Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Revitalization of the AM Radio Service	)	MB Docket No. 13-249
	)	
Second Further Notice of Proposed Rulemaking	)	

COMMENTS OF BROADCAST TRANSMISSION SERVICES, LLC[1]

Introduction & Summary

In this proceeding, the Commission seeks ways of revitalizing the AM broadcast service, known in 47CFR73 as *Standard* Broadcast Stations. It has been decades since AM radio set *the standard* for popular broadcast services. Though better technology, used in other frequency bands, precludes AM radio from being the reference *standard* for aural broadcasting in the future, this proceeding should close with results that will enable AM stations to meet today's consumer expectations, while permitting greater flexibility for stations to tailor their facilities to the needs of their service areas, where such can be done ***without degrading*** existing services.

Unfortunately, some of the Commission's proposals and commenters' suggestions will do quite the opposite, worsening the consumer experience in places where it is acceptable today. Whether this arises from a fundamental misunderstanding of the nature of the service, a blindered view of the criteria fogging the impact of the proposed changes, selfish interest in generating application preparation work, or a desire to be seen as doing something, regardless of result, is unknown.

While the Commission sought specific information on the protection of Class A stations in the 2nd FNPRM, the technical criteria to be so used have implications for all stations and will be so addressed in these comments. Overall, the instant comments are summarized as follows:

[1] Broadcast Transmission Services, LLC (bTs) offers technical services to radio and television broadcast stations, such as antenna specification, measurement, and adjustment, transmitting system configuration, diagnosis, and performance optimization, along with preparation of the technical sections of applications for FCC authorizations. The bTs principal, Karl D. Lahm, P.E., has 50 years of experience in broadcast transmission technology, having recently retired from Univision Communications, where he was Director, RF Systems Engineering for that company's local TV, FM, and AM stations. Prior to Univision, the author was the principal engineer for medium wave (AM band) transmitting systems at the USIA International Broadcasting Bureau, the then-parent of the Voice of America international radio service, from 1992 to 1999. From 1981 to 1992, he was a broadcast consulting engineer active in application preparation, AM antenna system design and field adjustment, and various industry activities.

- All stations should be protected at the 2 mV/m groundwave contour during daytime hours. Consideration should be given to RSS calculation of interfering signals at those contours. However, this change in protected contour should be made only if the protection (D/U) ratios are increased as recommended below.
- Class A stations should be protected at the 2 mV/m groundwave contour during nighttime hours, on an RSS basis with 25% exclusion, and during "critical hours", using the D/U ratios noted below in both cases.
- Desired-to-undesired (D/U) signal ratios at protected contours should be increased to 40 dB for the co-channel case and 20 dB for the first adjacent channel case.
- The Commission should consider development of a comprehensive AM allocations analysis tool that will facilitate and standardize calculation and analysis of desired and undesired signal levels caused by existing and proposed facilities, using the capabilities of modern multi-core personal computing systems. The Commission's development of TVStudy software has greatly facilitated the repacking of TV channels and something similar would be very helpful for AM band redevelopment, if funding can be found.

Taken together, these changes will protect the usable service of existing stations of all classes, without significant degradation, while eliminating the protection of areas where signals are not of sufficient strength or reliability to ensure a listener experience that is competitive with FM, digital, and streaming services. Incremental service improvements will then be possible.

<u>AM Radio Fundamentals</u>

Before considering protected contour and desired/undesired (D/U) signal ratio values, it is important to understand the nature of the AM medium and the impact of protected and interfering contours on the listener experience. The very nature of AM broadcasting causes a direct correlation of protected contour values and permissible interference at those contours with the consumer's experience. The service will continue to atrophy if it cannot provide a listening experience that is at least somewhat comparable to FM, satellite radio, and internet streaming. That means (a) sufficient signal strength to overcome environmental noise and (b) sufficient D/U ratios to minimize the audibility of interference, or, put another way, sufficiently low interfering signal levels to accomplish the same thing.

The allocation criteria of the AM technical standards are expressed in protected signal field strengths and permissible interfering field strengths at the locus of points achieving the protected signal value, i.e., the protected coverage contour. In the FM and TV services, the same approach is taken to defining the protected signal level, but the D/U ratio is specified instead of a permissible interfering signal absolute level. In these comments, the D/U ratios will be discussed extensively, though they do not appear literally in the criteria set forth in the rules today, nor in the Commission's proposals. The following is an adaptation of the current table of §73.37 with D/U ratios added:

Frequency Separation (kHz)	Contour of Proposed Station (Classes B, C, and D) (mV/m)	Contour of any other station (mV/m)	D/U Ratio (dB)
0	0.005	0.100 (Class A)	26
	0.025	0.500 (Other classes)	26
	0.500	0.025 (Other classes)	26
10	0.250	0.500 (All classes)	6
	0.500	0.250 (All classes)	6
20	5.0	5.0 (All classes)	0
	5.0	5.0 (All classes)	0
30	25.0	25.0 (All classes)	0

To a listener, a service is attractive if (a) the programming is of interest and (b) it can be heard without distraction by background noise or other programming lying underneath. Ultimately, the allocation criteria attempt to promote the latter by (i) defining a signal level likely to overcome environmental noise and (ii) limiting undesired signal levels so as to preclude aural distraction.

As an example, consider two audio program streams, a newscast and the play-by-play description of a sporting event, both available on an audio mixer. If the mixer's volume controls are set so that the audible levels of the two programs are the same, neither one can be followed, as components of each distract from the other, just as two simultaneous conversations in the same room do. As the level of the sporting event is reduced, the clarity of the newscast improves. At some point, the sporting event audio no longer distracts from following and understanding the newscast. AM radio interference, particularly co-channel interference, works in the same way and by the same ratio. For a desired program to be intelligible and attractive, the distracting effect of the undesired program must be minimized.

Unlike FM and digital services, the desired-to-undesired aural signal ratio, experienced by the listener, is essentially identical to the RF D/U protection ratio, assuming equal modulation density for desired and undesired signals. There is no "capture" by the receiver that makes a noisy signal usable and blocking the undesired signal's modulation, nor any form of digital error correction that reconstructs lost components. It doesn't take much scanning of the AM dial, especially at night, to find stations that with potentially usable signal levels, yet with the programming of interfering stations readily audible in the background, distracting from the intelligibility of the desired programming. This is the product of not only insufficient allocation standards, but also

longstanding Commission policies that have prioritized the addition of stations over the maintenance of minimum technical standards and preservation of listenability.[2]

The RF D/U ratio must be sufficient to promote an acceptable listening experience. FM radio is capable of audio signal-to-noise ratios in excess of 60 dB. Satellite, digital and streaming services can approach and exceed that level of performance. It is readily apparent that a co-channel D/U ratio of 26 dB is insufficient to ensure a listening experience competitive with other services.[3] While some consumers might accept such degradation to hear a highly desired program, such as a baseball game featuring a favored team whose games are not broadcast locally, it does not foster competitive success, in the general sense.

Minimum Usable Signal Level

The Commission proposed that protected groundwave signal contour for most AM stations be raised from 0.5 mV/m to 2 mV/m. The latter level has been recognized as the minimum signal level needed for service to communities of 2,500 people or more for decades.[4] There has been much support in comments submitted in this proceeding for this signal level as being the minimum usable in the modern era of countless sources of electromagnetic interference, as digital devices using RF-like internal signals proliferate. The use of that signal level is supported herein.

While the 2nd FNPRM did not request commentary on any minimum signal level for Class A stations other than the 0.5 and 0.1 mV/m levels contained in the current rules, there is no compelling reason to treat those stations any different than the other classes. Class A stations should also be adequately protected at their 2 mV/m groundwave contours, but for both day *and night* operation.

Minimum Protection (D/U) Ratios

Earlier in this proceeding, in April 2016, Univision Communications submitted Reply Comments urging the Commission to adopt D/U signal ratios of 40 dB for co-channel stations and 20 dB for adjacent-channel stations, based on the engineering documents submitted with its comments and authored by this writer before his 2018 retirement from Univision. [5]

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[2] Class B stations were originally protected from nighttime skywave interference at their 2.5 mV/m contours and were not authorized in cases where that interference level would be exceeded by signals from previously-authorized stations. The FCC subsequently allowed waiver of that restriction upon "showing of need" and that the population located between the interference-free and 2.5 mV/m contours did not exceed 10% of the population contained within the latter contour. Over the years, the threshold for "need" evaporated, allowing stations to operate at night with very high levels of incoming interference, in some cases causing signal levels above 25 mV/m to be required to overcome nighttime skywave interference, severely restricting service areas and fostering unsatisfactory consumer experiences..

[3] Until audio performance standards were stricken from the rules, AM broadcast stations were required to demonstrate a demodulated aural signal-to-noise ratio of 45 dB.

[4] See §73.182(d)

[5] The Univision Reply Comments included an extensive engineering analysis of de facto D/U ratios at the 2 mV/m contour in its Appendix 1, which is attached hereto for reference.

A 26 dB co-channel D/U ratio is insufficient for a satisfactory consumer aural experience, given the direct correlation of RF D/U ratios to demodulated aural D/U ratios in the AM service and the far higher aural ratios available in competing media. *De facto* RF D/U ratios increase as the protected contour field strength value is increased above the 0.5 mV/m (0.1 mV/m for Class A stations) value noted in the table of §73.37. At a minimum, the *de facto* RF D/U ratios at the 2 mV/m contour *today* are 38 dB for the co-channel case and 12 to 16 dB for the first adjacent channel case. ITU Recommendation BS.560-4 cites a co-channel protection ratio of 40 dB.[6] A consumer subjective study of D/U ratios performed by B. Angell for the National Association of Broadcasters in 1988 demonstrated that RF D/U ratios of 40 dB co-channel and 16 dB first adjacent channel were necessary for consumer satisfaction.

