMA") in four slot channels with 25 kHz channel spacing. TETRA is a 6.25 kHz equivalent technology and, due to its outstanding adjacent channel performance, has been successfully integrated into spectrum management regimes throughout the world. TETRA is designed to work in the 300 MHz to 1 GHz frequency range. TETRA utilizes a highly efficient data transport mechanism allowing Short Data messages and Status messages to be sent on the control channel. Circuit mode data and IP packet data can be transmitted at up to 36kbit/s

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[2] In addition to this waiver request, the Association presently is working with Industry Canada to obtain regulatory relief needed to deploy TETRA equipment in Canada.

[3] Specifically, 350 MHz, 380-400 MHz, 410-430 MHz, 450-470 MHz, 806-870 MHz and 870-921 MHz.

(gross) and 28kbit/s (net) for multi-slot operation. Enhancements to the standard allow data rates up to 600kbit/s by using more advanced modulation schemes and wider channel bandwidths.

Additionally, TETRA-based products come with built-in air interface encryption and optional end-to-end encryption features to protect the integrity of the voice/data mobile communications. Finally, TETRA allows for fast call set-up times of typically less than 300ms which are essential for mission critical mobile communications. In sum, TETRA combines the advantages of two-way radio, mobile telephony, messaging and data in a way that is clear, fast and less expensive than other technologies.

Moreover, TETRA excels in allowing devices to be interoperable: as the first truly open system standard for digital PRM, competing suppliers now produce compatible equipment. This allows customers to purchase TETRA devices with confidence, and allows them to source equipment from many vendors, ensuring greater choice and cost-effectiveness. TETRA also allows users to share networks and benefit from the resulting lower costs without sacrificing security.

There is presently TETRA equipment available to work on a number of frequency bands in the United States, including 450-470 MHz, 806-849 MHz and 851-894 MHz. TETRA meets all FCC Part 90 requirements except that TETRA modulation does not meet the FCC requirements for occupied bandwidth and emissions masks.

A. Occupied Bandwidth

TETRA marginally fails the Part 90 occupied bandwidth requirement. TETRA employs adaptive selection of modulation and coding according to propagation characteristics, and there are agreed upon schemes for links at the edge of coverage (4 QAM), moderate speeds (16 QAM), high speeds (64 QAM), and common control channel (Π/4 DQPSK). Channel bandwidths can be 25, 50, 75 or 100 kHz. The ETSI TETRA standard does not set occupied bandwidth limits. Rather, it sets standards for adjacent channel power and for unwanted emissions at different offsets, set forth in EN 300 392-2 [3], as detailed below:

Table 1 - Maximum adjacent power levels for frequencies below 700 MHz

Frequency offset	Max. level for MS power classes 4 and 4L	Max. level for other power classes
25 kHz	-55 dBc	-60 dBc
50 kHz	-70 dBc	-70 dBc
75 kHz	-70 dBc	-70 dBc

Table 2 - Maximum adjacent power levels for frequencies above 700 MHz

Frequency offset	Max. level
25 kHz	-55 dBc
50 kHz	-65 dBc
75 kHz	-65 dBc (note)
NOTE: A level of -70 dBc shall apply for BS Power Classes 1. 2 and 3 and for MS Power Classes 1 and 1L.	

Table 3 - Wideband noise limits for frequencies below 700 MHz

Frequency offset	Maximum wideband noise level		
	MS Nominal power level ≤ 1 W (class 4)	MS Nominal power level = 1.8 W or 3 W (class 3L or 3)	MS Nominal power level ≥ 5.6 W (class 2L) BS all classes
100 kHz – 250 kHz	-75 dBc	-78 dBc	-80 dBc
250 kHz – 500 kHz	-80 dBc	-83 dBc	-85 dBc
500 kHz – f_{rb}	-80 dBc	-85 dBc	-90 dBc
$>f_{rb}$	-100 dBc	-100 dBc	-100 dBc
NOTE: f_{rb} denotes the frequency offset corresponding to the near edge of the receive band or 5 MHz (10 MHz for frequencies above 520 MHz) whichever is greater.			

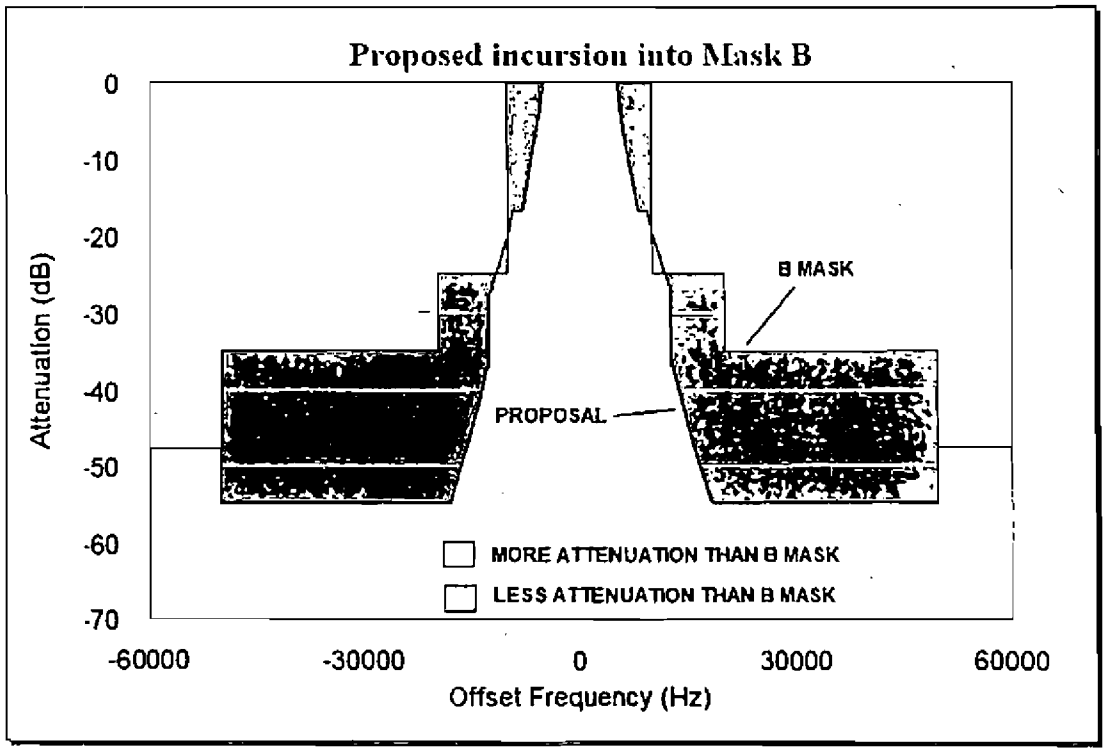
Table 4- Wideband noise limits for frequencies above 700 MHz

