November 6, 2001

Mr. Stan Wiggins
Senior Staff Attorney, Policy Division
Wireless Telecommunications Bureau
Federal Communications Commission
445 12th Street S.W.
Washington D.C. 20054

In Re: ***WT Docket No. 99-168 – Service Rules for the 746-764 and 776-794 MHz Bands and Revision to Part 27 of the Commission's Rules***

Dear Mr. Wiggins:

On August 15th, representatives of the Wireless Communications Division, Private Radio Section (PRS) of the Telecommunications Industry Association (TIA) met with you and other FCC officials to discuss the technical underpinnings of the petition for reconsideration filed by the National Public Safety Telecommunications Council (NPSTC) in the above-referenced proceeding.[1] NPSTC is seeking reconsideration of the FCC's rules relating to the operational and technical performance of commercial mobile systems operating in spectrum blocks C and D within the 746-806 MHz band.[2] Specifically, NPSTC is concerned that the overall requirement for out-of-band emission (OOBE) limits for commercial systems is insufficient to protect public safety operations in the 764-776/794-806 MHz bands.

When we last met, TIA PRS representatives spoke in general terms about how recent trends in the deployment of commercial mobile radio networks are having an increasing effect on public safety radio systems operating in the same frequency band. As you know, this issue is currently manifesting itself in the 806-821/851-866 MHz band and the 821-824/866-869 MHz band where digital commercial systems, such as those operated by Nextel and cellular operators, are using frequencies in the same band or adjacent bands to public safety systems. At our prior meeting, we discussed the development of the ***Best Practices Guide*** and its ***Technical Appendix***, which was jointly developed by APCO, CTIA, Nextel, Motorola and the Public Safety Wireless Network (PSWN), to assist users in identifying and resolving existing cases of interference as well as coordinating the deployment of future 800 MHz communications systems.[3]

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1 See *Ex Parte Letter from Derek R. Khlopin, TIA, to Magalie Roman Salas,* WT Docket No. 99-168, August 17, 2001.

2 *Petition for Reconsideration by The National Public Safety Telecommunications Council*, WT Docket No. 99-168, submitted March 7, 2001 (*NPSTC Petition)*.

3 *Avoiding Interference Between Public Safety Wireless Communications Systems and Commercial Wireless Communications Systems at 800 MHz – A Best Practices Guide,* December, 2000*,* available at http://www.apco911.org/afc/documents/BPG.pdf *(Best Practices Guide)*

The 800 MHz interference issue surfaced at approximately the same time the FCC finalized its technical and service rules for commercial operations in the 746-806 MHz band. The ***Best Practices Guide*** was printed in December 2000. This was one month before the FCC adopted its ***Second Memorandum Opinion and Order*** in WT Docket No. 99-168 dismissing petitions for reconsideration of the Commission's decision to allow commercial base stations to operate in the 777-792 MHz band.[4] Given this timing, it is not surprising that neither the FCC nor the public safety technical community fully considered the 800 MHz issue while developing rules that ensure compatibility between 700 MHz commercial systems and public safety. TIA's PRS believes that to be a mistake. In studying the mechanisms at play in the 800 MHz band, TIA members and the public safety community have learned a great deal about the root causes of interference and continue to learn more each day. The PRS can conclusively say that if 700 MHz commercial systems are allowed to deploy in a manner consistent with the existing rules, ***there will be significant harmful interference to 700 MHz public safety systems***. This conclusion is the unanimous position of all manufacturers that compete to develop and sell public safety communications systems.

As further discussed below, TIA's PRS sees three main areas of concern with the existing OOBE limitations for emissions that fall within the 700 MHz spectrum allocated for public safety. First, the PRS remains very concerned about the impact of the FCC's decision to allow high powered commercial base stations in the 777-792 MHz band, which is a mere 2 MHz removed from the public safety base station receiver band at 794-806 MHz. The existing commercial OOBE limits in Section 27.53 are insufficient to protect public safety systems principally because they were not developed with that system configuration in mind. Rather, the original OOBE requirements were developed when commercial base stations were limited to operating in the 747-762 MHz band meaning that public safety base station receivers would benefit from a frequency displacement of at least 32 MHz, which would result in greater attenuation of interfering OOBE. Further, PRS members are not confident that cost-effective filtering solutions for the commercial base stations' transmissions exist to mitigate this interference.[5]

The analysis performed by TIA's PRS indicates that the previous recommendation for OOBE requirements from Commercial Mobile Radio Service (CMRS) base stations to public safety base stations (Section 27.53(c)(3) as attached) must be adhered to when the CMRS base station is within a few tenths of a mile of the public safety base or remote receiver site.[6] These requirements could be relaxed for CMRS stations that are further removed.

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4 *Second Memorandum Opinion and Order,* WT Docket No. 99-168, January 12, 2001.

5 While filtering will be extremely difficult for any type of deployed technology, the FCC's technical flexibility policies make it even more difficult to analyze this issue since the type of technology that will be deployed in the 700 MHz commercial allocation is completely unknown at this time.

6 *See NPSTC Petition* at Attachment (*Protection of Public Safety Systems from 700 MHz CMRS Band Interference*).

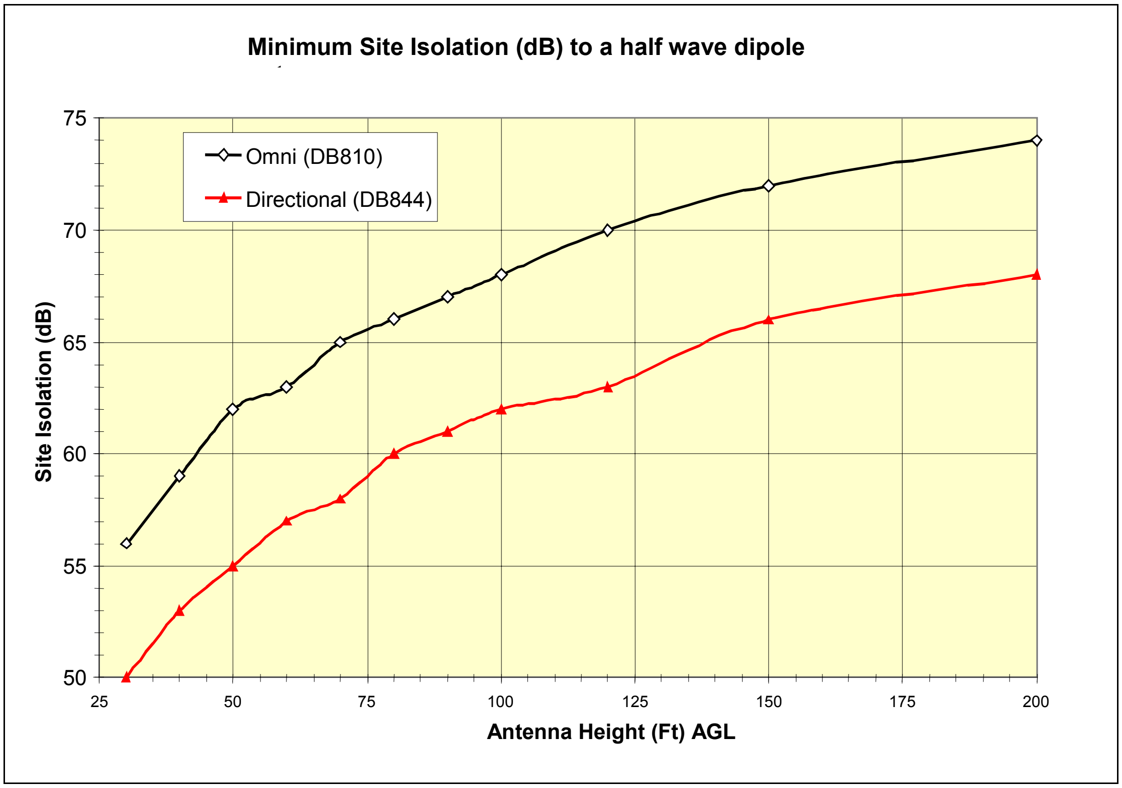
Even if the FCC were to reconsider its decision to allow commercial base stations to operate in the 777-792 MHz band, the existing OOBE limits in Section 27.53 are insufficient to protect public safety systems because of the next two interference mechanisms – the reduction in isolation from CMRS sites and increased intermodulation interference.

As a result of the analysis of 800 MHz interference scenarios, we have learned that the observed reduction in commercial system site isolation has correlated precisely with an increase in public safety interference situations. In TIA PRS's view, this trend will ensure that the current 700 MHz technical and operational rules are insufficient to prevent interference to public safety systems.

Site isolation is used to describe the loss of signal that occurs between the input to a base station antenna and the output of a public safety mobile station's antenna (assuming a half wave dipole) at varying distances from the undesired base station. This parameter is a function of the interfering base station antenna's gain, its pattern and the site geometry (tower heights and distance from the site). Propagation losses are also part of the equation. As the isolation between the public safety mobile receiver and the undesired commercial base station is decreased, the resulting higher levels of interfering signals degrades or prevents successful communications in public safety systems.

In the recent past, public safety system designers could expect at least 75 dB of site isolation from any proximate base stations. However, as commercial base stations are now operating at increasingly lower heights and becoming more plentiful, they are raising the noise floor for public safety mobile receivers and producing extremely strong in-band signals at locations in the immediate vicinity of the commercial base station.

We have analyzed two common antenna types -- an omni-directional antenna and a directional antenna -- that are currently being deployed by commercial mobile system operators. Each antenna was modeled in a spreadsheet, using the specific antenna patterns provided by the manufacturers. Multiple tower heights were modeled so that the site isolation could be plotted as a function of distance from the tower for each height. The minimum site isolation was determined from each plot and is depicted in the following figure.



As shown in this figure, the directional base station antenna located 100 feet above ground results in a minimum site isolation of approximately 62 dB. As the public safety mobile radio moves away from the commercial base station tower, the isolation does increase and interference is reduced. However, at the distance of minimum site isolation, the public safety mobile unit will have an additional 13 dB of additional noise to overcome with respect to the standard case (*i.e.,* 75 dB site isolation) if it is to receive the transmissions from its base station. An even worse example can be seen as the height of the interfering antenna decreases to 75 feet. Then the minimum site isolation decreases to approximately 58 dB resulting in 17 dB of additional noise with respect to the standard case.