Accordingly, these comments reiterate the appropriateness of changing the D/U ratios to 40 dB for co-channel and 20 dB for the first adjacent channel relationships, universally across daytime, critical hours, and nighttime operation. The recommended changes to §73.37(a) are found in the following table:

Frequency Separation (kHz)	Contour of Proposed Station (mV/m)	Contour of any other station (mV/m)	D/U Ratio (dB)
0	0.02	2.0	40
	2.0	0.02	40
10	0.20	2.0	20
	2.0	0.2	20
20	5.0	5.0 (All classes)	0
	5.0	5.0 (All classes)	0
30	25.0	25.0 (All classes)	0

References to 0.1 mV/m and 0.5 mV/m contours throughout §73.182(a) and (q) should be changed to 2 mV/m and distinctions between groundwave and skywave in §73.182(a)(1) and (a)(2) eliminated. References to permissible interfering signal levels in §73.182(q) should be revised to 20 µV/m "SC" and 200 µV/m "AC", also universally.

Contour Surrogacy

If the allowable RF D/U ratio (and, therefore, the aural D/U ratio) at a signal level of 0.5 mV/m does not result in a satisfactory listener experience, then what is the purpose of defining the 0.5 mV/m contour as the point of protection? That contour and the D/U ratio specified there serve as

[6] The ITU recommendation for the adjacent channel case varies as a function of transmission bandwidth and assumed audio signal processing, with none of the latter scenarios corresponding to typical North American operation.

a ***surrogate*** for effective protection of the 2 mV/m contour. In other words, the inadequate protection of the 0.5 mV/m contour ensures adequate *de facto* protection of the 2 mV/m contour, under the existing rules and standards.

The practical effect of the use of *surrogate* contours is to cause arcs of protection to potentially impacted stations, from potentially-interfering stations, to be wider than necessary. Figures 11-13 of Appendix 1 demonstrate this effect graphically.

Nowhere is the impact of contour surrogacy more pronounced than for the case of Class A stations, where the 0.5 mV/m *secondary* (skywave) service contour is currently protected. This can necessitate broad and deep suppression of radiation from co-channel and adjacent-channel stations, toward an area where usable service may exist for only 50% of locations and 50% of time.

To illustrate the restrictions imposed on Class B (and many duplicated Class A) stations by the current skywave protection requirement, a hypothetical Class A station, operating on 940 kHz, was placed at Kansas City, MO. Using a 190° (anti-fading) antenna and assuming a uniform ground conductivity of 15 mS/m, its 0.5 mV/m groundwave contour reaches 260 km, but its 0.5 mV/m 50% skywave contour reaches from 790 to 1050 km, depending on direction from the station. To protect that skywave contour, a hypothetical co-channel station located at Springfield, MA, would have an arc of protection of 56° (from 236° to 292°), with radiation restricted to 75 mV/m on the direct bearing between the stations and rising up to around 200 mV/m at the outer edges of protection. However, if only the groundwave contour were protected, as the FCC has proposed, the arc of protection would reduce to 16°, from 259° through 275°, and the permissible radiation would be nearly doubled throughout that arc. It is also notable that protecting the 0.5 mV/m groundwave contour of the hypothetical Class A station results in a D/U ratio at its 2 mV/m of slightly over 40 dB, the minimum co-channel protection ratio recommended herein.

If the Commission is unwilling to modernize and increase the RF D/U protection ratios for co-channel and first adjacent channel relationships, then the only way to avoid degradation of service is to maintain §73.37 as it is and continue to apply the seldom-usable 0.5 mV/m contour and inadequate protection ratios as a *surrogate* for contours of usable strength, protected adequately.

<u>Class A Skywave Signal Adequacy</u>

Comments filed in this proceeding have addressed the limitation of Class A skywave service by incoming interference, especially by foreign stations. The following table demonstrates the maximum skywave field strengths calculated for a hypothetical 50 kW, nondirectional Class A station located at Kansas City, MO, directly eastward[7] for several different antenna heights:

[7] The effect of geomagnetic latitude will cause somewhat lower field strength northward and higher field strength southward, so an eastward direction was used to typify the average situation.

Height (°)	Distance (km)	Field Strength (mV/m)
160	265	1.35
170	285	1.28
180	310	1.21
190	340	1.13
200	375	1.05

In none of these scenarios does the maximum field strength approach 2 mV/m, the value noted as necessary for acceptable service in modern times by many commenters.

As noted in the Univision Reply Comments, protection of the Class A skywave service is residue of an era long gone, when AM radio had not been fully developed and there were no FM, TV, satellite, or internet aural services available and before man-made electromagnetic noise reached the levels that exist today. In many areas within a Class A station's 0.5 mV/m skywave contour, its service is effectively wiped out by a local Class A station on the first adjacent channel.[8] Continuing protection of this halftime, location variant, *secondary* service unnecessarily restricts the fulltime, *primary* service of not only Class B, but also Class A stations operating with directional antennas on duplicated channels.

Class A Nighttime Protection

In the 2nd FNPRM, the FCC proposed to protect the 0.5 mV/m nighttime groundwave contour of Class A stations at the same D/U ratios used for daytime groundwave protection, 26 dB co-channel and 6 dB first adjacent channel, and inquired as to the calculation methodology to be used. Most such stations provide service to large metropolitan areas and many remain economically competitive. As note previously herein, the Commission should take no action that would degrade the consumer experience in places where signal levels are sufficient today to overcome environmental noise and interference. The large nighttime 2 mV/m daytime and nighttime groundwave service areas of Class A stations are no exception and should be robustly protected.

Protection of the 0.5 mV/m skywave service contour and, where no skywave service exists due to use of high directional suppression, the 0.5 mV/m groundwave contour, at a 26 dB D/U ratio causes a much higher D/U ratio at the 2 mV/m contour, thereby acting as a *surrogate* for truly adequate protection of meaningful groundwave service. As noted previously, the use of *surrogate* contours at low signal levels causes unnecessary protection of large areas where signal strength is not sufficient for meaningful, competitive service.[9]

[8] For example, the skywave service of WABC, 770 kHz, from New York City, is wiped out in northwestern Ohio and southeastern lower Michigan by the local service of WJR, 760 kHz, at Detroit and in northern Illinois and Indiana, southern Wisconsin, and southwestern lower Michigan by the local service of WBBM, 780 kHz, at Chicago.

[9] The Univision Reply Comments cite the service improvements that four of its major-market Class B stations could achieve if it were not necessary to protect the 0.5 mV/m skywave service of Class A stations.

Specifically, the 2 mV/m nighttime groundwave contours of Class A stations should be protected from skywave interference using the D/U ratios noted above, 40 dB for co-channel and 10 dB for first adjacent channel, applied on a 25% exclusion RSS calculation basis at contour points defined at a minimum azimuth intervals not exceeding 10°. Where existing RSS interfering signal levels exceed 0.02 mV/m, existing contributor levels should be grandfathered, but no adjustment to the protected contour made and no further increase allowed. This will ensure the preservation of robust *primary* nighttime service within metropolitan areas, while eliminating the protection of *secondary* and *intermittent* service far from those areas. Such protection will preserve the potential for *de facto* skywave service over large areas, but perhaps not as wide as those today, in many cases.

Protection of the 2 mV/m nighttime groundwave contour further reduces the arc of protection to a Class A station by others. Using the previous example of the hypothetical 940 kHz Class A station at Kansas City and Class B station at Springfield, MA, the suppression arc to protect the 0.5 mV/m 50% skywave contour is 56 degrees, to protect the groundwave contour at the same strength is 16 degrees, and to protect the 2 mV/m contour is 10 degrees. Each step of sector reduction widens the opportunity for the hypothetical Springfield station to improve its *primary* service, while robustly protecting the Class A station's *usable primary* service.

Class A Critical Hours Protection

The 2nd FNPRM questions whether "critical hours"[10] protection of Class A stations should be continued and, if it is, whether it should be provided at the 0.5 mV/m or 0.1 mV/m groundwave contour, the latter being the current standard. Though a more pertinent question is the relevance of "critical hours" concerns to ***all*** AM broadcast stations[11], that is clearly beyond the scope of this proceeding, though it is recommended that the Commission consider it in the future.

The need for "critical hours" protection is real. However, as has been stated clearly throughout these comments, protection should be applied at the signal level/contour where usable service can be realized. In this case, the methodology of §73.187 should be adjusted so that the 2 mV/m groundwave contour is protected on a 40 dB D/U basis during "critical hours".

Integrity of the AM Service

Revitalizing the AM service means, to the extent practical and legal, undoing some of the past policies and procedures that have allowed large amounts of mutual interference in the AM band. In seeking to provide "relief" to "long suffering" AM stations, the Commission should not authorize facility improvements where incoming interference is high and an extension of service will lead to greater consumer frustration, thereby reinforcing in consumers' minds that the AM service is faulty and substandard. If the protection of Class A stations' skywave service areas is rescinded, many Class D stations are likely to seek nighttime power increases. However, many of

[10] The 2 hours following local sunrise and the 2 hours before local sunset, see §73.187

[11] Contrary to the arguments of some parties, the laws of physics impacting a station are not a function of its class.

those stations will suffer strong incoming interference from the Class A facilities using the same frequencies. The Commission should be mindful of this fact and not authorize Class D power increases where the incoming skywave interference exceeds 0.5 mV/m.[12] Operation in such circumstances does not provide a competitive consumer experience and can lead to consumer frustration that discourages use of AM services that do not suffer such high incoming interference. It is the Commission's abandonment, long ago, of the 2.5 mV/m nighttime groundwave protected contour that not only allowed more AM stations to be authorized, but also caused overall service quality reductions that, in part, drove receiver bandwidth decreases and consumer migration to FM. Continuing that approach will not revitalize the AM service.

A Fresh Approach to Allocations Engineering

The rules and standards that govern AM allocations, prediction of coverage, and calculation of interference all date from the 1939 *Standards of Good Engineering Practice* and the graphical analysis methods that were in use at that time. It is appropriate to question whether those methods should remain in use when numerical methods are increasingly used to administer frequency allocations and evaluate stations' service.[13] While software has been developed to mimic the graphical processes and make them more efficient, programs are not integrated into a well-functioning, comprehensive whole. It is the hybrid graphical/numerical approach used today that complicates approaches such as calculating the cumulative effects of all interferers at the protected contour of a station.