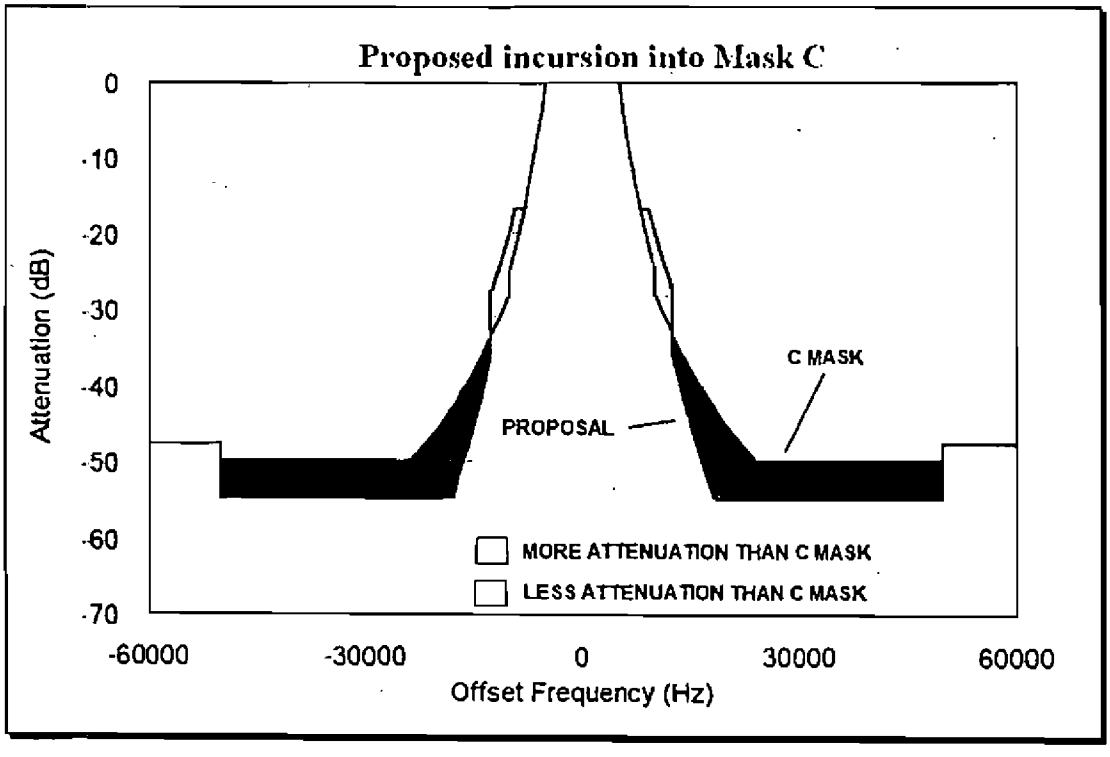
Frequency offset	Maximum wideband noise level		
	MS Nominal power level ≤ 1 W (class 4)	MS Nominal power levels from 1.8 W to 10 W and BS Nominal power levels ≤ 10 W	MS and BS Nominal power levels from 15 W to 40 W
100kHz - 250kHz	-74 dBc	-74 dBc	-80 dBc
250kHz - 500kHz	-80 dBc	-80 dBc	-85 dBc
500kHz - f_{rb}	-80 dBc	-85 dBc	-90 dBc
> f_{rb}	-100 dBc	-100 dBc	-100 dBc
NOTE: f_{rb} denotes the frequency offset corresponding to the near edge of the received band or 10 MHz whichever is greater			

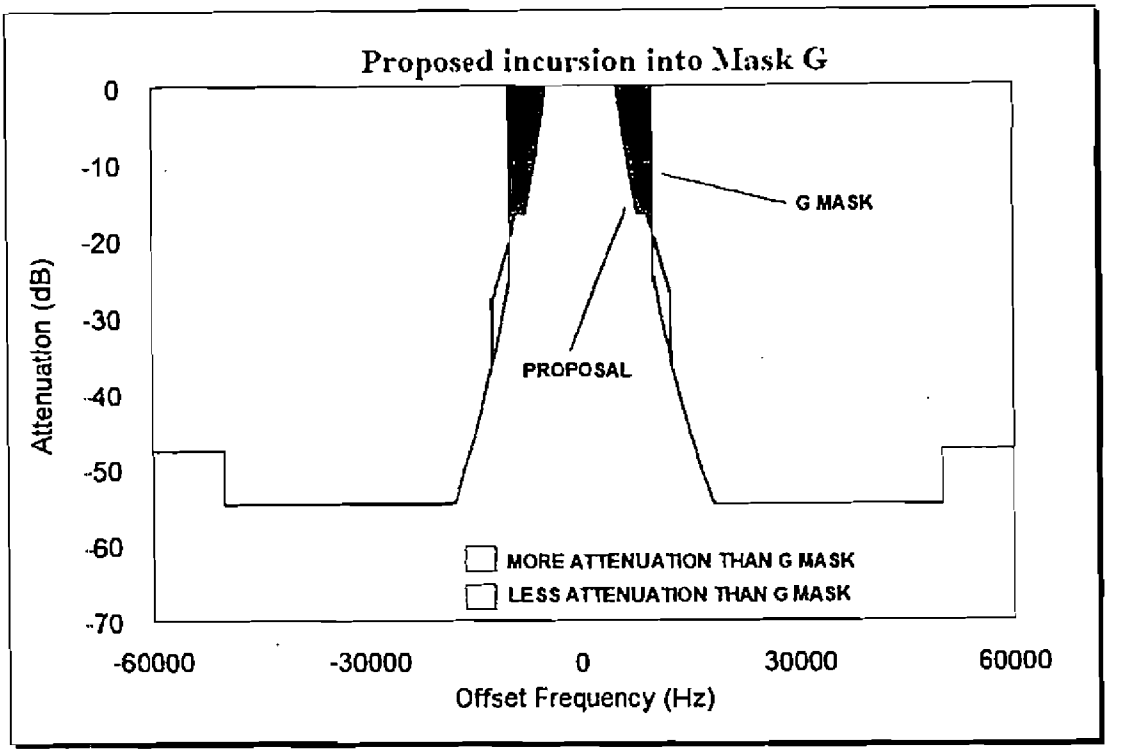
B. Emissions Masks

Similarly, the TETRA standard comes close to meeting but does not meet the Part 90 emissions mask requirements.