This degradation of the public safety communications link is a direct result of OOBE from adjacent band systems. It cannot be filtered out at the public safety victim receiver because the interfering energy falls within the desired channel's bandwidth. Only filtering at the source and "isolating" the victim receiver from the source can decrease the harmful affects of OOBE.

The required amount of transmitter filtering can de determined by taking NPSTC's and TIA PRS's recommendations, -126 dBm in a 6.25 kHz channel bandwidth, and increasing it by the minimum site isolation. This then determines the level of OOBE that can be allowed at the base of the transmitting station's antenna. For example if the CMRS tower is 50 feet high, then the isolation for a directional antenna, as shown in the above figure, would be 55 dB and the allowable OOBE would be -126 dBm + 55 dB (isolation) = -71 dBm at the input to the potentially interfering CMRS transmit antenna. This would produce an interfering OOBE signal from a single source equal to the noise floor of the victim public safety receiver. If a typical portable radio were in use the isolation would increase by approximately 3 dB due to the less efficient portable antenna. If multiple sources were present, additional filtering would be required. Our experience at 800 MHz has shown this to be the predominant cause of interference from CMRS base stations to public safety mobile units.

It is recognized that TIA PRS's recommended OOBE limits for base stations into the public safety mobile receive band (*i.e.,* base transmitter band) would not be sufficient to prevent interference in all cases at all locations.[7] From the knowledge gained in the study of the interference problem in the 800 MHz band it is obvious that there will always be some level of interference from CMRS. As long as the maximum amount of that interference is defined and adhered to and is not too large, a public safety system can be designed to operate in this environment. The basic level of protection requirement previously recommended by Motorola, -126 dBm/6.25 kHz or –120 dBm/25kHz, was chosen to reflect real world conditions which will allow public safety systems to be designed with the required degree of reliability albeit with somewhat less range but not place an undue burden on the performance of the CMRS equipment.

Also, as noted in our earlier *ex parte* meeting, minimum site isolation generally occurs where public safety mobile facilities operate in close proximity to the interfering CMRS base station. For example, the data points in the above figure were calculated for public safety mobile units operating at distances ranges from less than 100 feet to nearly 3000 feet from the base of the theoretical interfering base station site. However, it is also important to note that in all of our calculations, the site isolation did not exceed the previous public safety standard of 75 dB until the public safety mobile unit was over approximately 3500 feet from the base of the interfering CMRS antenna.[8]

The third interference factor is receiver intermodulation. Based on our analysis of 800 MHz interference situations, this mechanism is an increasing source of interference due to the trend of more commercial base stations operating at lower antenna heights. This increases the levels of undesired signals in the public safety receivers and creates more sources of intermodulation interference.

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7 TIA PRS has previously recommended that on all frequencies from 764 to 776 MHz, commercial out of band emissions be attenuated by a factor not less than 91 + 10 log(P)dB (-61 dBm, 10 dB less stringent than the example) in any 6.25 kHz band segment, for base and fixed stations at any location. TIA PRS's recommended changes to the out-of-band emissions requirements of Section 27.53 were contained in the August 17th *ex parte* letter and they are again attached here for convenience. Note, however, that in the attached version, TIA PRS has corrected a typographical error in paragraph 27.53(c)(4). The original recommendations referred to out of band emissions for "mobile and fixed stations." This is corrected herein to refer to "base and fixed stations."

8 Attachment 2 to this letter are figures representing the spreadsheet simulations of the various antenna heights.

A typical public safety system has less than 20 watts into the transmit antenna. Thus if 75 dB of site isolation is available, the maximum potential IM producing signals would be +43 dBm - 75 dB = -32 dBm. Compare this to 10 watts into a CMRS directional antenna when only 55 dB of site isolation is available due to the site configuration (*i.e.,* antenna height and antenna pattern characteristics). The interfering signal levels are, +40 dBm - 55 dB = -15 dBm. These are extremely high signal levels and can produce nearly 51 dB more desensitization due to the 3 dB change for every dB change in IM producing signal levels [3 x (-15 dBm -(-32 dBm)) = 51 dB]. Current state of the art for hand-held receiver design makes it extremely difficult to protect a receiver from strong inband, potential IM generating signals due to the high current drain required to improve IM performance. Likewise it is difficult to protect a receiver from these strong out-of-band signals due to the inability to provide effective preselector filtering of a reasonable size for hand held units at 700 or 800 MHz.

The FCC's decision to allow TDD base stations to operate in both segments of the 700 MHz allocation will result in an increase in the number of potential sources of intermodulation interference. While it could be possible to increase public safety power levels to overcome the undesired interfering signals, this is considerably less effective than reducing the field strength of the potential IM sources.[9] Therefore it makes better sense to reduce the levels of and the number of the undesired signals from CMRS sources. To minimize the effects of intermodulation interference, the power levels of the CMRS base sites should be down to approximately -45 dBm at street level within approximately 400 meters of the site in any 6.25 kHz band segment in the 764 - 776 MHz band. This is equivalent to 88 dBu to a half wave dipole at 1.5 meters above the ground level. This should be relatively easy to achieve if the CMRS licensees carefully consider their choice of antenna type and height.

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9 A three dB reduction for 3rd order and a 5 dB reduction for 5th order IM occurs whereas increasing the desired is only a dB per dB improvement.

TIA's PRS appreciates and supports the FCC's desire to promote technical flexibility and provide commercial licensees with the technical ability to address a variety of market needs. In so doing, however, the Commission must ensure that adjacent band systems – in this case, public safety operations – are adequately protected from interference. TIA PRS members that serve the public safety community are unanimous in their belief that the current 700 MHz technical rules are a recipe for disaster that will frustrate the best intentions of Congress and the FCC to develop a new spectrum home for interoperable public safety communications. The PRS recommends that the Commission modify Section 27.53 as previously recommended to minimize the expected levels of interference.

Respectfully Submitted,

__/s/___________________

Bill Belt
Director, Wireless Communications Division
Telecommunications Industry Association

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Attachment 1
TIA PRS Proposed Revision to Section 27.53 of the Commission's Rules

§ 27.53 Emission limits.

* * * * *

(c) For operations in the 747 to 762 MHz band and the 777 to 792 MHz band, the power of all emissions outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed bands(s) of operation, measured in Watts, in accordance with the following:

(1) On any frequency outside the 747 to 762 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + l0 log (P) dB;
(2) On any frequency outside the 777 to 792 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + l0 log (P) dB;
(3) On all frequencies from 794 to 806 MHz, by a factor not less than 110 + 10 log(P)dB in any 6.25 kHz band segment, for base and fixed stations at any location;
(4) On all frequencies from 764 to 776 MHz, by a factor not less than 91 + 10 log(P)dB in any 6.25 kHz band segment, for base and fixed stations at any location;
(5) On all frequencies between 764-776 MHz and 794-806 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz segment, for mobile and portable stations;
(6) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;
(7) Compliance with the provisions of paragraphs (c)(3) and (c)(4) and (c)(5) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

* * * * *

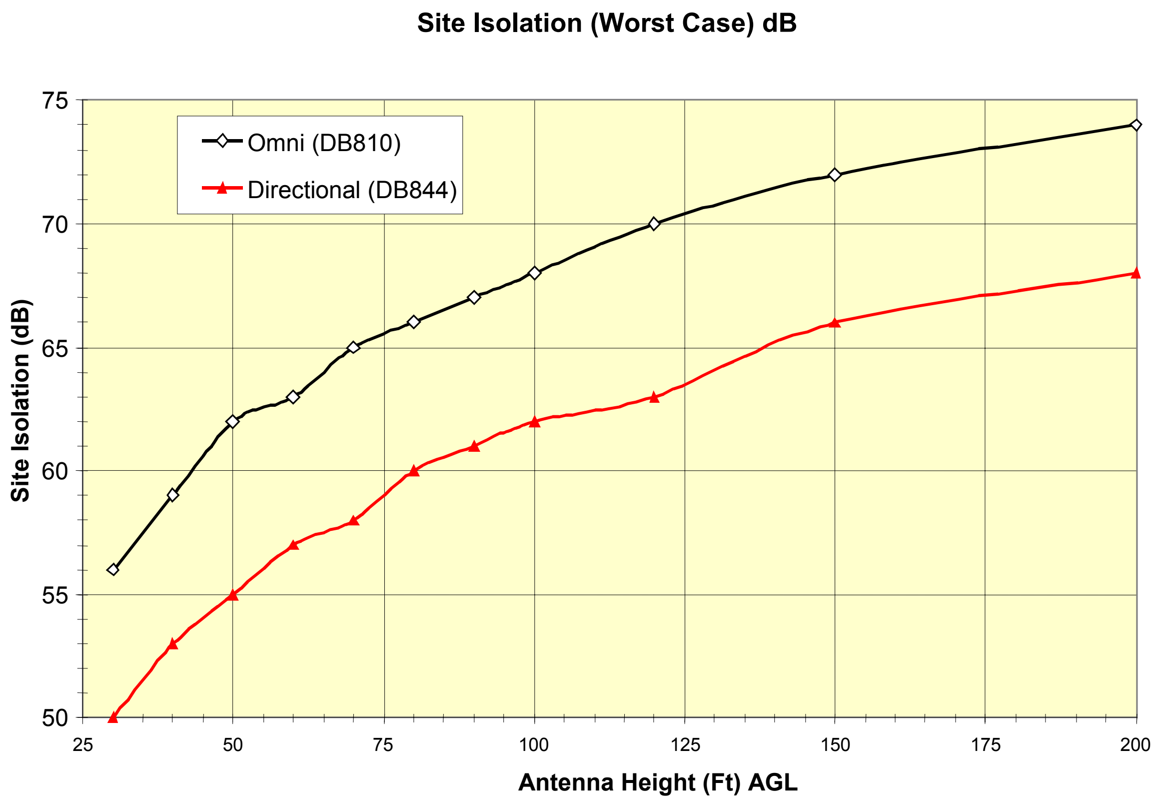
Recognizing that external filters may be required to meet these rigorous but necessary requirements, TIA PRS recommends that the FCC add wording permitting their effect to be included in meeting these criteria.

Attachment 2
Site Isolation Calculations

The following figures represent the spreadsheet simulations of the various antenna heights. The calculations are based on a fixed receiver location, 5 feet above ground level. Therefore, the actual height used in the calculation is the tower height minus 5 feet. The specific antennas used were available antenna pattern files and recommendations from Nextel.