A "clean sheet" approach to AM band allocations administration can provide more accurate determination of service and interference, facilitate the use of the most accurate data available, and achieve more granular analysis of service, interference, and protection, in less time and with less human intervention.

Specifically, the Commission should consider discontinuing the use of graphical contours to evaluate AM station protection and instead use numerical analysis of signal levels calculated at points along the protected contour(s). The granularity of numerical analysis is dependent upon the azimuth step interval used. For the purpose of initiating discussion, a minimum interval of 5 degrees is suggested. However, given the processing speed of modern desktop and laptop computers, an interval of 1 degree would be practical. And, when the evaluation of interference is done numerically, it becomes practical to consider the total impact of all interfering signals. Using RSS calculations of groundwave skywave interfering signals (weighted by appropriate D/U ratios) at points along the protected contour would better protect stations from service degradation as others tailor improvements that changes in the technical standards might foster.

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[12] Effectively, Class D operation would continue to be prohibited within the 0.5 mV/m skywave contour of Class A stations.

[13] A prime example of this is the Commission's TVStudy software, used by the Media Bureau and technical consultants nationwide to evaluate television service and interference. All parties can generate identical results readily, facilitating the processing of applications and minimizing doubt as to service and interference.

Furthermore, the use of numerical methods could gradually incorporate into the FCC's database the ground conductivities that have been measured over the past 80 years. When a new application for construction permit is filed, any measured conductivity data used can be uploaded, using a standardized file format, and become available to predict the pertinent station's groundwave field strength and protected contour point distances, going forward.[14]

Here is a high-level outline of how an integrated AM allocations system might work:

1. The user enters the site location, antenna design data, and any measured ground conductivities for a proposed new or modified station (or it is imported from the LMS).
2. The system identifies co- and adjacent-channel stations that might suffer interference from the station or cause it interference, using a pertinent search radius and/or rough approximation signal calculation.
3. For each station studied, the system retrieves Figure M-3 conductivities along the radial bearings defined by the standardized azimuth interval, substitutes measured conductivities where available and appropriate, and calculates the protected contour distance(s) and contour point coordinates. These points could also be stored as part of the station data set, lessening the need to determine them for existing stations, within each study.[15]
4. From each potentially interfering station, its interfering signal level is calculated at the each contour point defined for the protected station. Groundwave calculations can incorporate measured conductivity data where such is pertinent and available. The system creates the hierarchical RSS interference table for each such point and calculates the total interference based on channel relationships and pertinent D/U ratios.
5. "Before" and "after" scenarios are compared by the algorithm to determine whether any increase in interference will be caused.
6. Study configuration "switches" allow the user to output to data files as much detail as desired of the calculations underlying the service and interference determination.

Conclusion

In completing this proceeding, the Commission should ***do no harm*** to service that is of sufficient quality to compete with FM and satellite broadcasting, internet streaming, and other consumer options. That means not allowing significant ***degradation*** of the *de facto* D/U ratios that exist ***today*** at the 2 mV/m signal level and higher. At the same time, continued protection of areas where signals are insufficient for a competitive, reliable consumer experience is unwarranted, as doing so constrains the achievement of whole-market service by many other stations. To administer such changes in the most efficient, fair, and accurate way possible, the Commission should consider replacing age-old graphical evaluation methods with numerical approaches.

[14] Such data could be extracted from the Commission's paper files by a contractor, though the time and cost involved in that could be prohibitive.

[15] Recalculation would ne necessary whenever fresh measurements of ground conductivity are submitted.

Respectfully Submitted,

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Appendix 1

Groundwave Contour Protection

Univision Local Media Engineering – April 2016

1. All AM stations are protected from *objectionable* interference caused by other AM stations. Interference is *objectionable* if, at the protection boundary defined, a potentially-interfering station's signal is predicted to exceed the bounding signal level less the desired-to-undesired (D/U) signal ratio. For co-channel and first adjacent-channel relationships, 0.5 mV/m (54 dBμ) is the bounding contour field strength value and the D/U ratio is 26 dB for the co-channel case and 6 dB for adjacent channel situations. Prior to 1991, the latter was 0 dB.

2. These co-channel and first adjacent channel assignment standards ensure that a much higher D/U ratio exists today at the 2 mV/m contour. The desired signal is 12 dB higher than that at the protected contour, while the additional distance from the interfering station reduces its signal below the value permitted at the 0.5 mVm contour. The *de facto* D/U ratios at the 2 mV/m contour that result from today's assignment standards are in the 40s of dB for the co-channel case and 20s of dB for the first adjacent channel case, as detailed herein.

3. The Commission wisely concluded that service is seldom realized at the 0.5 mV/m contour, due to increased man-made noise, and has proposed to redefine *objectionable* interference at the 2 mV/m (66 dBμ) contour.[1] However, it erroneously proposed to use the current co-channel and the pre-1991 0 dB adjacent channel D/U ratios at that contour, to define *objectionable* interference, going forward. As today's *de facto* D/U ratios at that contour are far higher, the Commission's proposal will significantly degrade the quality of service and consumer experience at the 2 mV/m contour of many, if not most, stations. The degradation of existing service has been noted by the AM Radio Preservation Alliance in its comments.

4. If all AM stations increased power by 12 dB, these changes would be acceptable, as the stations' areas of interference would not change. Today's quality of service at the 2 mV/m (66 dBμ) contour would be realized at the 8 mV/m (78 dBμ) contour, but the distance of the latter contour from each transmitter site would match today's 2 mV/m distance. However, no station operating at a power greater than 3 kW can realize such a power increase, due to the "hard" 50 kW limit on transmitter power. International protections and differing assignment relationships also impose power limits that preclude a 12 dB increase in power for most stations. These variations have been detailed in the comments submitted by the National Association of Broadcasters.

5. To maintain the existing quality of service at the 2 mV/m contour, the co-channel D/U ratio at that contour should be raised to 40 dB and the first adjacent channel ratio should be raised to 20 dB. The inefficiency of protecting the 2 mV/m service via lesser protection of the 0.5 mV/m surrogate should be eliminated. This would narrow the arcs of protection for many stations, allowing simplification of directional antennas and service improvements. It would ensure adequate protection of today's *usable* service while providing many broadcasters with additional flexibility in locating and realizing their stations' facilities and services.

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[1] Since 1939, the 2 mV/m contour has been defined as the threshold for service to communities with populations exceeding 2,500. See §73.182(d). The record in this proceeding has demonstrated conclusively that groundwave service is seldom longer realized at the 0.5 mV/m contour, due to man-made noise.

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Introduction

6. The protected contour signal level and the D/U ratio enforced at that level are not absolute, go/no-go inflection points in service. They are the technical standards intended to achieve the administrative need to balance the quality of reception with the demand for stations.

7. The Commission's rules for AM broadcasting repeatedly note that the *primary* service area of a station is where its service is free of *objectionable* interference.[2] Note that there is no definition of practical D/U ratios for satisfactory consumer reception specified in the rules. Interference is *objectionable* if it would frustrate the FCC's administrative objective of balancing reception quality with station population.

8. The current AM technical standards have their roots in the 1939 Standards of Good Engineering Practice. At that time, the development of AM broadcasting was not yet mature. Much of the country lacked reliable broadcast service, especially at night, from AM stations. FM, TV, and satellite stations did not exist. Further growth and improvement of the AM band service was necessary. The definition of *objectionable* interference sought to foster such development.

9. Since 1939, a 2 mV/m signal level has been defined in the rules as the minimum for service to communities of 2,500 people or more.[3] Such communities contain the vast majority of the American population, as rural populations have declined since 1939 and metropolitan populations have grown strongly. Assuming the existing definition of objectionable interference, the *de facto* D/U ratios for usable service to communities of modest size and larger, implied by the 1939 Standards at the 2 mV/m contour, are at least 12 dB higher than those enforced at the 0.5 mV/m contour, as the required signal level is 12 dB greater.

10. To maintain the freedom from co-channel and adjacent-channel interference that exists today at the 2 mV/m contour, the co-channel D/U ratio must be a *minimum* of 38 dB (26+12) and the first adjacent channel D/U ratio must exceed 12 (0+12) to 18 (6+12) dB, depending on whether one is using the pre-1991 or existing ratio as the reference. The international protection standards for the AM band are near these numbers.[4] This is not what the Commission has proposed.

Analysis of *de facto* D/U Ratios at 2 mV/m

11. The variation of ground conductivities and changing "exceptions" to station assignment criteria over the years cause some variation of *de facto* D/U ratios at any specified signal contour. This analysis does not attempt to define or even provide a representative sample of the range of such situations. Instead, hypothetical examples are offered based on a mid-band frequency, mid-range ground conductivity, and typical station power levels, to illustrate D/U

[2] See the definition of *primary service* in §73.14

[3] See §73.182(d)

[4] See ITU-R Recommendation BS.560-4. The co-channel protection ratio is specified at 40 dB. The adjacent channel ratio is specified as a function of program content and degree of audio processing, but is not based on the audio processing practices common in North American stations. It is typically higher than 6 dB.

ratios that can be expected at the 2 mV/m contour today. Any substantial degradation of the *de facto* D/U ratio that exists today will diminish, not enhance, the consumer's listening experience.

12. Specifically, the D/U ratio relationship of hypothetical 950 kHz stations, one pair operating at 5 kW each and the other pair operating at the dissimilar powers of 10 kW and 1 kW were studied. Quarter-wavelength radiators (1 km radiation values of 305 at 1 kW, 680 mV/m at 5 kW, and 970 mV/m at 10 kW) and a uniform ground conductivity of 8 mS/m were presumed.