As discussed above, the ETSI TETRA standard does not establish channel bandwidth limits via emission masks, but rather sets standards for adjacent channel power and for unwanted emissions at different offsets. Three Part 90 emissions masks are considered appropriate for TETRA technologies: masks B, C and G. TETRA just fails to meet the Part 90 requirements by up to 5dB around 10 kHz offset from the center frequency, typically somewhere in the range 8-12 kHz, as demonstrated below.


Proposed incursion into Mask B
0
-10
-20
-30
-40
-50
-60
-70
Attenuation (dB)
B MASK
PROPOSAL
MORE ATTENUATION THAN B MASK
LESS ATTENUATION THAN B MASK
-60000
-30000
0
30000
60000
Offset Frequency (Hz)


Proposed incursion into Mask C
0
-10
-20
-30
-40
-50
-60
-70
Attenuation (dB)
C MASK
PROPOSAL
MORE ATTENUATION THAN C MASK
LESS ATTENUATION THAN C MASK
-60000
-30000
0
30000
60000
Offset Frequency (Hz)



Notably, the present Part 90 emissions mask requirements are designed for analog devices. For digital modulation technology such as TETRA, Adjacent Channel Coupled Power ("ACCP") would be a better measurement criteria for this technology, as in adjacent channels TETRA outperforms the FCC's emissions masks. This performance is a better guarantee of the ability of TETRA technology to avoid interference and co-exist with other radio systems. The Association notes that ACCP was adopted in the 700 MHz public safety narrowband proceeding for use by other Part 90 systems.[4]

C. Permissive Change

As an interim measure, certain TETRA manufacturers are seeking FCC certification of radios using a modified TETRA standard – essentially reducing power to levels that will permit compliance with existing Part 90 rules. This is being done to meet critical, immediate demand for TETRA-style radios while the waiver request is being processed. Assuming that the waiver request is granted, the effected manufacturers will modify the radios produced using the interim standard to make them consistent with the worldwide TETRA standard.

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[4] *See* 47 C.F.R. Part 90, Subpart R.

Generally. the Commission does not allow certain changes to certificated equipment, including changes to the maximum power, without application and authorization of new grant of equipment certification.[5] The Association seeks a waiver of this rule to allow the TETRA manufacturers who have received authorizations for interim TETRA equipment, as described above, to upgrade to standard TETRA upon grant of this waiver request without having to go through the process of filing new equipment authorization applications and requesting new FCC ID numbers.

Grant of this request would serve the public interest, as it will ensure that both manufacturers and Commission staff will not have to undergo the equipment certification process twice.[6]

II. A Waiver Would Be in the Pubic Interest

The Commission may waive its rules if the underlying purpose of the rule would not be served or would be frustrated by application of the rule, and waiver of the rule is in the public interest.[7] Such considerations exist in this instance, as the underlying purpose of Sections 90.209 and 90.210 would be frustrated by application of the rule. Grant of a waiver, on the other hand, would serve the purpose of the rule by giving users of the technology enhanced capabilities greatly need by public and private mobile radio users. A waiver also would effectuate the Commission's policies favoring prudent and efficient use of spectrum.

In this instance, grant of a waiver would do no harm. TETRA has been successfully integrated into spectrum management regimes around the world, and TETRA systems are able to co-exist very well with other technologies. The TETRA standard ensures that RF transmitters do not interfere with other radio equipment operating in the same area by limiting the power emitted to adjacent channels and at different frequency offsets. For this reason, it is not necessary to employ guard bands with TETRA devices, and ETSI does not set limits, other than total

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[5] 47 C.F.R. § 2.1043(a).

[6] The Association recognizes that there is an exception to the permissive change rules for software defined radio ("SDR") devices. 47 C.F.R. § 2.1043 (b)(3). However, the Association believes that it would make for a more consistent process to waive the permissive change rule rather than rely on individual manufacturers to apply for equipment certification as SDR.

[7] 47 C.F.R. § 1.925(b)(3).

transmitter power limits, to the transmitted signal level at different offsets within the authorized bandwidth.

A waiver would pose very little risk of interference to other Part 90 operations due to TETRA's adjacent channel performance. The Association is attaching an analysis of the potential performance of TETRA equipment in the United States.[8] Using Adjacent Channel Power Ratio ("ACPR") to measure the quantification of interference, this analysis demonstrates that TETRA offers adjacent channel protection that is no poorer than, and often better than, other narrowband systems currently operating in the LMR bands.[9] TETRA emissions only marginally exceed the emissions masks, for example with Emission Mask B only at the shoulders between 10 kHz and 10.5 kHz from the center.[10] In sum, TETRA can co-exist without negative impact to adjacent channels. As well, TETRA is robust enough so that it is adequately protected from interference.

Additionally, TETRA operations in more than one hundred countries provide further evidence that the technology can co-exist well with other technologies. The country of Spain has provided the Association with written certification of this fact. New Zealand has recommended that P25, TETRA and analogue devices can co-exist, specifically by adopting rules allowing for the overlay of TETRA and APCO P25 digital channels on the existing analog channel roster. And, a CEPT analysis, using Monte Carlo Simulation, studied the adjacent channel compatibility of 400 MHz TETRA and analog FM PMR, and found that under everyday conditions the technologies are able to co-exist without guard bands

A waiver will facilitate more efficient and enhanced performance. Continued application of the rules, by way of contrast, would frustrate the underlying purpose of Sections 90.209 and 90.210 by depriving the public of the benefits of TETRA technology.

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[8] *See* Attachment A.
[9] *Id.* at 7 and 9.
[10] Attachment A at 2.

III. A Waiver Would Achieve Significant Public Benefit

Granting the Association a waiver will yield significant benefits. With authority to market products in the United States, manufacturers will be able to provide next generation digital mobile radio technology used in more than 100 countries right now.

The TETRA standard has been successfully integrated into spectrum management regimes in use throughout the world. The technology is used principally by public safety and critical infrastructure entities. both public and private. While the public safety community in the United Sates has adopted the P25 standard for a variety of reasons, many other entities responsible for managing critical infrastructure would benefit substantially from access to TETRA, which is particularly well suited to metropolitan and urban environments.