The isolation is sum of the antenna gain, loss of gain due to the antenna pattern at the calculated vertical angle to the point 5 feet above the ground level, the free space loss in the distance the signal travels. Since it is defined as Isolation (loss in dB) it is expressed as a positive value.

The first half of this report contains the omni-directional site isolation simulation; the second half contains the directional site isolation simulation.



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Appendix 1 -Decibel DB810M-XT Antenna Evaluation

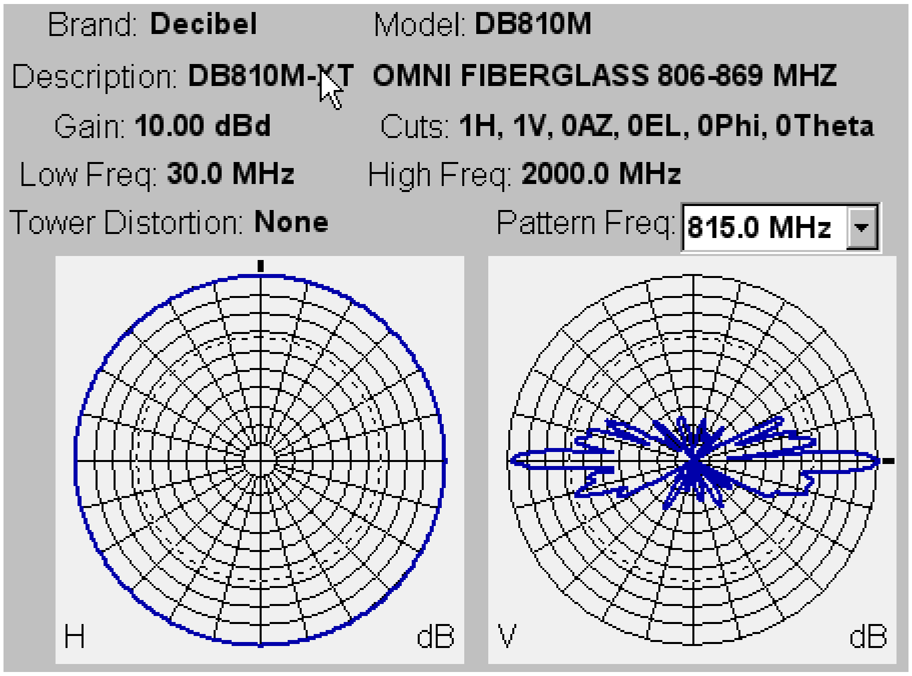

Figure A-1 Antenna Pattern. Vertical Right portion used for evaluation

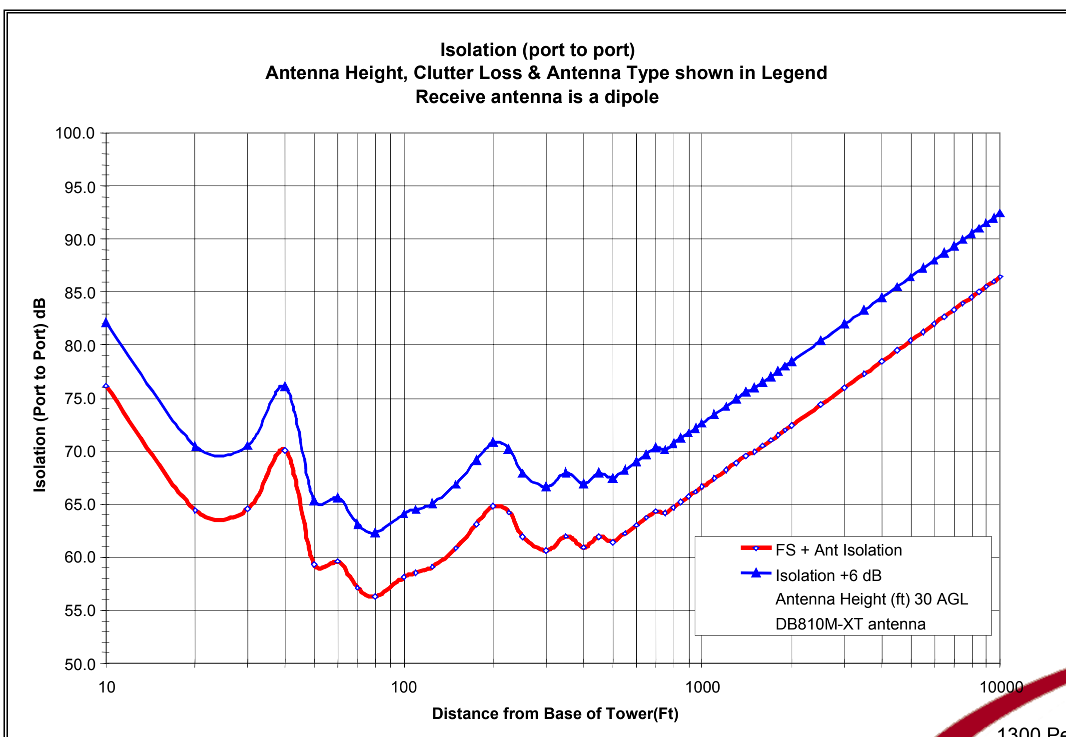

Figure A 2, 30' Antenna Height

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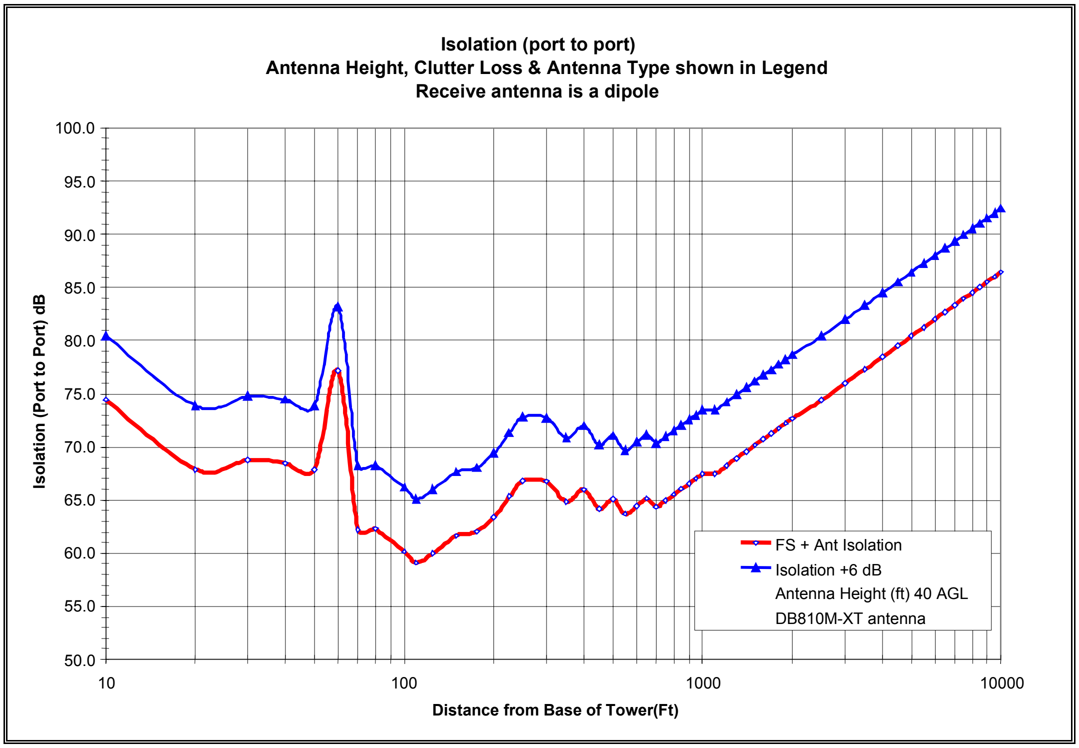