Co-Channel Case

13. Both pairs of hypothetical stations were spaced such that their 0.5 mV/m and 0.025 mV/m groundwave contours do not overlap, which requires a separation of 430 km for both pairs under the conditions specified. The signal level of each station at the 2 mV/m contour position of the other was determined using standard methods, thereby yielding the *de facto* D/U ratio at that contour resulting from the present co-channel groundwave protection standard. The distances and field strengths at which the ITU-recommended 40 dB D/U ratio is realized were also determined. The field strength and D/U relationships for these stations are shown by Figure 1 for the 5 kW stations and Figure 2 for the 10 kW and 1 kW stations. The *de facto* D/U ratio can be readily determined for any candidate protected signal level, using these graphs.

Table I: Co-Channel 2 mV/m Contours
430 km Site Separation

Station	2 mV/m Distance, km	2 mV/m D/U Ratio, dB	40 dB D/U Distance, km	40 dB D/U Field, mV/m
5 kW	64	43	72	1.51
10 kW	74	49	100	0.935
1 kW	44	42	40	1.68

Adjacent-Channel Case

14. Following a similar approach, the *de facto* first adjacent channel protection ratio, at the 2 mV/m contour, can be found. The transmitter site spacing necessary to comply with the post-1991 rule is 260 km for the 5 kW stations and 250 km for the 10 kW / 1 kW station pair. The *de facto* D/U ratios, based on the current rules, along with 20 dB D/U distances and contour values, are shown in Table II. Figure 3 illustrates the situation of the paired 5 kW stations, while Figure 4 illustrates that for the 10 kW / 1 kW station pair.

Table II: First Adjacent Channel 2 mV/m Contours
260 / 250 km Site Separation

Station	2 mV/m Distance, km	2 mV/m D/U Ratio, dB	20 dB D/U Distance, km	20 dB D/U Field, mV/m
5 kW	64	25	76	1.33
10 kW	74	29½	98	1.01
1 kW	44	23½	50	1.54

15. Most AM broadcast stations were authorized prior to 1991, when the first adjacent channel protection ratio was 0 dB at the 0.5 mV/m contour. Accordingly, the

transmitter site spacing between the 5 kW stations was set to 225 km and spacing between the 10 kW / 1 kW pair was set to 210 km, avoiding 0.5 mV/m contour overlap. The above data were regenerated for these states, as shown in the following table. Figure 5 shows the field strength, D/U ratio, and distance relationships for the 5 kW station pair, while Figure 6 illustrates that for the 10 kW / 1 kW station pair.

Table III: First Adjacent Channel 2 mV/m Contours
225 / 210 km Site Separation

Station	2 mV/m Distance, km	2 mV/m D/U Ratio, dB	20 dB D/U Distance, km	20 dB D/U Field, mV/m
5 kW	64	20½	64½	1.95
10 kW	74	23½	81	1.57
1 kW	44	20½	45	1.92

16. These data show that the de facto D/U ratios at the 2 mV/m contour are in the 40s for the co-channel case and in the 20s for the first adjacent channel case.

Power Increase Impact of Applying the Proposed D/U Ratios at 2 mV/m

17. The primary purpose that the Commission cites for changing the rules is to facilitate station power increases to overcome noise. Most stations would likely seek to do that without changing transmitter sites.

18. Equal percentage power increases of both stations in a paired interference relationship will not change the D/U ratios that exist now at any particular location. At the present 2 mV/m contour distance, the signal strength will be increased, but the D/U ratio would remain what it is today. However, the 2 mV/m contour would be located farther from the transmitter site and the D/U ratio at that contour would worsen.

19. There will be many cases where one station in an interference-paired relationship can increase power, but the other cannot. This may be caused by the 50kW power limit, the need to hold cross-border signal strengths at their present values, or other assignment constraints. Where stations cannot increase power equally, the station making the lesser or no improvement may suffer a deterioration of service quality at its 2 mV/m contour location. The dB change in the D/U ratio will follow the change in operating power in dB.

20. Taking the example of the 5 kW stations from above, a power increase to 50 kW of one station will lessen the D/U ratios at the 2 mV/m contours of both, by 10 dB for the 5 kW station and by 6 dB for the 50 kW station. However, the contour of the station increasing its power is extended, so its current listeners experience no degradation.

21. When stations presently have normally protected and potentially interfering contours close to each other, any dissimilar percentage increase in power will improve the higher percentage station's service at the expense of the station not increasing power or increasing it to a lesser degree. These impacts can be evaluated for the hypothetical examples by adjusting the field strength values on Figures 1-5 by the dB differences in power.

Move-In Impact of Applying the Proposed D/U Ratios at 2 mV/m

22. The Commission has proposed application of the co-channel D/U ratio of the current rules and the pre-1991 adjacent channel D/U ratio at the 2 mV/m contour. This proposal appears to presume that these ratios define a quality service. They do not, particularly given the far greater audio signal-to-noise ratios of FM broadcasting, satellite broadcasting, and even Internet streaming. The present protection standards exist to as a surrogate to ensure a quality service at the 2 mV/m contour, by their definition at the 0.5 mV/m contour. The degradation of the existing *de facto* D/U ratios at the 2 mV/m contour and shrinkage of the service range to achieve present D/U ratios will be detailed in this section, using the same hypothetical example stations as above.

Co-Channel Case

23. Both pairs of hypothetical stations were spaced such that their 2 mV/m and 0.1 mV/m groundwave contours do not overlap, which requires a minimum separation of 270 km for the 5 kW station pair and 305 km for the 10 kW / 1 kW station pair. The distances and field strengths at which the ITU-recommended 40 dB D/U ratio is realized were also determined. The field strength and D/U relationships for these stations are shown by Figure 7 for the 5 kW stations and Figure 8 for the 10 kW and 1 kW stations.

Table IV: Co-Channel 2 mV/m Contours
270 / 305 km Site Separation

Station	2 mV/m Distance, km	2 mV/m D/U Ratio, dB	40 dB D/U Distance, km	40 dB D/U Field, mV/m
5 kW	64	26	35	6.65
10 kW	74	36½	65	2.74
1 kW	44	26	26	5.33

24. Comparing the data of Table I to that of Table IV, the 5 kW stations could suffer a 17 dB D/U ratio loss, the 10 kW station could suffer a 12½ dB loss, and the 1 kW station could suffer a 16 dB degradation. The 40 dB D/U service ranges are reduced by 51% for the 5 kW stations, 20% for the 10 kW station, and 35% for the 1 kW station.

Adjacent-Channel Case

25. The minimum transmitter site spacing necessary to comply with the proposed 0 dB protection at the 2 mV/m contour is 130 km for the 5 kW stations and 125 km for the 10 kW / 1 kW station pair. The D/U ratios, based on the proposed rules, along with 20 dB D/U distances and contour values, are shown in Table IV. Figure 9 illustrates the situation of the paired 5 kW stations, while Figure 10 illustrates that for the 10 kW / 1 kW station pair.

Table V: First Adjacent Channel 2 mV/m Contours
130 / 125 km Site Separation

Station	2 mV/m Distance, km	2 mV/m D/U Ratio, dB	20 dB D/U Distance, km	20 dB D/U Field, mV/m
5 kW	64	½	34	7.40
10 kW	74	2½	47	5.58
1 kW	44	2	20	8.15

26. Given that most AM stations were assigned under the pre-1991 0 dB first adjacent channel D/U ratio, the data above was compared to that of Table III. The D/U ratio at the 2 mV/m contour is degraded by 20 dB for the 5 kW stations, 21 dB for the 10 kW station, and 18½ dB for the 1 kW station. The distance at which a 20 dB D/U ratio exists is reduced by 47% for the 5 kW stations, 42% for the 10 kW station, and 56% for the 1 kW station.

Protection Arc Sectors and Application of Criteria Recommended

27. Figures 11 and 12 illustrate the co-channel contour overlap situations of the 5 kW and 10 kW / 1kW station pairs, spaced 430 km apart. The assumed "touching" 0.5 mV/m and 0.025 mV/m contours define an arc of protection of 30 degrees between each 5 kW station. The 2 mV/m contour and the 0.02 mV/m interfering contour that is implied from the 40 dB D/U ratio described herein are shown in green. Figure 9 shows the impact of both stations increasing power to 8.5 kW, the point at which their blue 2 mV/m and 0.02 mV/m contours would touch and the arc of protection is reduced 43%, to 17 degrees. Figure 10 shows that one station could achieve 10 kW of power (blue contour) if the other one remains at 5 kW. In this case, the arcs of protection are 17 degrees for the 10 kW station toward the 5 kW station and 20 degrees for the 5 kW station, toward the 10 kW station. The arc of protection for all these cases is significantly reduced by recognizing the 2 mV/m contour as that protected, in lieu of the 0.5 mV/m contour.

28. Figure 13 illustrates the adjacent channel interference situation of the 5 kW station pair, spaced 225 km apart, to avoid overlap of their 0.5 mV/m contours, as required prior to 1991. With both stations at 5 kW, the green 0.02 mV/m interfering contour barely clears the 2 mV/m protected contour. It is not possible for either station to increase power under this scenario. However, changing the protected contour significantly decreases the sector of protection, from 60 to 33 degrees.

29. The situations of the 10 kW and 1 kW paired stations are not illustrated, but are generally more favorable to improvement, particularly for the 1 kW station, than the 5 kW stations described above. The point of Figures 11-13 is to illustrate the concept of robust protection at the 2 mV/m contour, not evaluate a general case of stations' abilities to make improvements.

Conclusion

30. The foregoing data clearly show that the Commission's proposed protection criteria at the 2 mV/m contours fail to maintain the present quality of service at and near that contour. Adequate protection can be ensured by increasing the protection ratios, while retaining 2 mV/m as the new contour value protected from interference. Even with this maintenance of protection, stations should be able to improve facilities and service, in many cases.