No other available LMR technology has the capabilities of TETRA, which combines voice (two-way radio), mobile telephony. status messaging, short data service, packet data up to 28.8k/bits, enhanced data (up to 600k/bits), encryption, and more. TETRA also supports a wide-range of supplementary services, many of which are exclusive to TETRA.

There are a large number of TETRA product manufacturers worldwide, including U.S. companies such as Motorola and Tyco/Harris. This, coupled with the compatibility of products by the different manufactures due to the open standard, allows for greater competition and lower prices.

IV. Conclusion

For the reasons set forth herein, the Association requests waivers of Sections 90.209, 90.210 and 2.1043, permitting the TETRA standard to be used in the United States. These requested waivers will serve the public interest, as the availability of TETRA in the United States will open the U.S. market to a low cost, fully-interoperable, and cutting edge technology much needed by public safety and private mobile radio users.

Respectfully submitted,

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ATTACHMENT A

ANALYSIS OF THE ABILITY FOR TETRA TO CO-EXIST WITH OTHER LMR TECHNOLOGY IN THE UNITED STATES

PURPOSE

The purpose of this technical note is to analyze TETRA's impact on other technologies used for Land Mobile Radio (LMR) in the United States and to show that it can co-exist without causing interference to users of such technologies.

SCOPE

The scope is to explore the impact that TETRA will have on other LMR technologies deployed in the U.S., focusing specifically on the impact on radios using adjacent channels.

REFERENCES

TIA Telecommunications Systems Bulletin, TSB-88.1-C, *Wireless Communications Systems Performance In Noise And Interference Limited Situations, Part1: Recommended Methods For Technology Independent Performance Modeling.*

BACKGROUND

1. The introduction of the TETRA digital radio standard into the U.S. marketplace requires a waiver of certain FCC technical rules, namely the occupied bandwidth and emissions mask requirements. This, in turn, requires a showing of the feasibility of coordination of suitable spectrum assignments and implementation within available spectrum alongside legacy systems.

2. TETRA systems use π/4-DQPSK modulation with 25 KHz channel spacing; supporting a transmission rate of 36 Kbps. TETRA is a Time Division Multiple Access (TDMA) standard, where time is divided into slots. A TETRA frame consists of 4 time slots, *i.e.*, each RF carrier includes 4 logical channels, and therefore can be considered a 6.25 KHz equivalent technology in terms of use of spectrum.

METHODOLOGY

TETRA can be treated as equivalent to the aggregation of two 12.5 kHz assignments or as equivalent to an aggregation of four 6.25 kHz assignments. The adjacent channel interference is effectively determined by measuring the adjacent channel power ratio (ACPR) as experienced by receivers that would be operating in adjacent channels. It can also be modeled by using measured transmitter spectral power densities (SPD) and the receiver filter characteristics for adjacent channel systems. TSB-88.1-C [1] provides measured SPD values for several modulation types as well as a method for modeling the adjacent channel power ratio for various receiver filter characteristics.

The following section provides an analysis of the ACPR performance of TETRA and other systems.

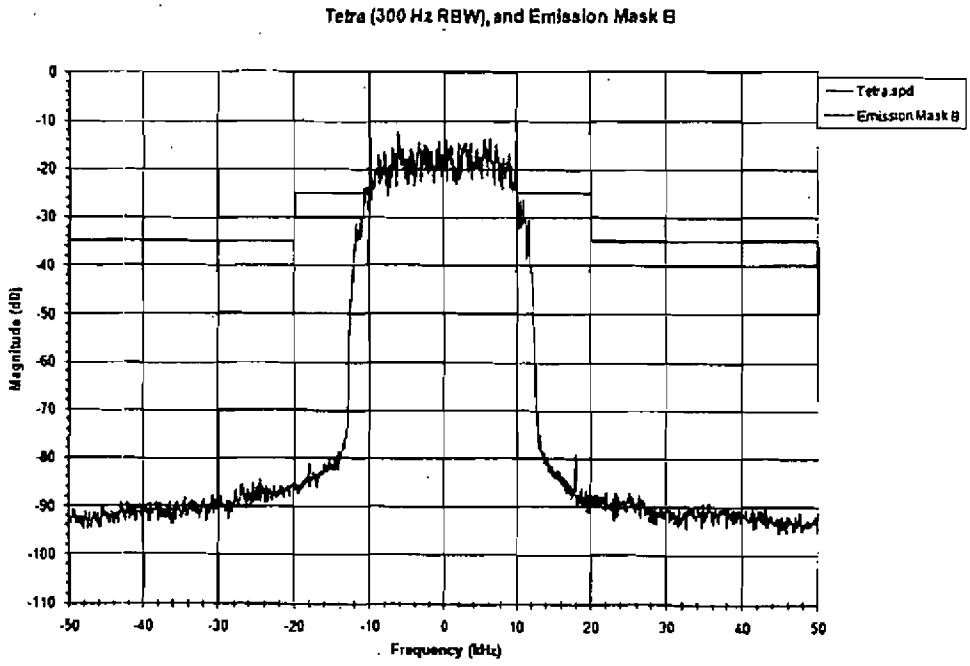
TETRA PERFORMANCE AGAINST REGULATORY CRITERIA

To operate on 25 kHz channel spacing in the UHF or 800 MHz bands, TETRA would be required to meet Emission Mask B, C or G and to be constrained within 20 kHz authorized bandwidth. Emission Mask B is defined in Table 1.

Table 1 - Emission Mask B

Displacement Frequency, f_d (% of the Authorized Bandwidth)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
$50 \le f_d \le 100$	25	300
$100 < f_d \le 250$	35	300
$f_d > 250$	43+10 log(P)	Except where otherwise stated, on any frequency removed from the carrier frequency by more than 250% of the authorized bandwidth, a resolution bandwidth of at least 100 kHz must be used for frequencies to be measured below 1000 MHz

TETRA's emission is shown in comparison to Emission Mask B as in the chart below.



It can be seen that TETRA emissions may marginally exceed the mask at the "shoulders" between 10 kHz and 10.5 kHz offset from the channel center. This divergence from the prescribed 25 kHz emission mask requires a waiver of the FCC rules.