Figure A 3, 40' Antenna Height

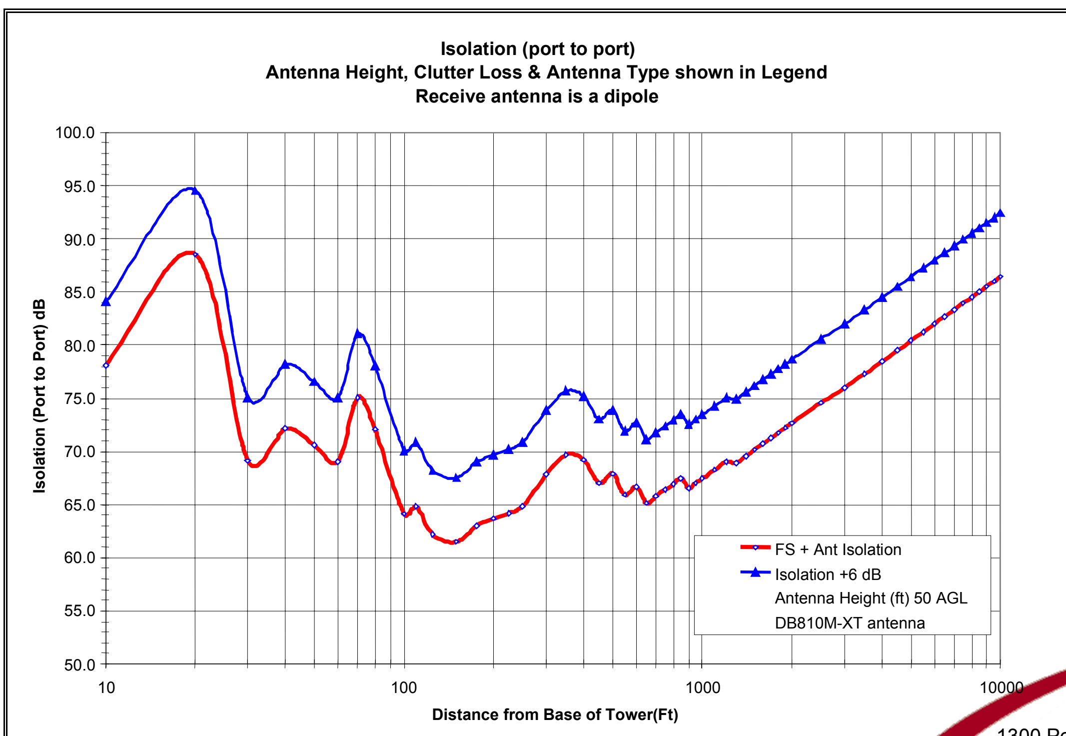

Figure A 4, 50' Antenna Height

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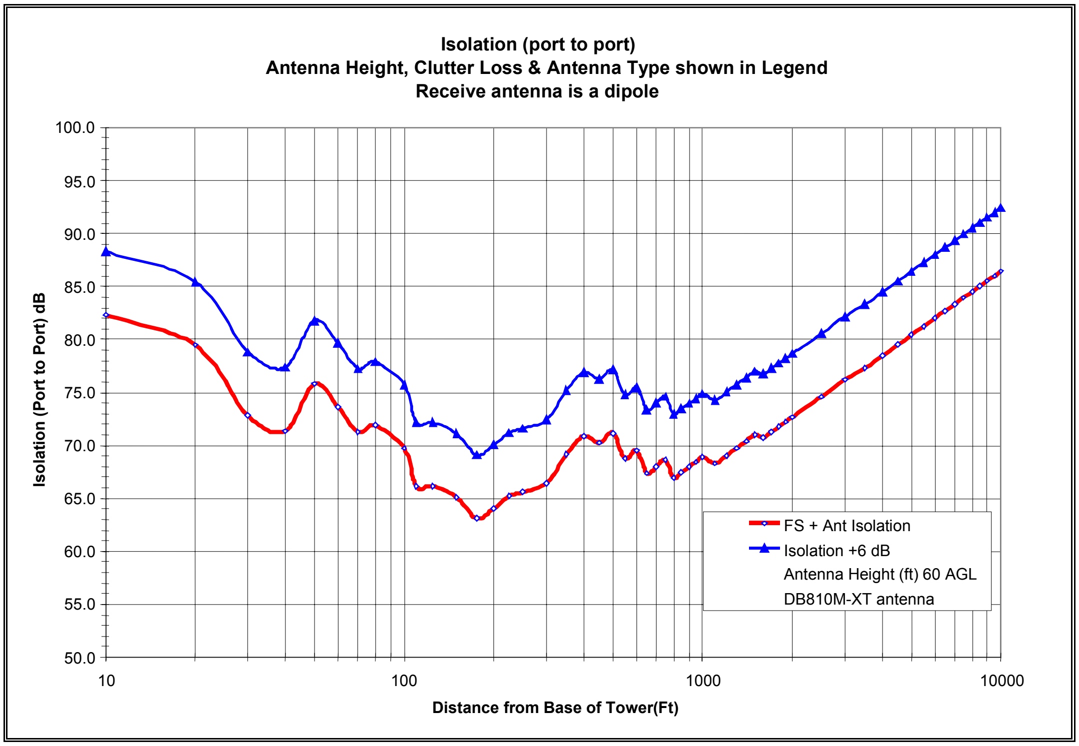

Figure A 5, 60' Antenna Height

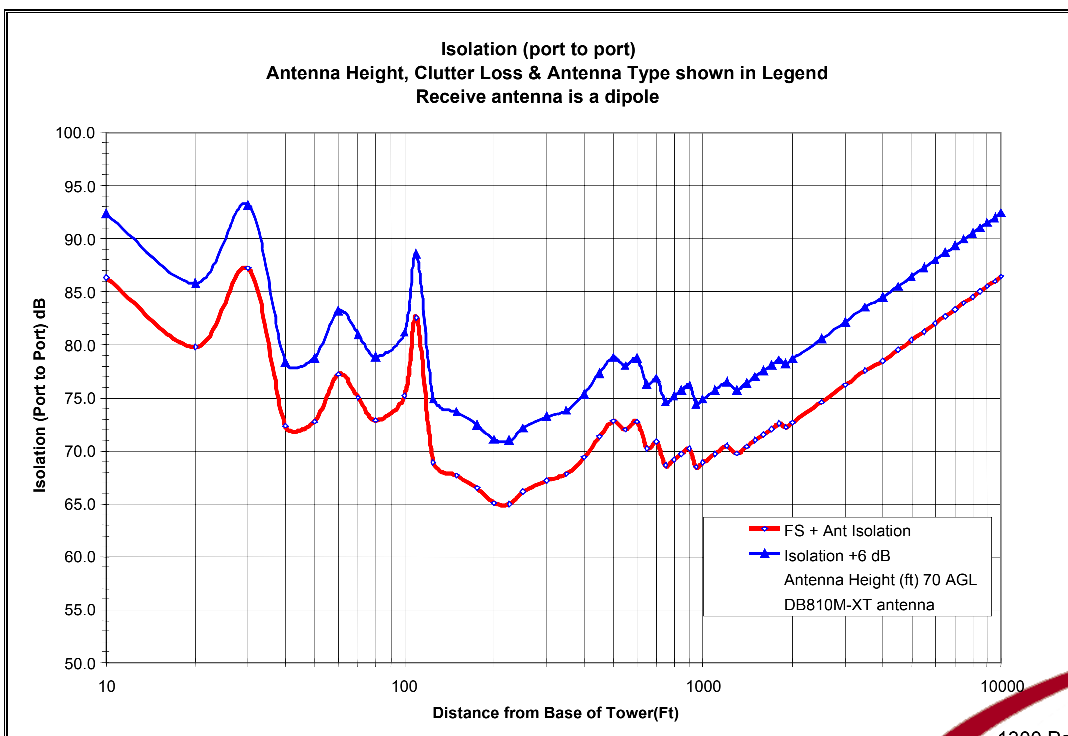

Figure A 6, 70' Antenna Height

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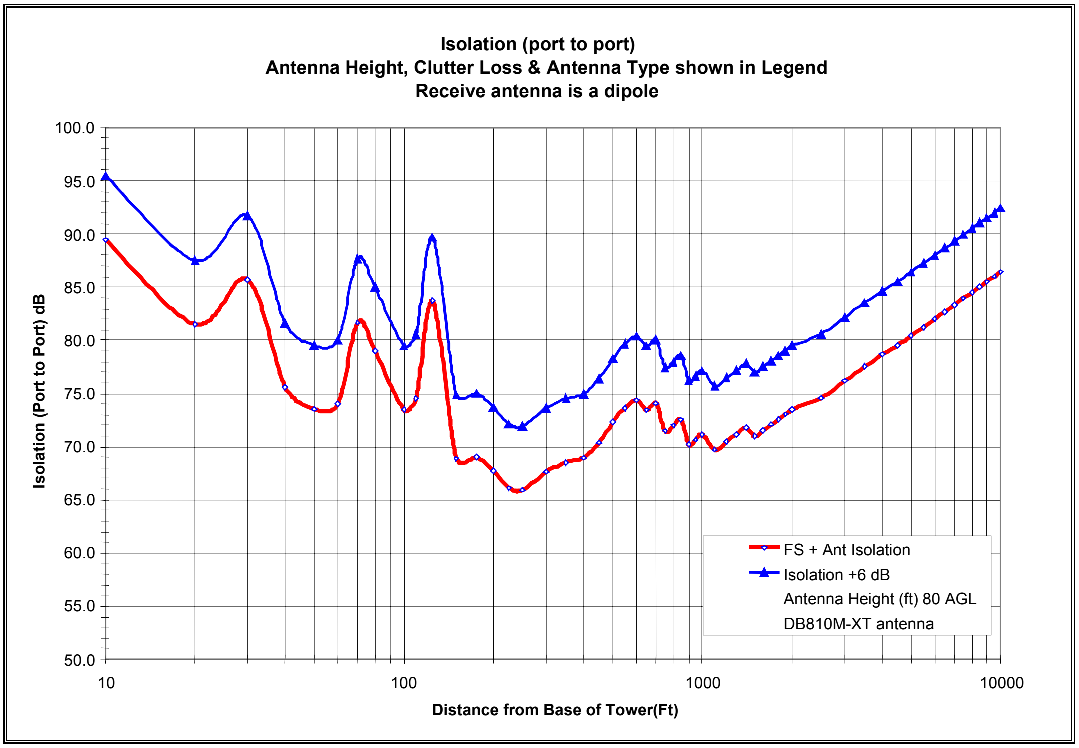