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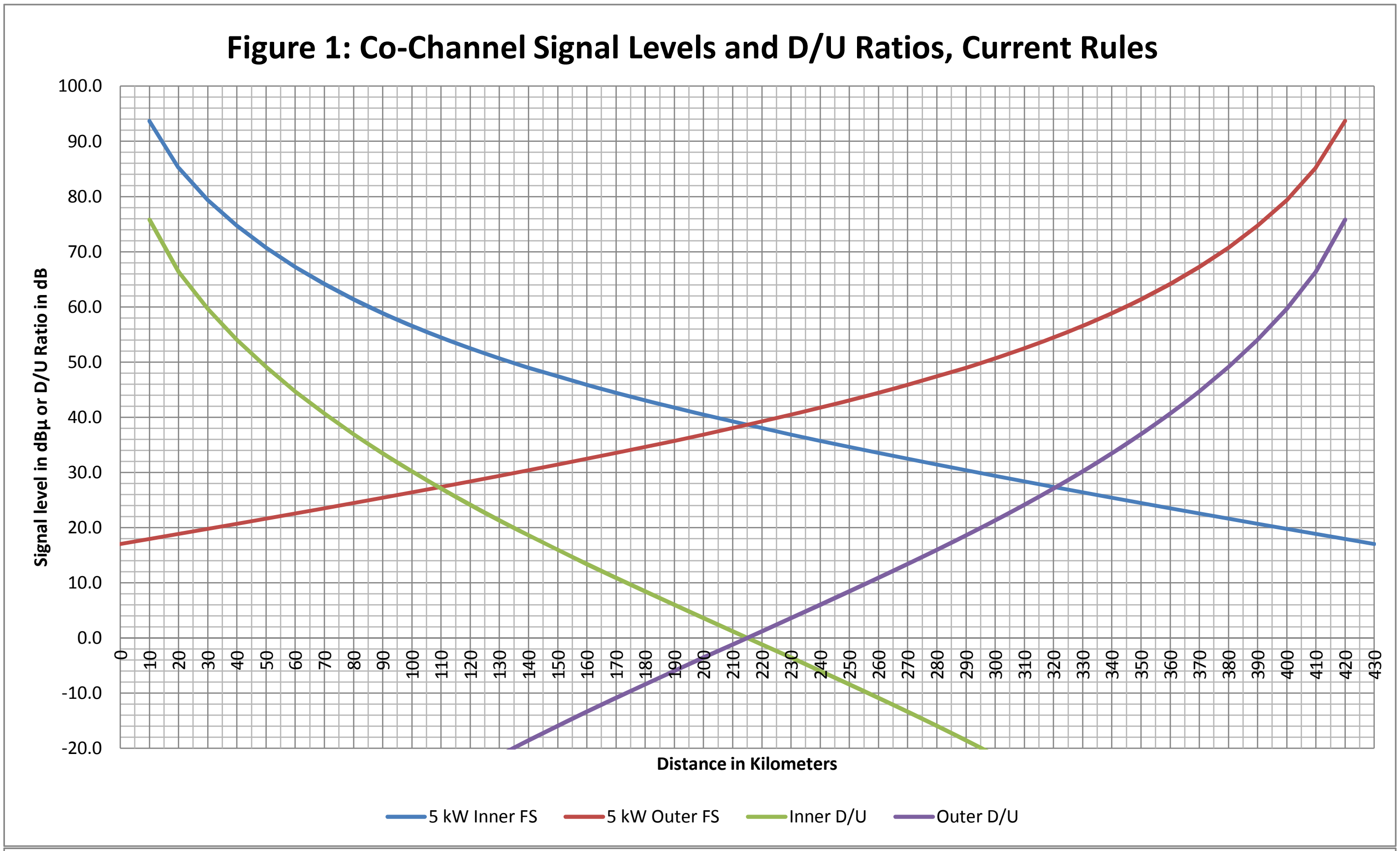
Figure 1: Co-Channel Signal Levels and D/U Ratios, Current Rules
Signal level in dBμ or D/U Ratio in dB
Distance in Kilometers
5 kW Inner FS
5 kW Outer FS
Inner D/U
Outer D/U

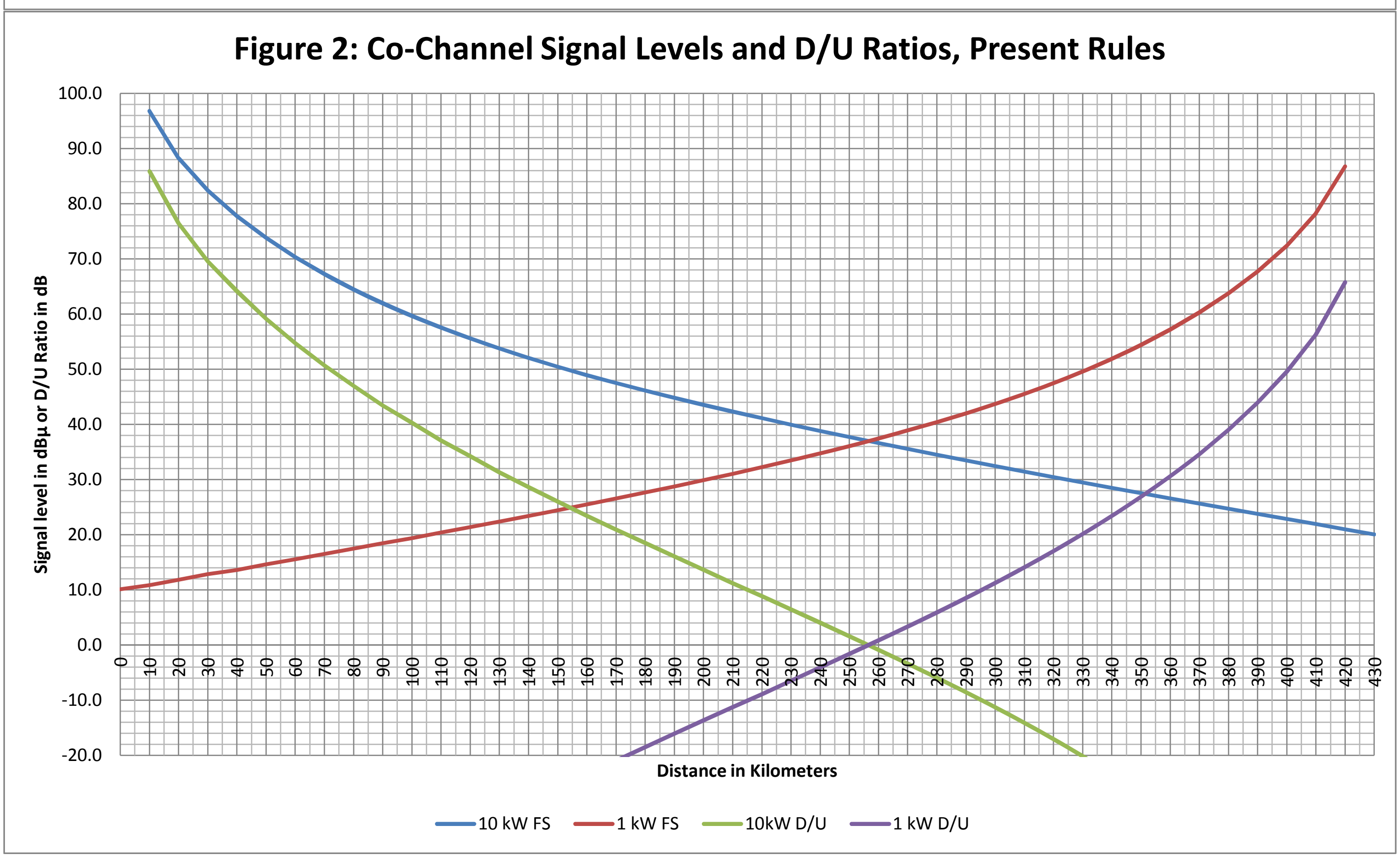
Figure 2: Co-Channel Signal Levels and D/U Ratios, Present Rules
Signal level in dBμ or D/U Ratio in dB
Distance in Kilometers
10 kW FS
1 kW FS
10kW D/U
1 kW D/U

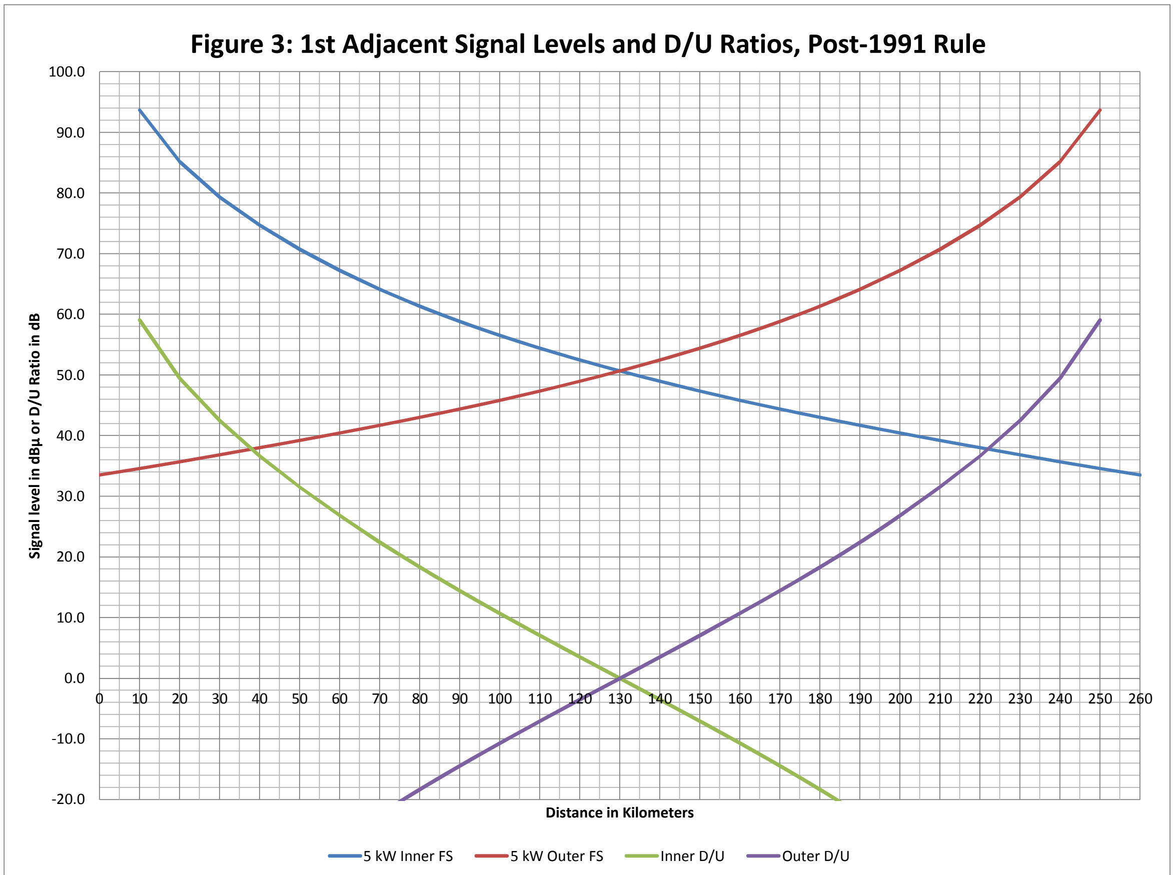
Figure 3: 1st Adjacent Signal Levels and D/U Ratios, Post-1991 Rule
Signal level in dBµ or D/U Ratio in dB
Distance in Kilometers
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5 kW Outer FS
Inner D/U
Outer D/U