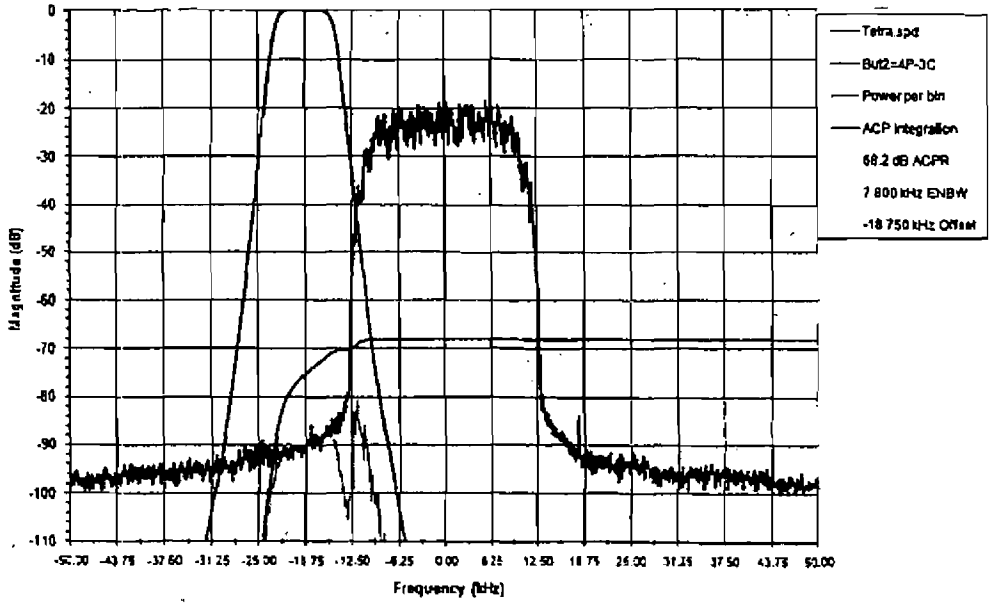
Similarly, at the measurement resolution bandwidth (RBW) specified TETRA emissions marginally exceed Mask C and Mask G. At lower measurement RBW (200 as opposed to the 300 Hz specified), TETRA can be shown to meet Mask B, and can also meet Masks G and C at an RBW of 100 Hz.

Emission mask definitions, as a basis for certification of equipment, are artificial constructs that attempt to model the impact of emissions on systems occupying adjacent and other channels. However, they do not adequately differentiate the real-world impact of different technologies. A technology may exceed an emission mask under certain measurement conditions but may actually couple less power into a co-channel or adjacent channel system than would a technology (such as OpenSky in the instance of FCC Part 90 operations) that fits within the prescribed emission mask.

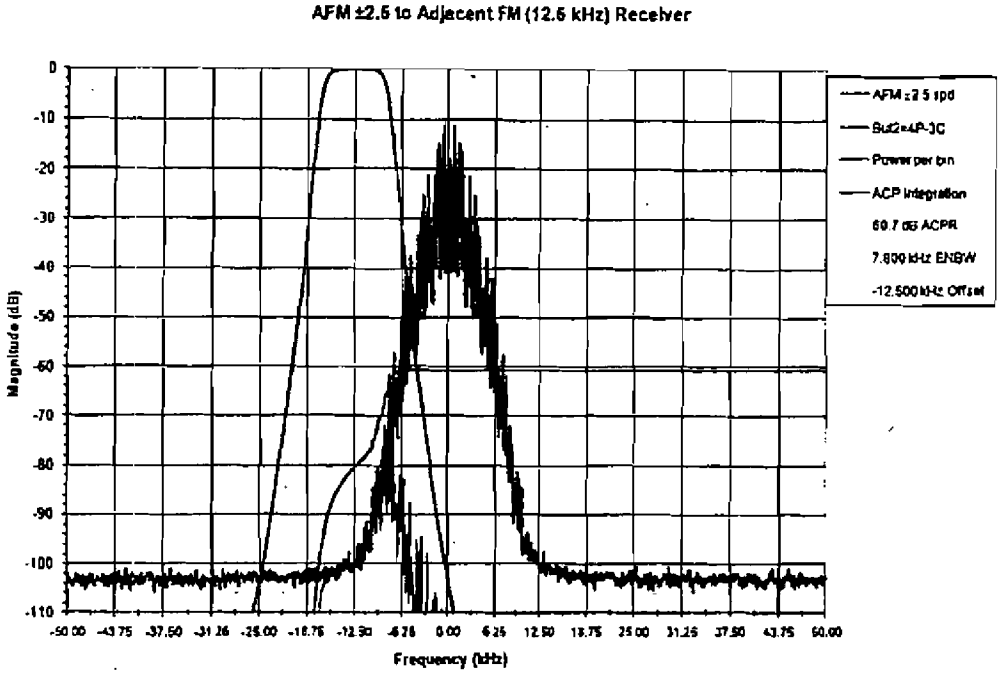
The Adjacent Channel Power Ratio (ACPR) coupled with the typical victim receiver filter characteristics is more directly applicable to technology co-existence and spectrum coordination, as it provides a measurable quantification of interference (Aggregated Channels).

The chart below shows the interference characteristic of a TETRA emission (measured values from [1]) assigned as an aggregation of two 12.5 kHz assignments (*i.e.*, centered interstitial to two assignments). The receiver filter indicated is a typical narrowband (12.5 kHz) FM analog receiver located on the next adjacent 12.5 kHz assignment. The resultant ACPR, as coupled from TETRA into the adjacent narrowband FM receiver, is 68.2 dB.

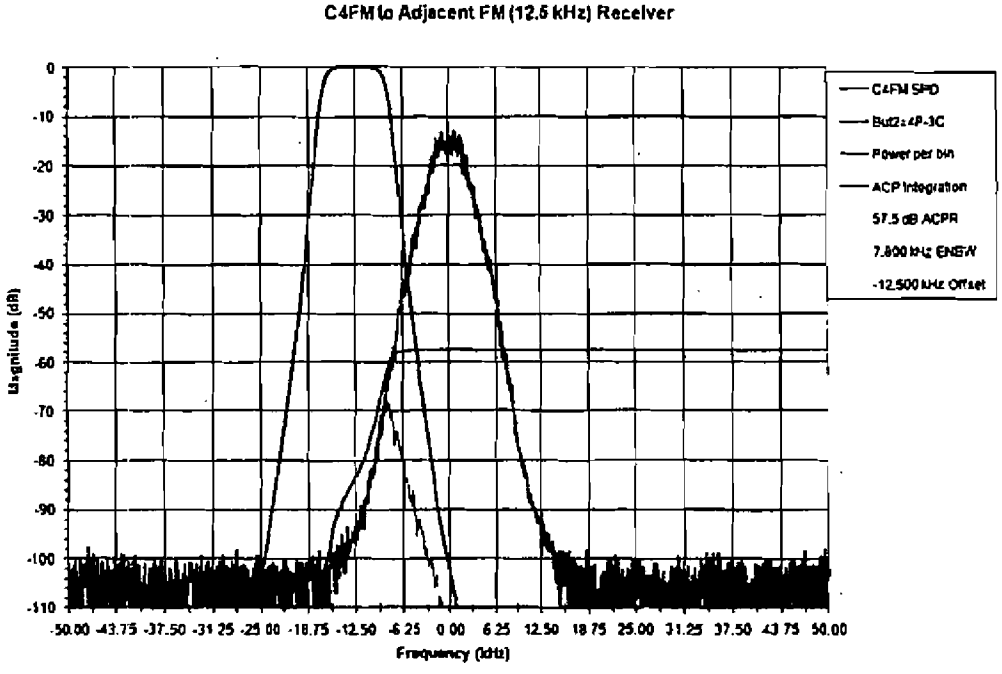
Tetra, to Adjacent FM (12.5 kHz) Receiver