Figure A 7, 80' Antenna Height

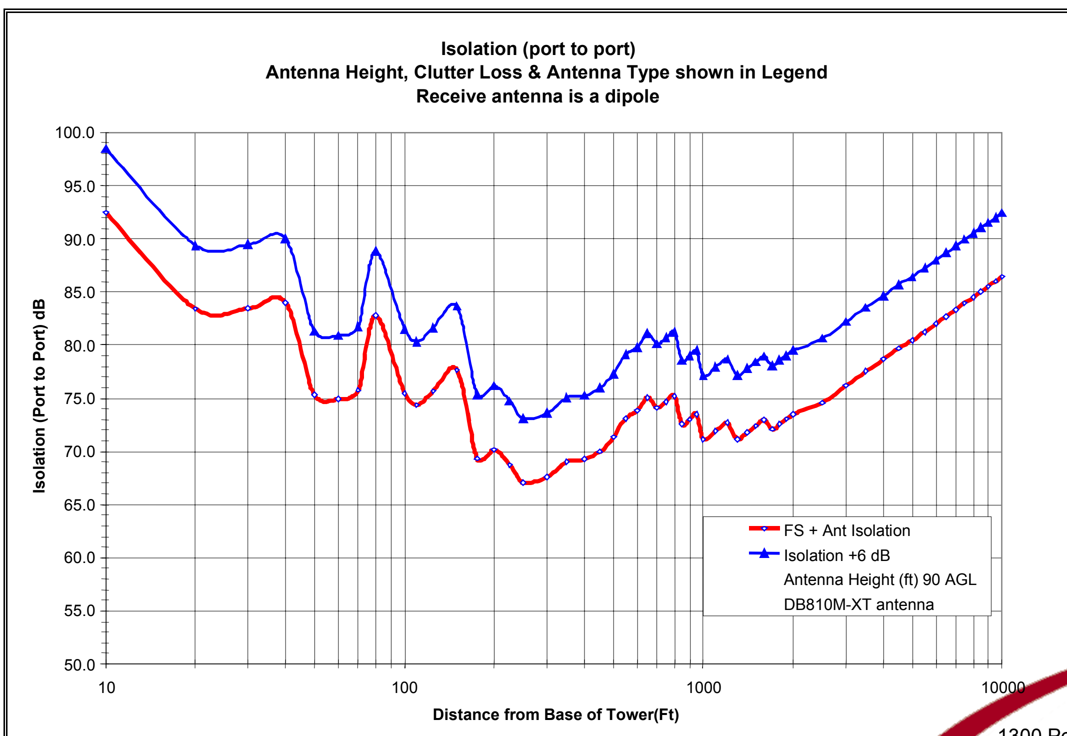

Figure A 8, 90' Antenna Height

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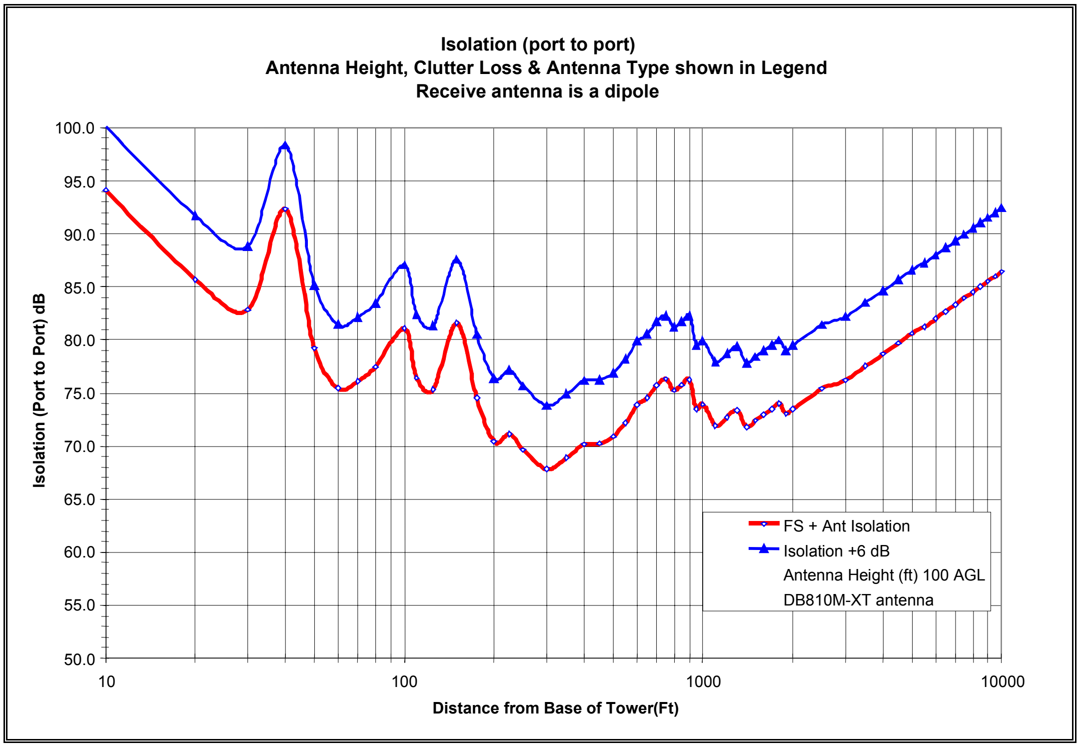