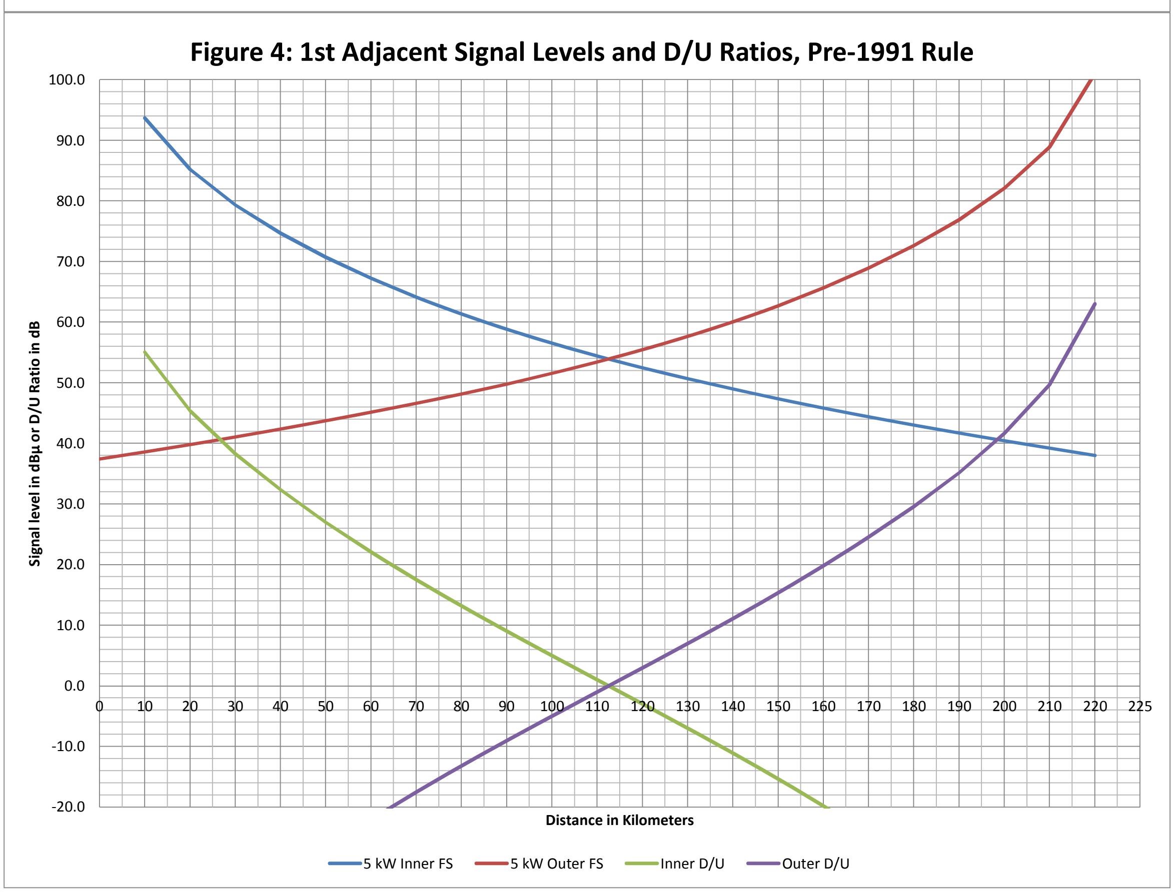
Figure 4: 1st Adjacent Signal Levels and D/U Ratios, Pre-1991 Rule
Signal level in dBµ or D/U Ratio in dB
Distance in Kilometers
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5 kW Outer FS
Inner D/U
Outer D/U