In comparison, a 12.5 kHz FM analog system offers an ACPR to the adjacent assignment of only 60.7 dB, as shown below.



For further comparison, P25 Phase 1, using C4FM modulation, provides an ACPR of only 57.5 dB to an adjacent 12.5 kHz FM system.

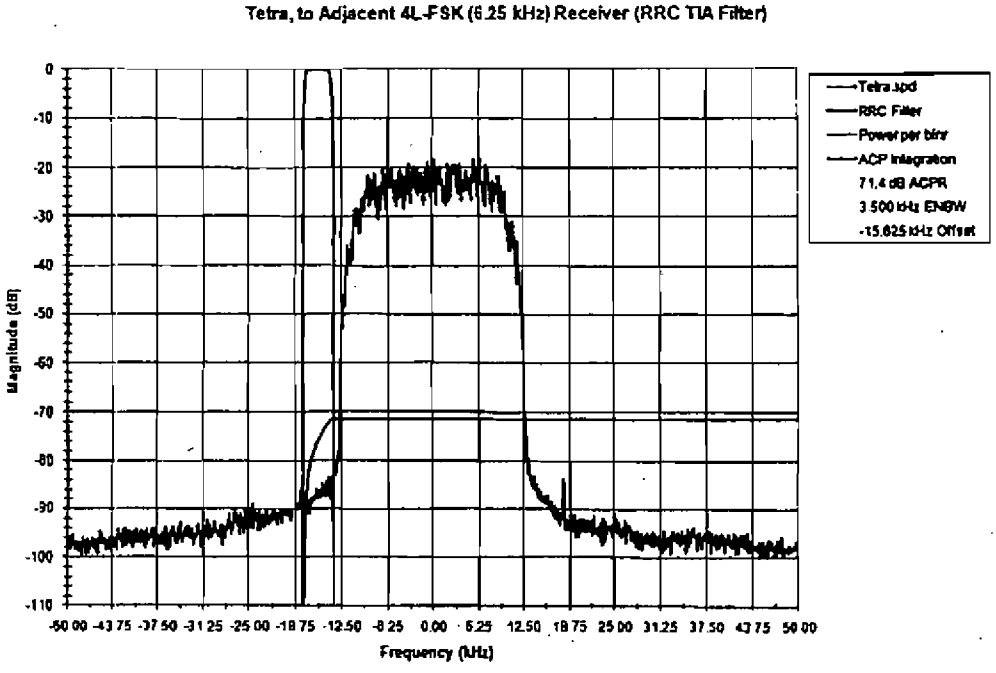


This comparison can be carried further to 6.25 kHz channel assignments, assuming treatment of TETRA as an aggregation of four channels. However, that comparison is largely a matter of comparing the adjacent channel power and receiver filters of digital modulation schemes that aggregate channels similar to TETRA, as there is

little expectation that 6.25 kHz narrowband systems will be adopted to any significant degree in LMR bands.

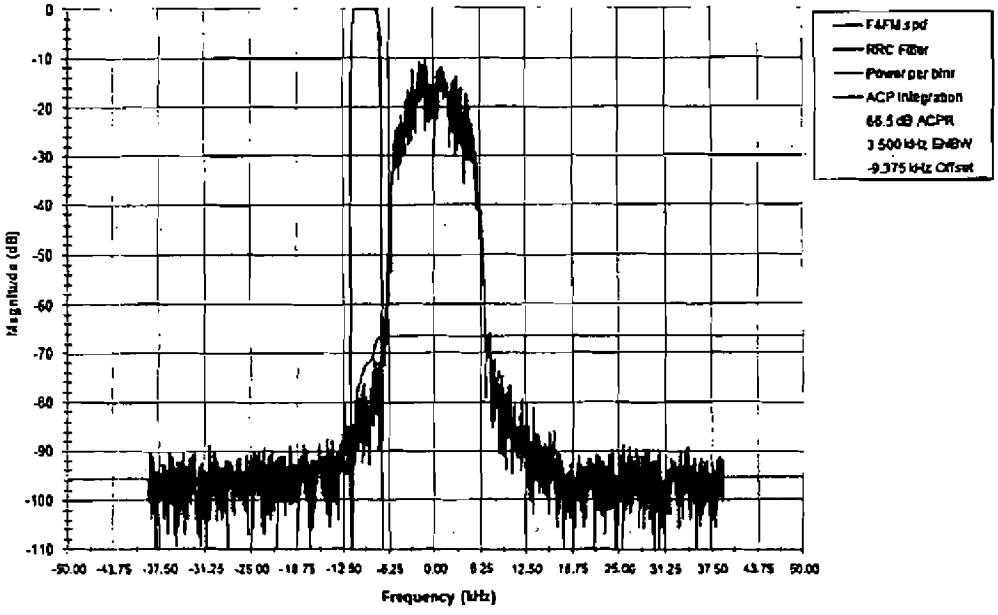
The receiver filter characteristics of 4L-FSK provide a suitable reference for comparison of TETRA versus Filtered 4-Level FM modulation (F4FM is a proposed modulation in a Phase 2 Project 25 TDMA system) ACPR on adjacent 6.25 kHz channels. In this situation TETRA is treated as the aggregation of four 6.25 kHz assignments (centered two and half channels, or 15.625 kHz from the next 6.25 kHz channel), and F4FM is treated as the aggregation of two 6.25 kHz channels (centered one and a half channels, or 9.375 kHz from the next 6.25 kHz assignment).