Figure A 9, 100’ Antenna Height

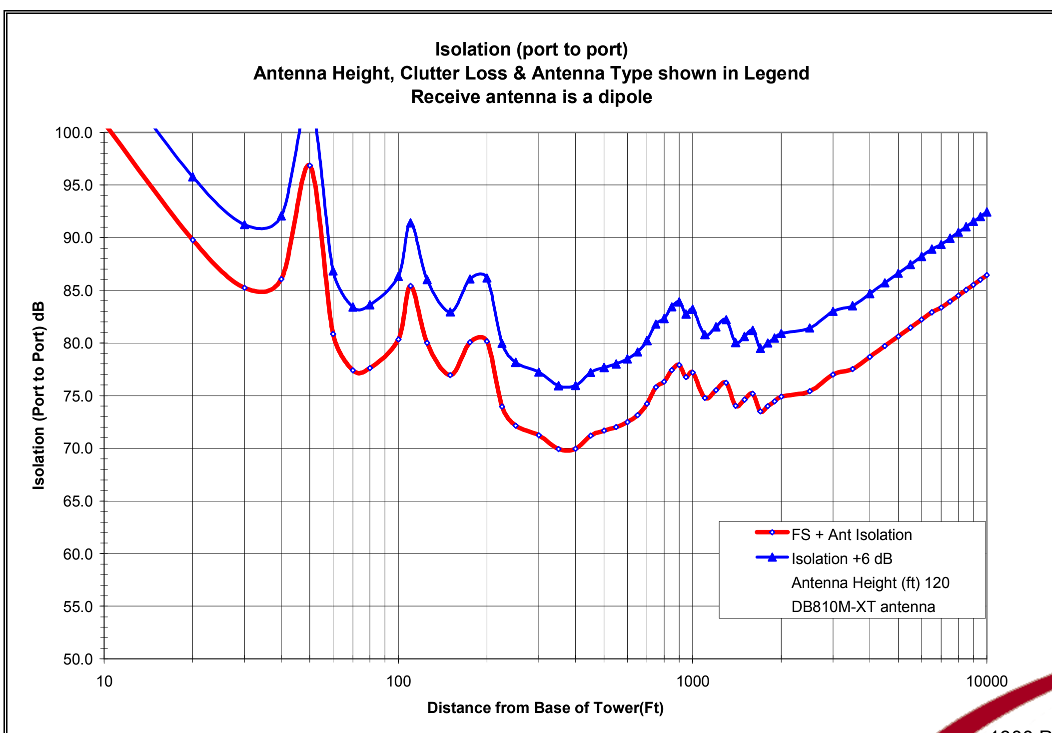

Figure A 10, 120’ Antenna Height

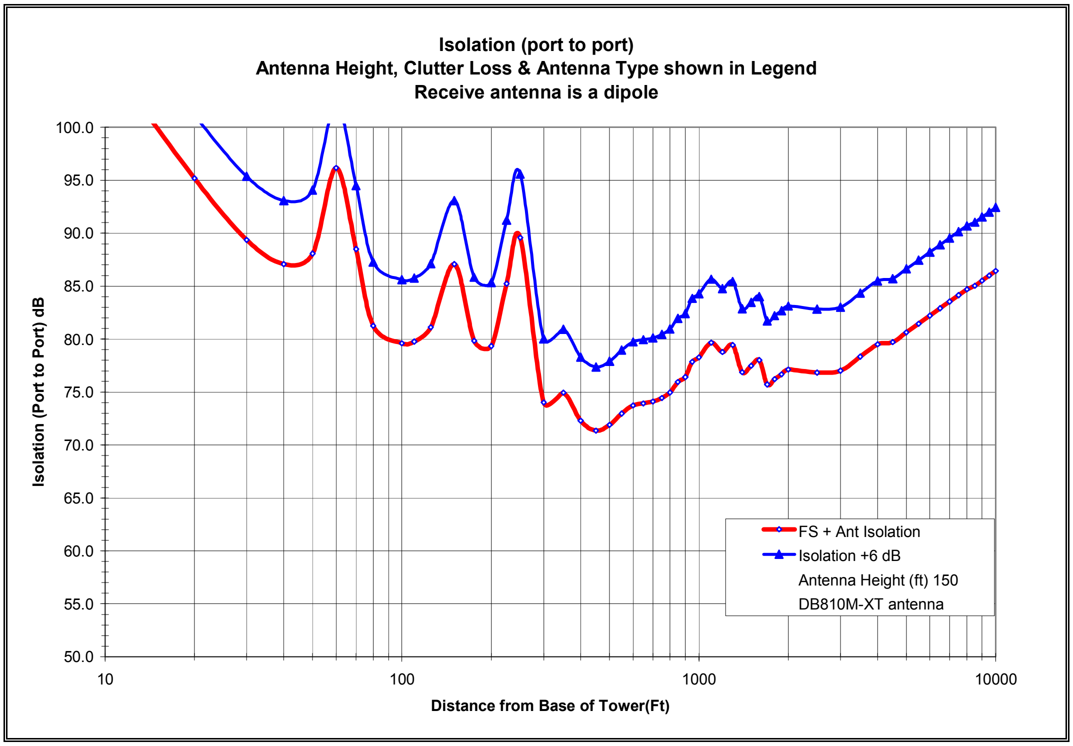

Figure A 11, 150' Antenna Height

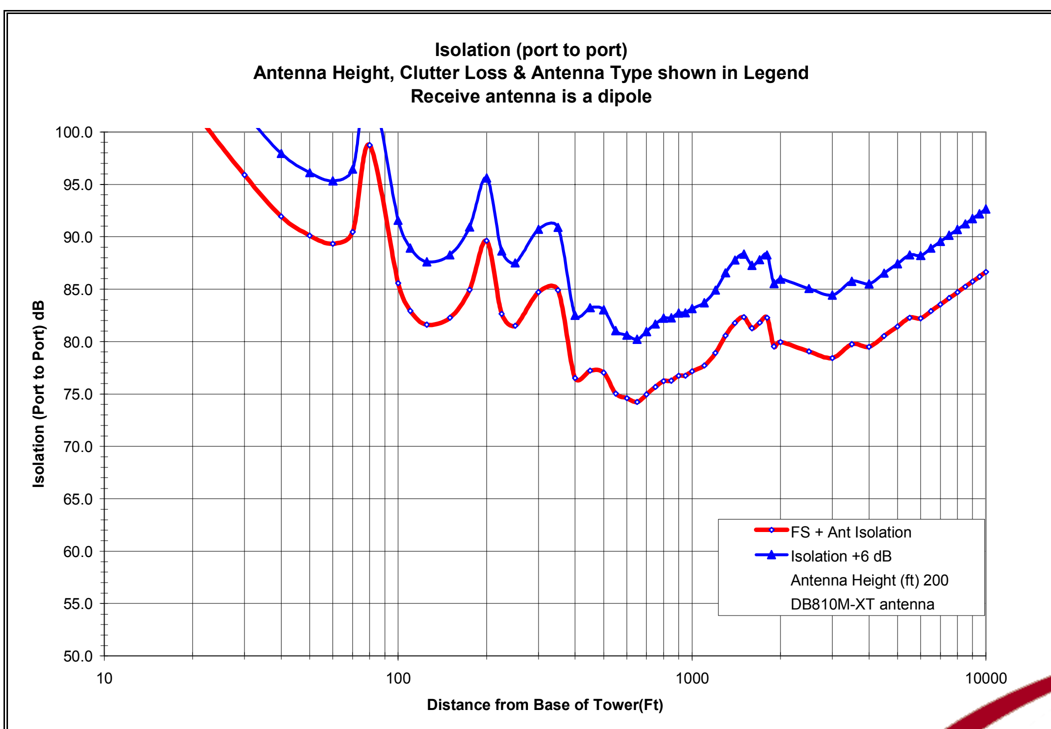

Figure A 12, 200' Antenna Height

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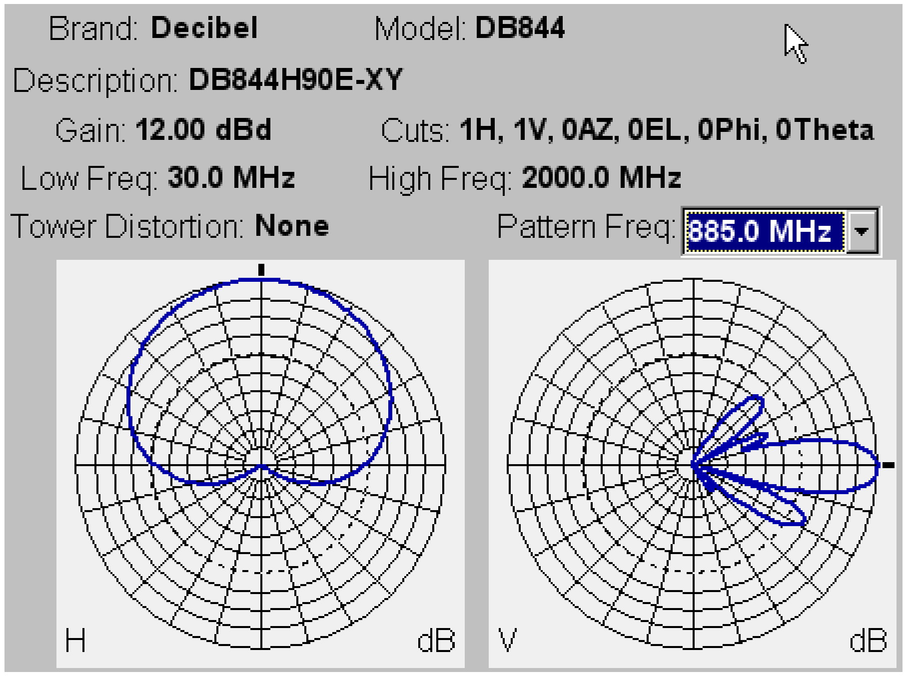
Appendix B - Decibel DB844H90E-XY Antenna Evaluation



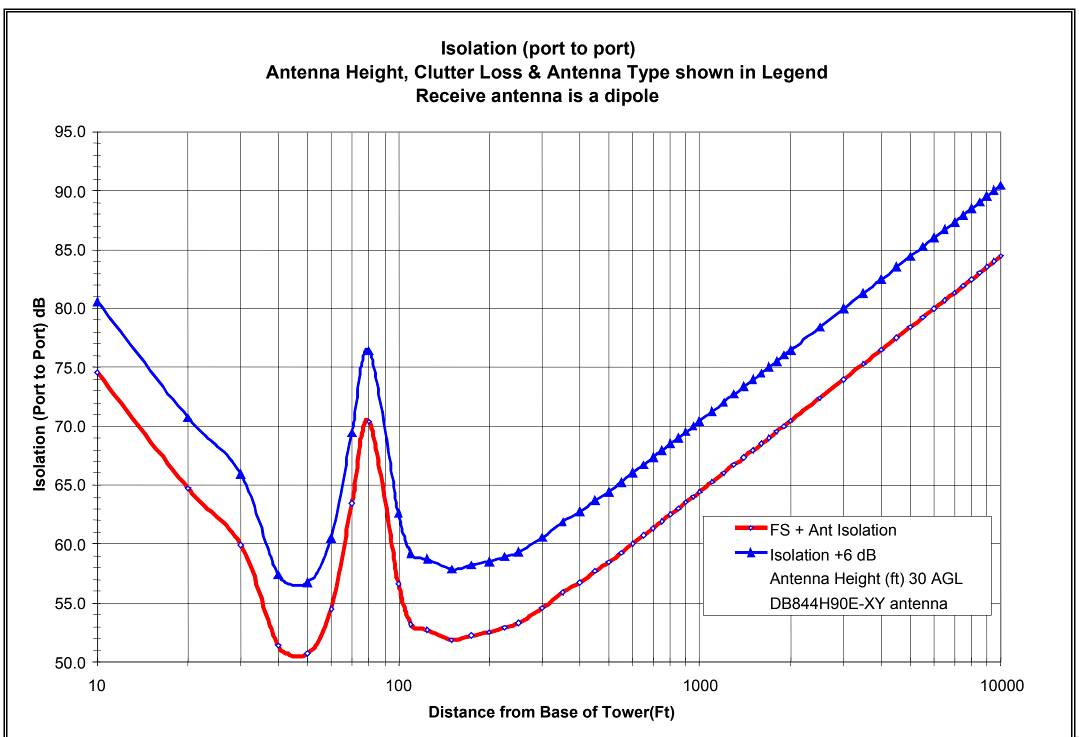


Figure B 2, 30' Antenna Height

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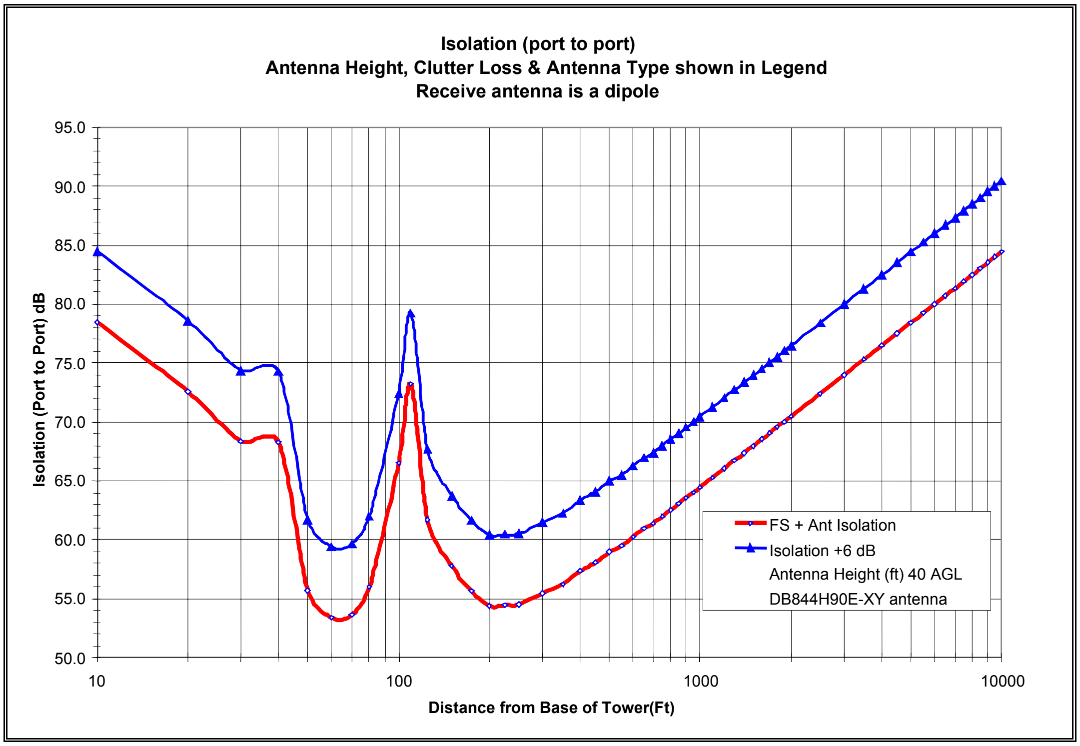