Figure 5: 1st Adjacent Signal Levels and D/U Ratios, Post-1991 Spacing

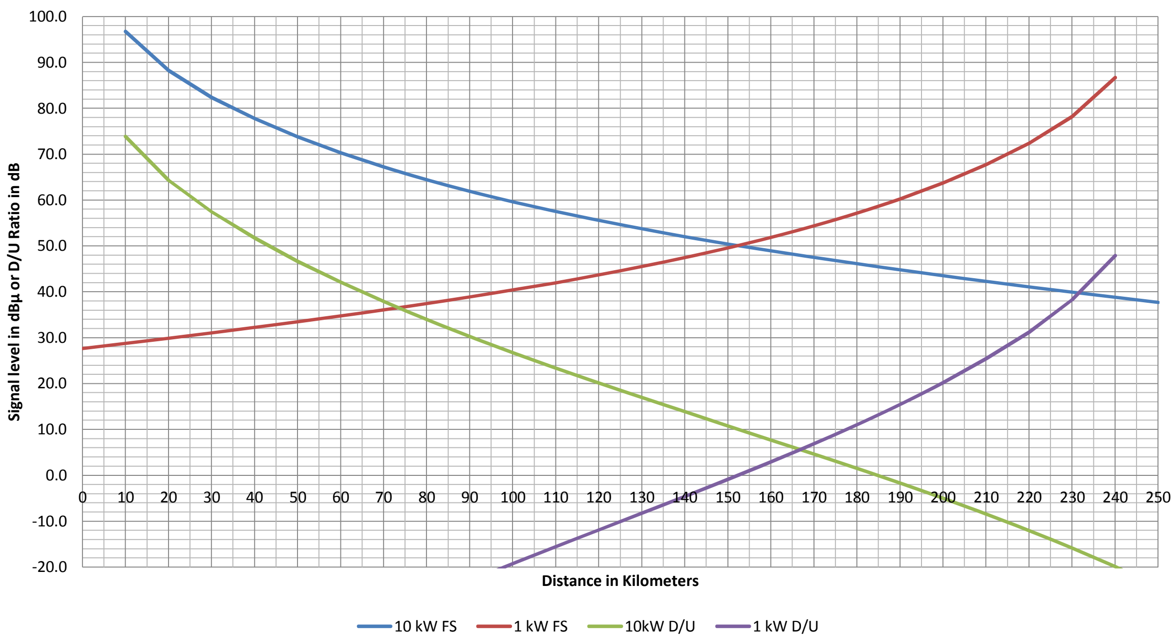


Figure 6: 1st Adjacent Signal Levels and D/U Ratios, Pre-1991 Spacing

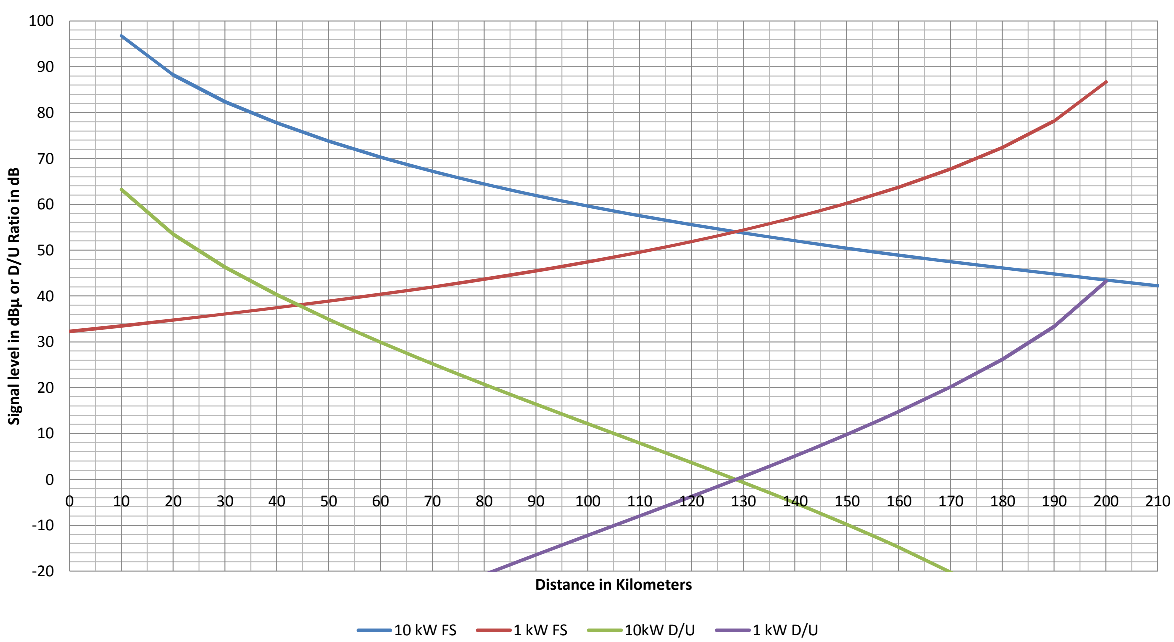


Figure 7: Co-Channel Signal Levels and D/U Ratios, Proposed Rules

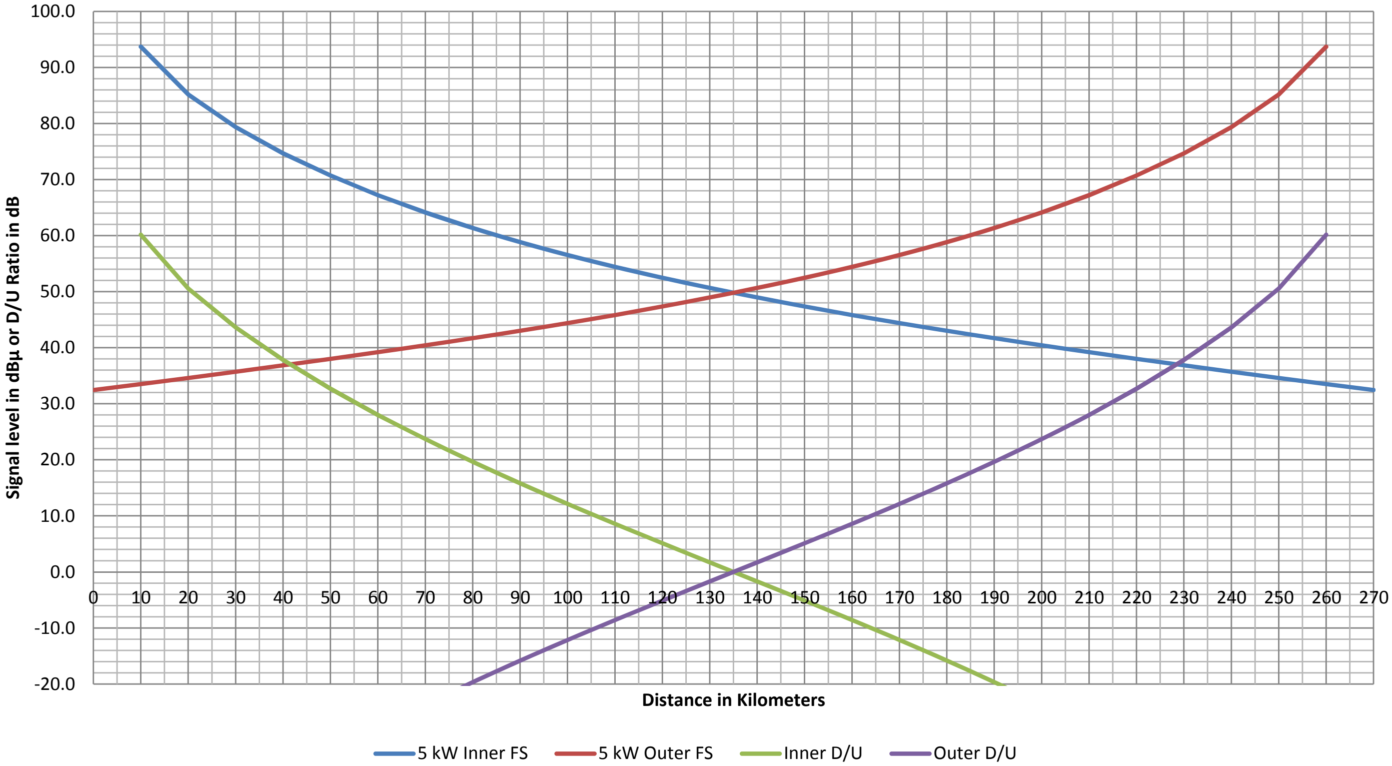
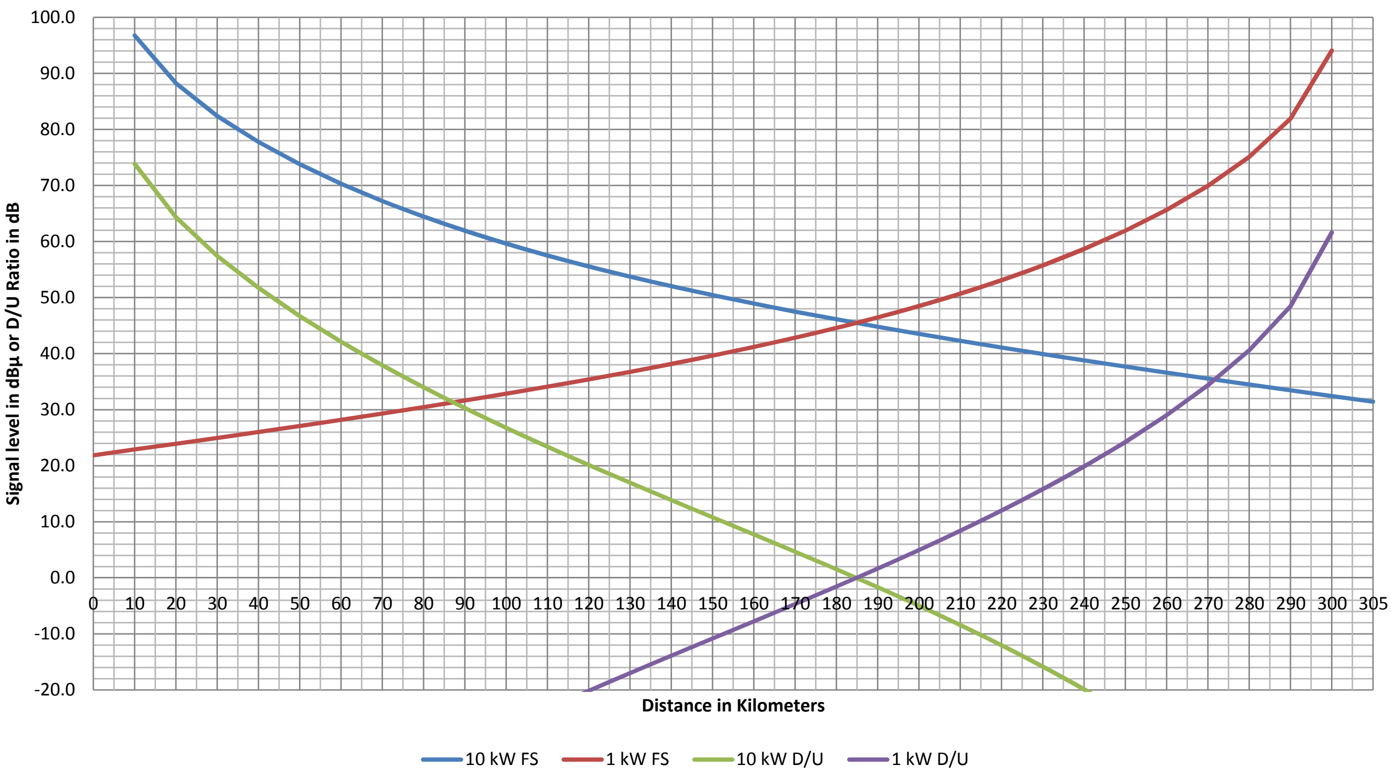


Figure 8: Co-Channel Signal Levels and D/U Ratios, Proposed Rules



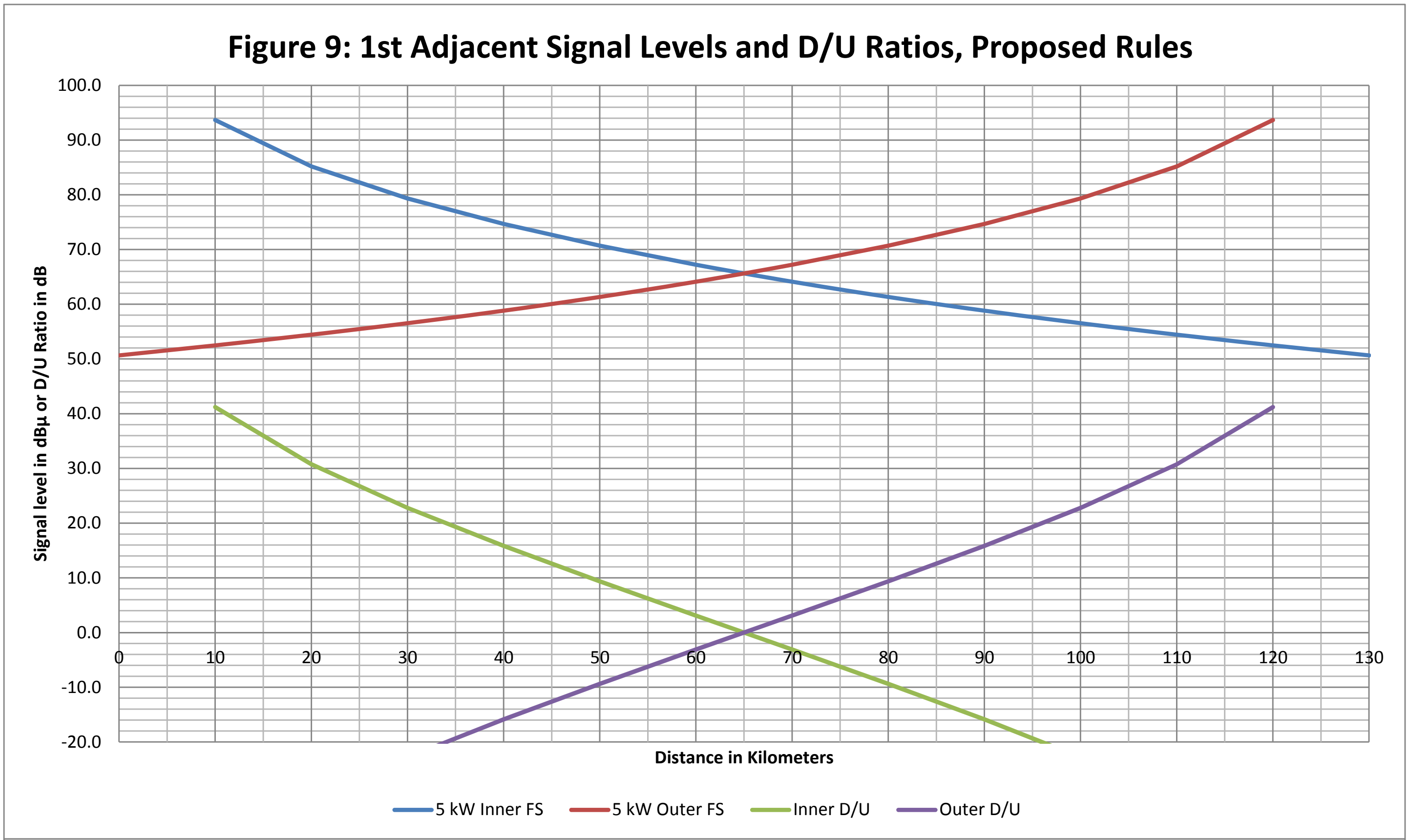


Figure 9: 1st Adjacent Signal Levels and D/U Ratios, Proposed Rules
Signal level in dBμ or D/U Ratio in dB
Distance in Kilometers
5 kW Inner FS
5 kW Outer FS
Inner D/U
Outer D/U