The chart below shows the ACPR of the TETRA assignment to a receiver on the next adjacent 6.25 kHz, an ACPR of 71.4 dB.



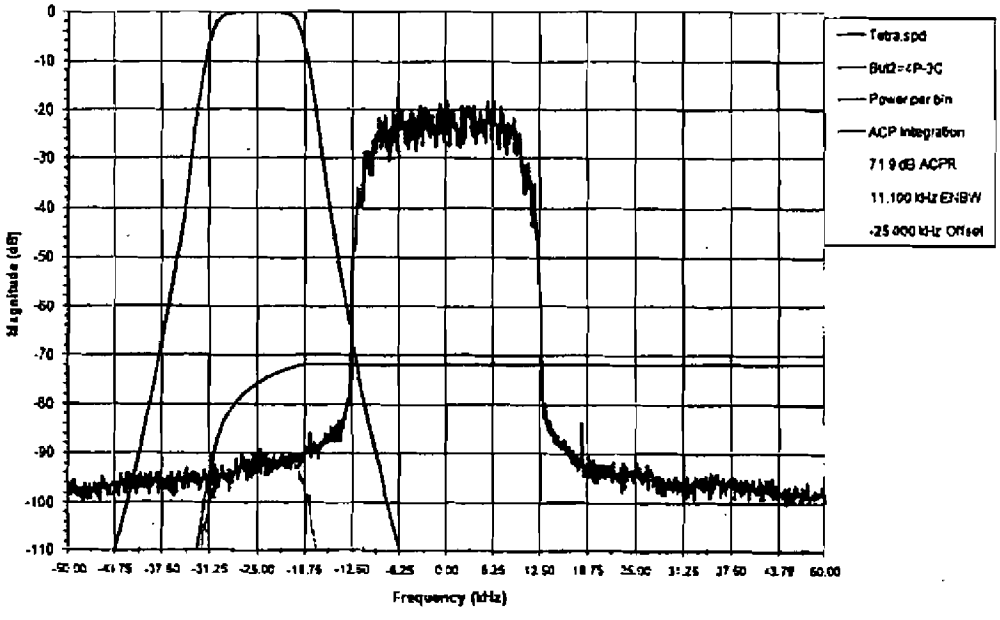
For comparison an F4FM system ACPR to a receiver on the adjacent 6.25 kHz channel (shown in the chart below) is 66.5 dB, roughly 5 dB worse than the TETRA ACPR.

F4FM, to Adjacent 4L-FSK (6.25 kHz) Receiver (RRC TIA Filter)



TETRA's adjacent channel coupled power into adjacent 25 kHz FM receivers is not as high as other technologies occupying 25 kHz channel assignments and not that high when compared to equipment with adjacent channel selectivity found in digital receivers and high selectivity analog receivers. The chart below shows the TETRA ACPR for 25 kHz adjacency to a 25 kHz FM analog receiver.

Tetra, to Adjacent FM (25 kHz) Receiver



The table below summarizes the ACPR for 25 kHz channel assignments for EDACS, FM Analog, iDEN, OpenSky and TETRA 25 kHz offset from FM analog receivers with wideband and NPSPAC band receivers.

Tx → Victim Rx ↓	EDACS (NPSPAC)	EDACS (WB)	FM Analog (WB)	iDEN	OpenSky (F4GFSK)	TETRA
FM Analog WB (16 kHz ENBW)	62.6dB	57.7dB	78.9dB	64.2dB	57.8dB	60.3dB
FM Analog NPSPAC (11.1 kHz ENBW)	66.5dB	63.7dB	82.7dB	68.8dB	64.3dB	71.9dB
IDEN & TETRA 18 kHz ENBW	61.4dB	56.1dB	80.1dB	64.6dB	55.9dB	69.2dB

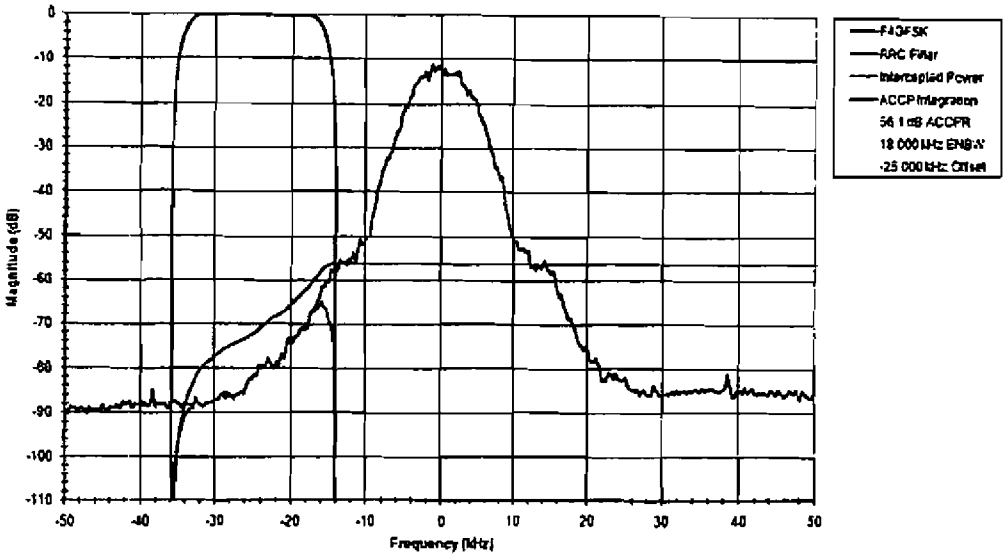
Apparent in this comparison is that TETRA can provide better adjacent channel protection than some other 25 kHz technologies that the FCC has approved, such as OpenSky, provided adjacent channel receiver filters are relatively selective. In terms of the practical application, it demonstrates that TETRA can co-exist at 25 kHz channel offsets from 25 kHz receivers with high adjacent channel selectivity and that adjacent channel assignments could be achieved even with less selective adjacent channel receivers.