Figure B 3, 40’ Antenna Height

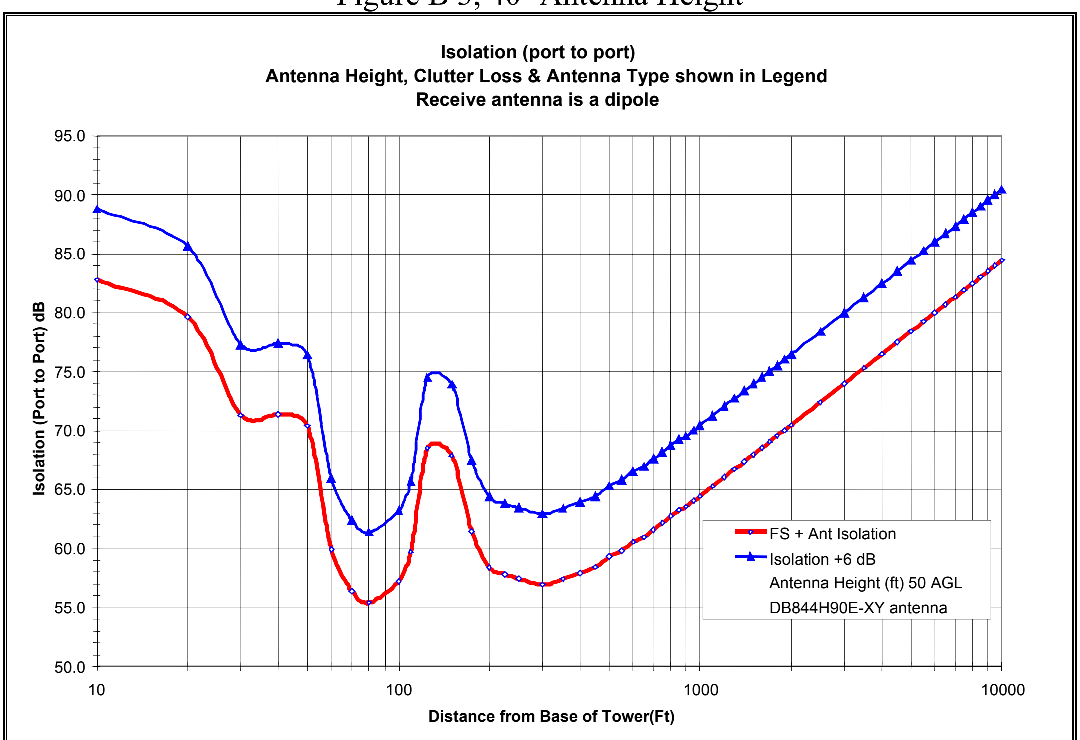


Figure B 4, 50’ Antenna Height

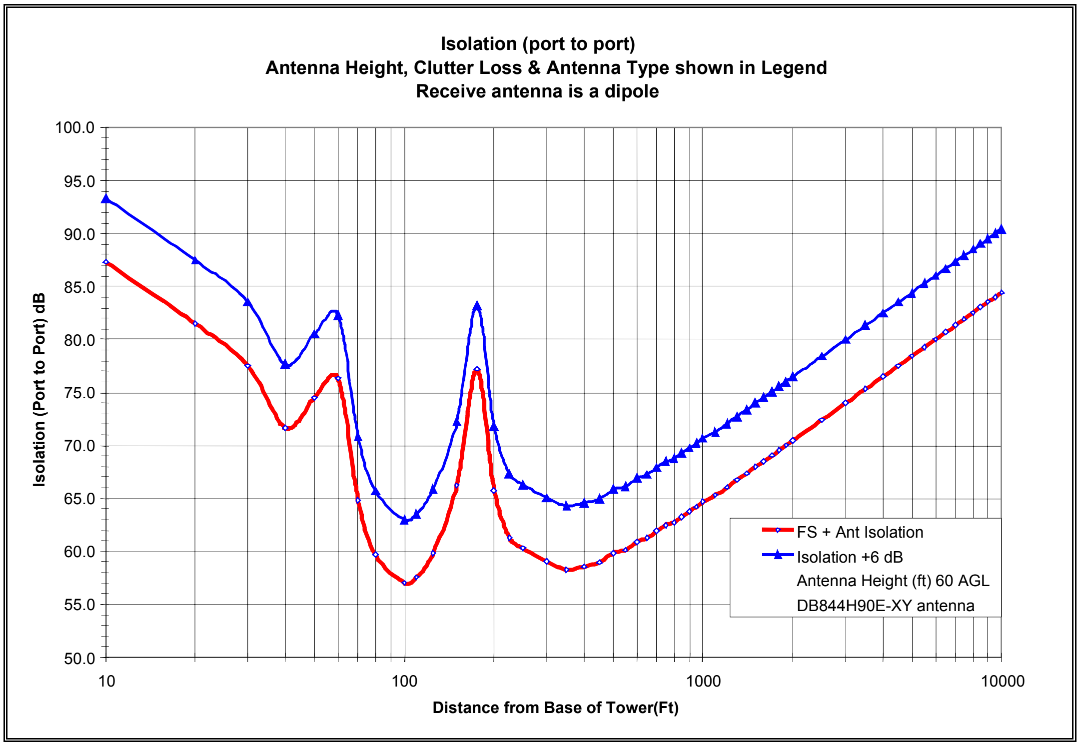


Figure B 5, 60' Antenna Height

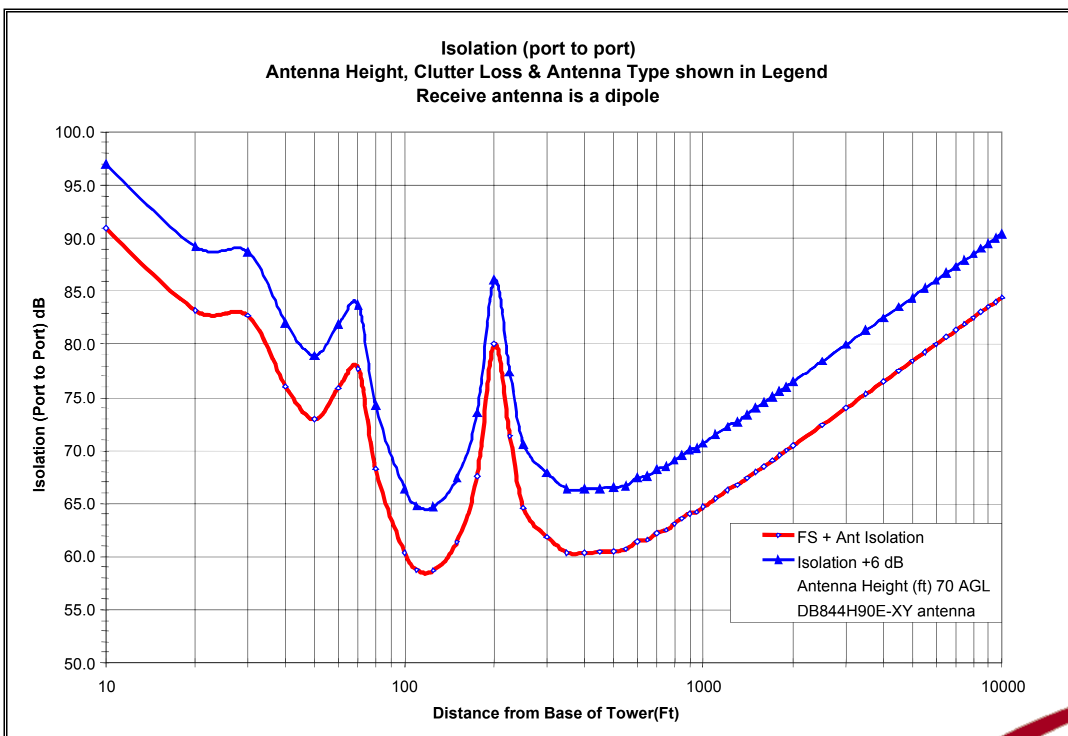


Figure B 6, 70' Antenna Height

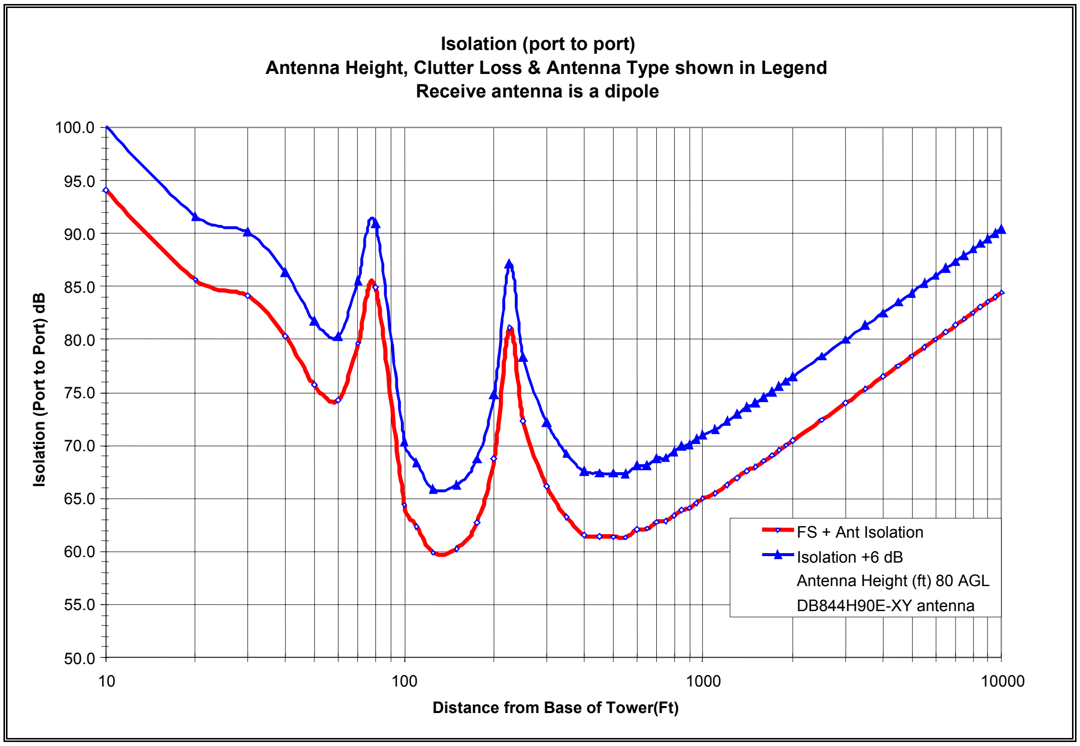
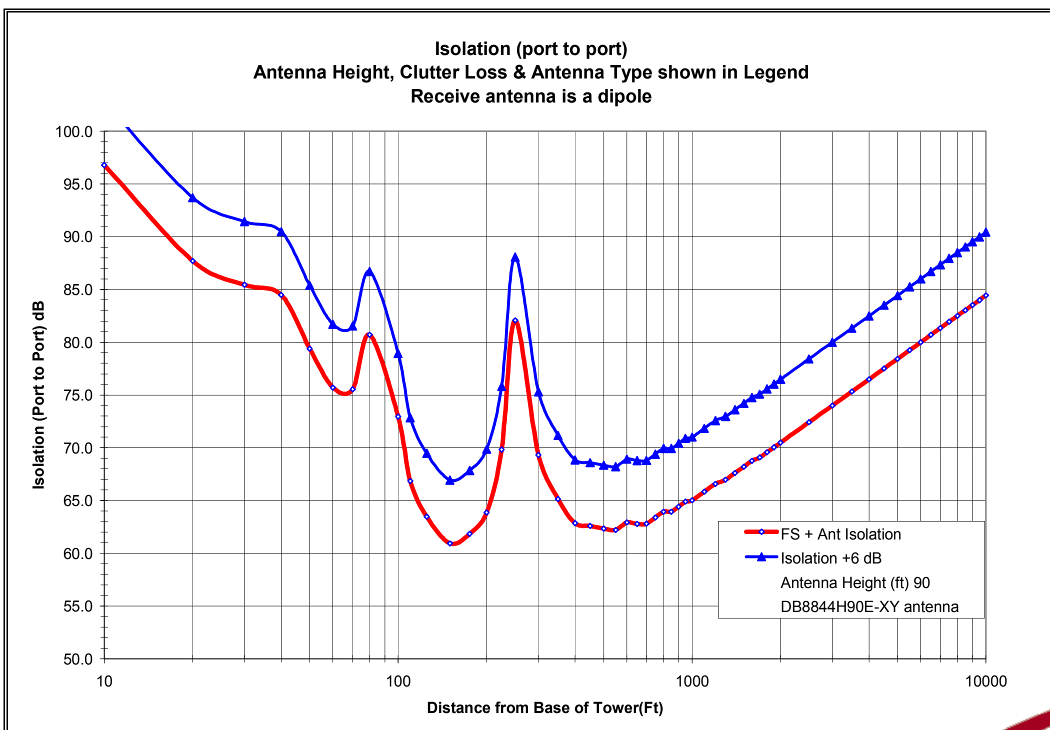