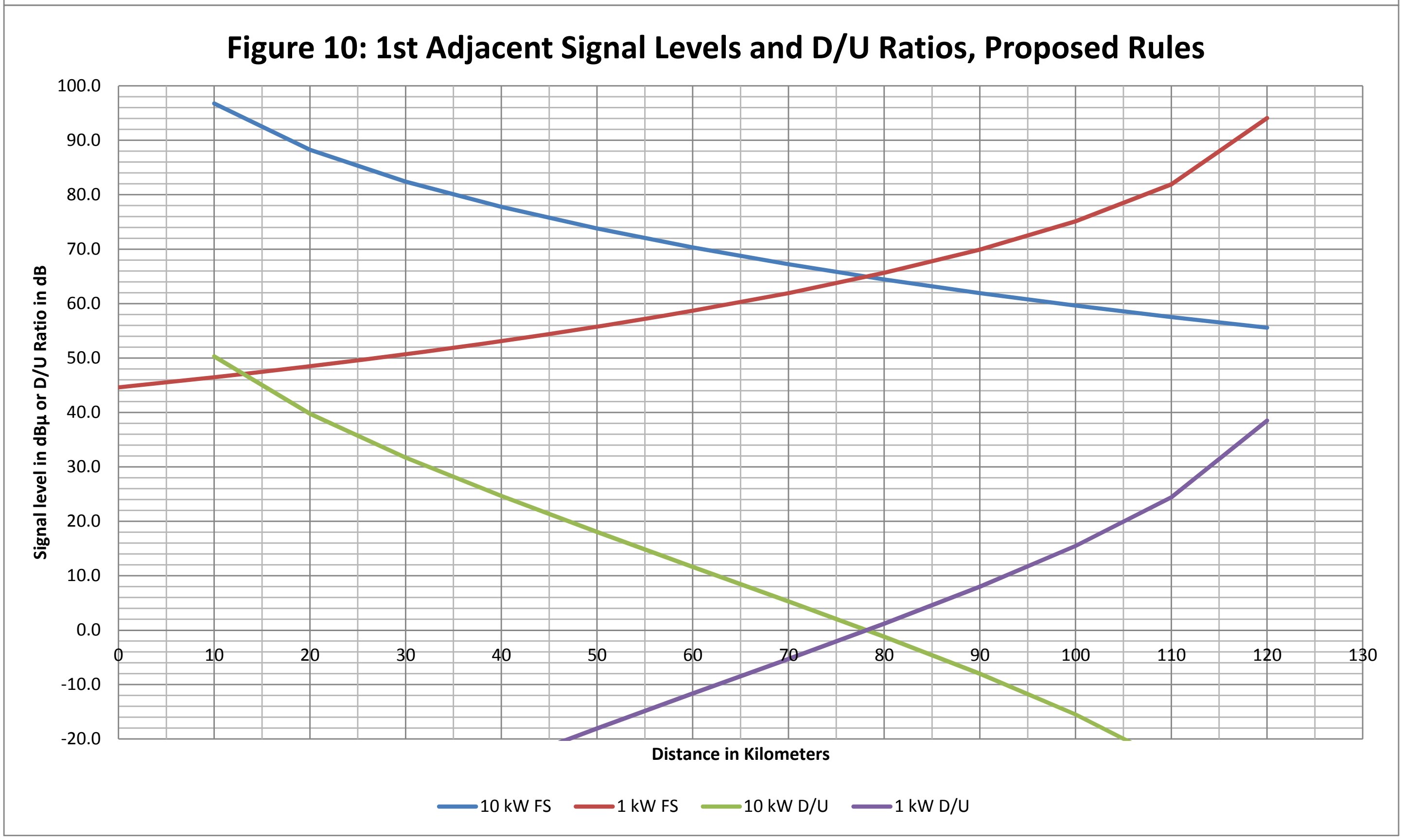


Figure 10: 1st Adjacent Signal Levels and D/U Ratios, Proposed Rules
Signal level in dBμ or D/U Ratio in dB
Distance in Kilometers
10 kW FS
1 kW FS
10 kW D/U
1 kW D/U

Figure 11: Co-Channel Protection, 40 dB D/U at 2 mV/m
Equal Station Improvement

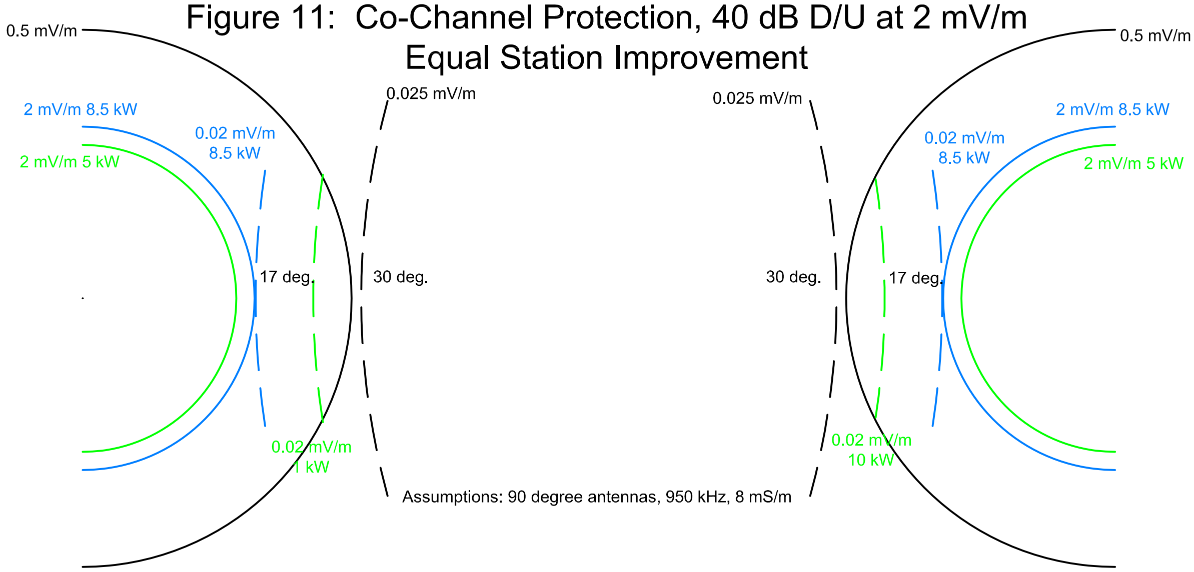


Figure 12: Co-Channel Protection, 40 dB D/U at 2 mV/m
Single Station Improvement

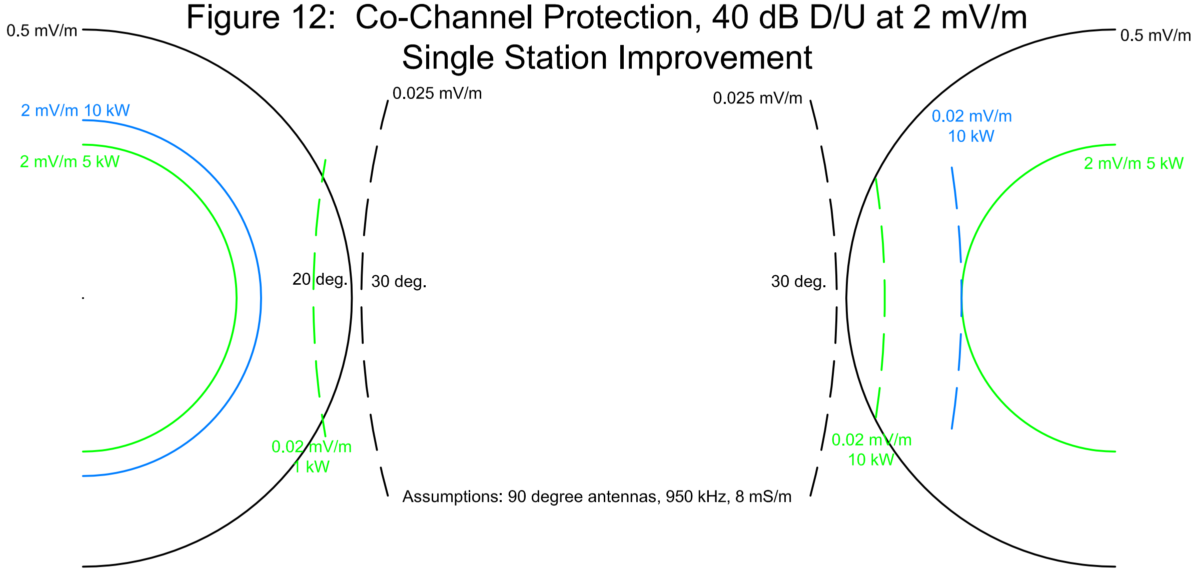


Figure 13: 1st Adjacent Channel Protection
5 kW, 20 dB D/U at 2 mV/m