TETRA AS THE VICTIM RECEIVER

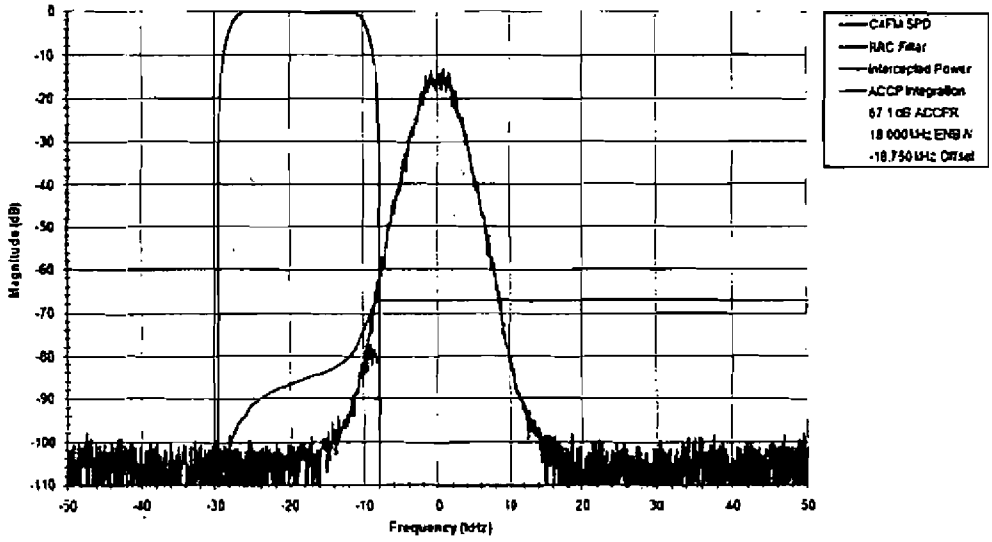
TETRA appears sufficiently robust to not be unduly interfered with by other modulations, with the possible exception of OpenSky. It does not appear to require any particular protection from 25 kHz adjacent channels, and is adequately protected from 12.5 kHz assignments provided the TETRA assignment is treated as an aggregate of two 12.5 kHz assignments (18.75 kHz offset).

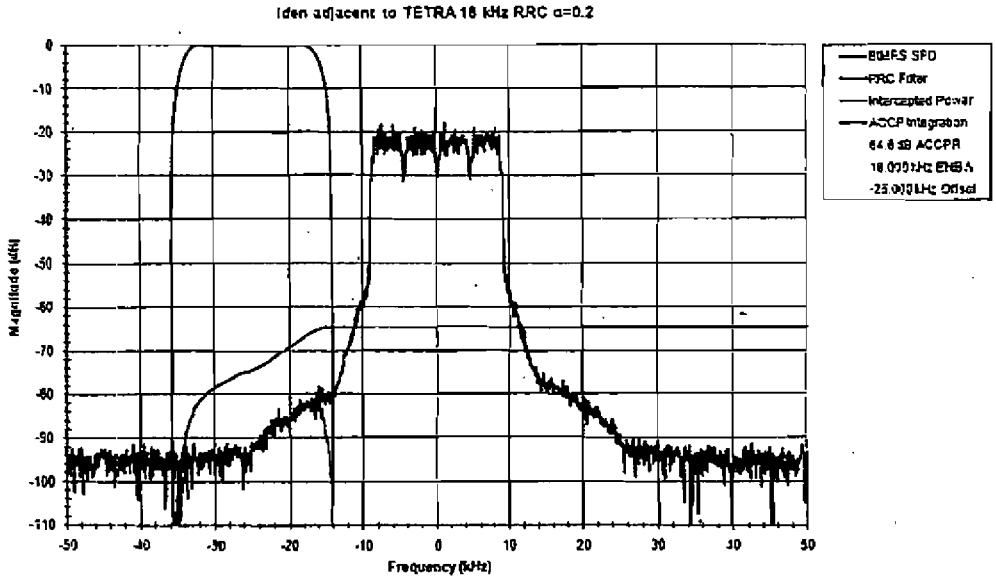
From this analysis, TETRA could be located within 800 MHz commercial band, adjacent to iDEN and other 25 kHz bandwidth systems, or in other UHF bands that remain primarily utilized on 25 kHz assignments.

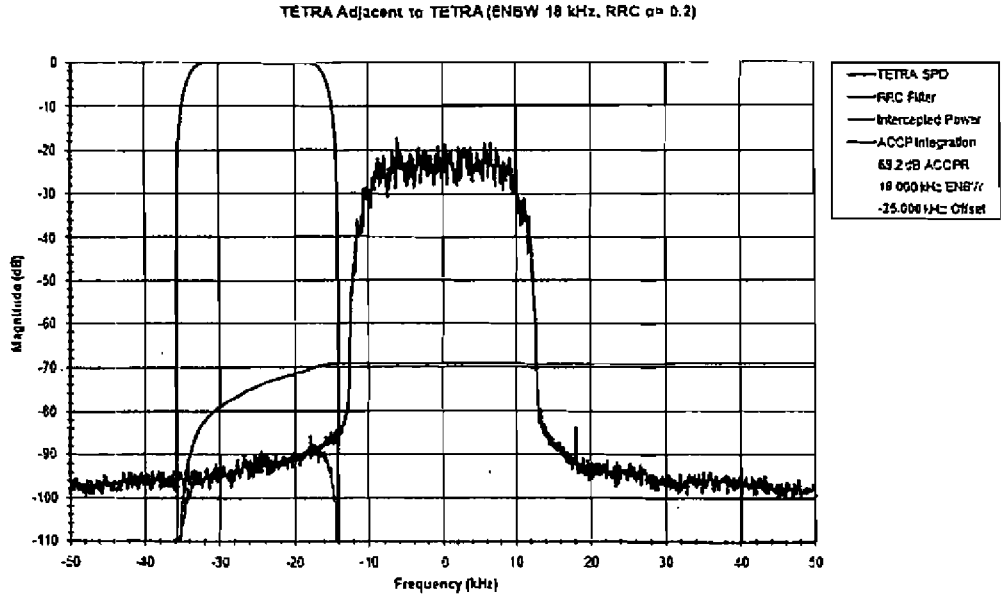
Opensky interfering with TETRA



P25 (C4FM) adjacent to TETRA ENBW 18 kHz RRC α=0.2







CONCLUSION

The conclusion of this analysis is that TETRA, treated either as an aggregation of two 12.5 kHz channels or as four 6.25 kHz channels, offers equal or better adjacent channel protection than do other narrowband systems that are currently permitted to operate in the LMR bands in the U.S. It can co-exist at interstitial offsets to 12.5 kHz and 6.25 kHz receivers without negative impact on the adjacent channel assignments. It also can co-exist with existing 25 kHz channelized systems, at least as well as other 25 kHz technologies already approved by the FCC.