Figure B 7, 80' Antenna Height



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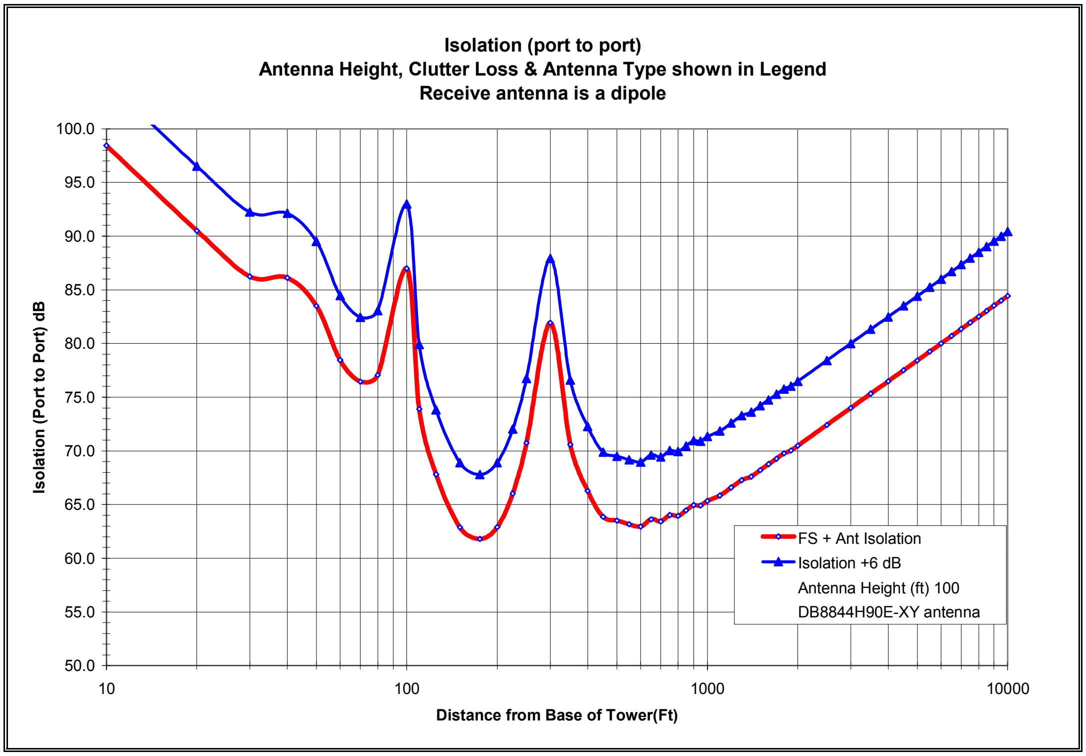
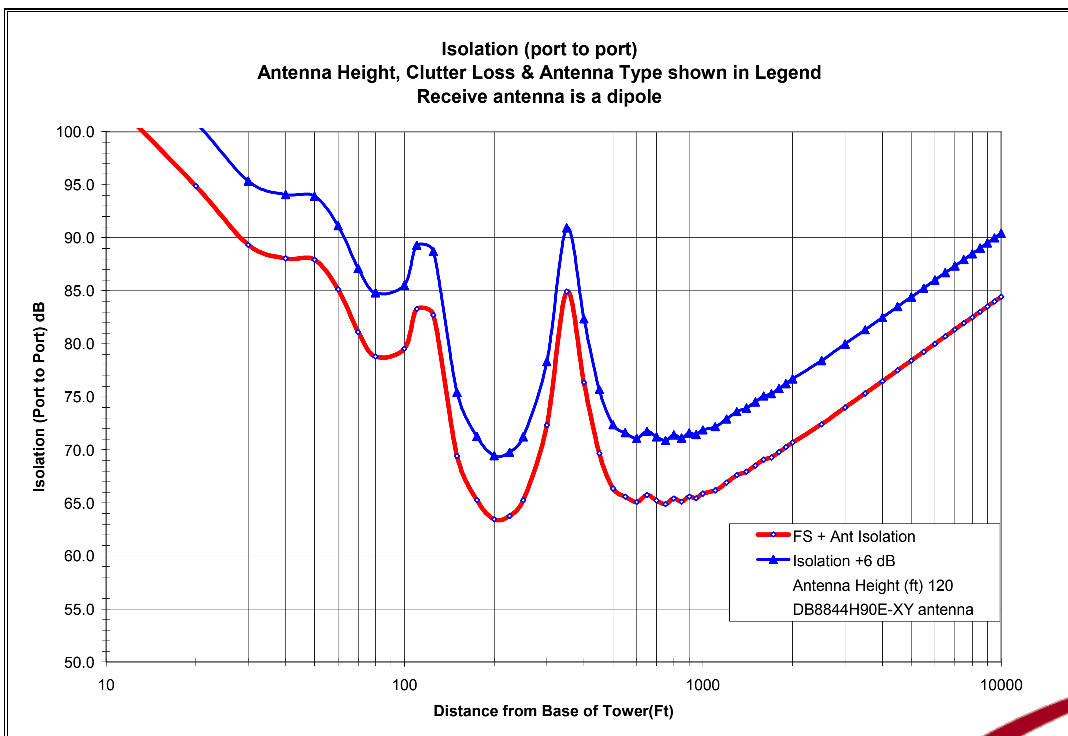


Figure B 9, 100’ Antenna Height



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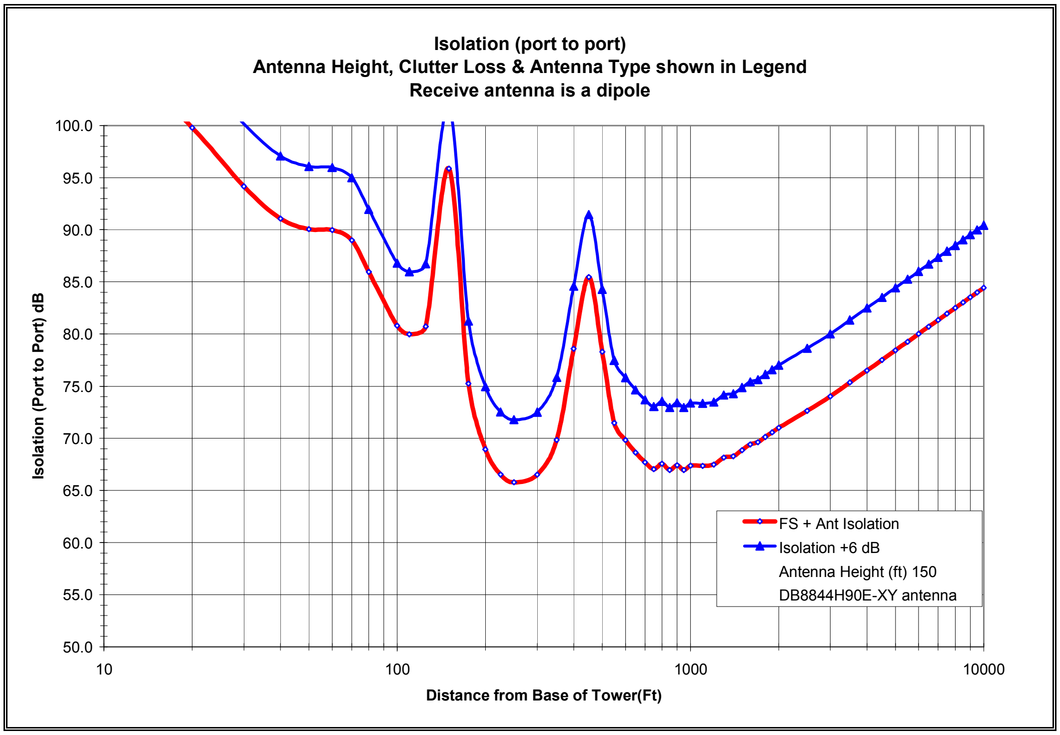

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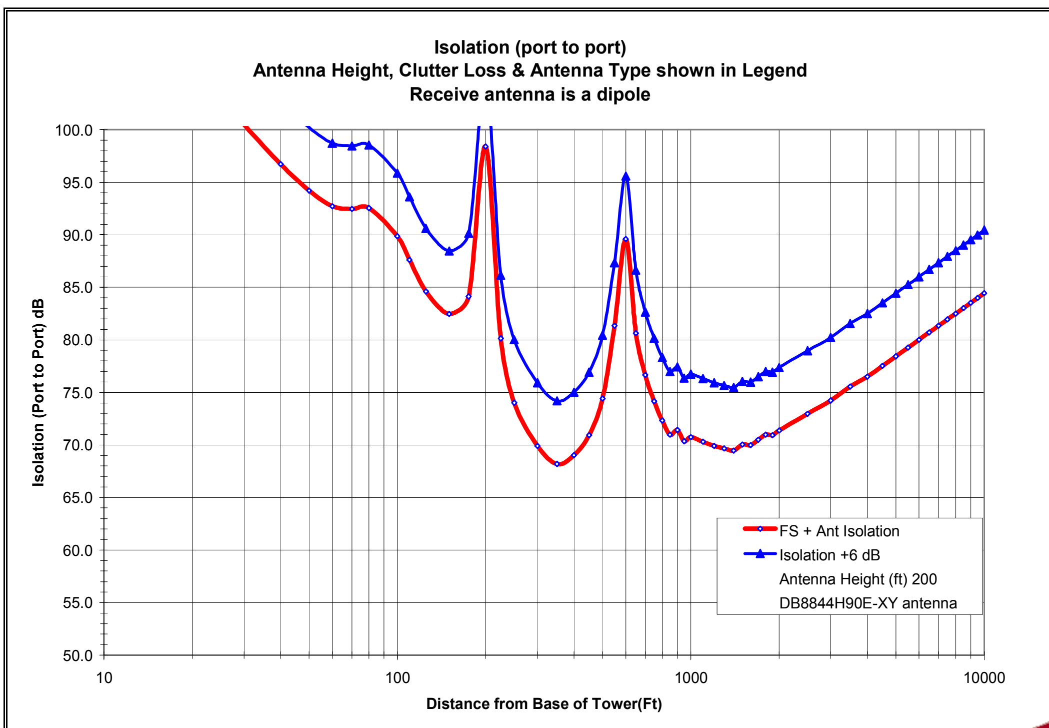

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