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Title	**Methods of Predicting Interference - FCC Appendix D**
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Re:	FCC method of modeling interference including propagation model.
Abstract	This document contains the FCC procedure (Appendix D of Two-way Ruling) for predicting interference between systems licensed in the 2.5 GHz ITFS/MMDS band. It also contains the FCC propagation model for this band. It is provided as a reference for the coexistence studies being conducted in TG2.
Purpose	For discussion in TG2 in Denver.
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METHODS FOR PREDICTING INTERFERENCE FROM RESPONSE STATION TRANSMITTERS AND TO RESPONSE STATION HUBS AND FOR SUPPLYING DATA ON RESPONSE STATION SYSTEMS. MM DOCKET 97-217

1. This document sets out the methodology to be used in carrying out certain requirements with respect to response stations used as part of two-way cellularized MDS and ITFS systems. It details the methods for conducting interference studies from and to two-way systems, and it defines a file format to be used in submitting data in response station hub applications. It also describes the propagation analysis techniques to be used in these studies.

Four Major Steps for Response Station Interference Analysis

2. In carrying out the studies of interference from response station transmitters, the aggregate power of the interfering signals to be expected from the response station transmitters shall be determined using a process comprising four major steps, as described below. First, a grid of points shall be defined that is statistically representative of the distribution of transmitters to be expected within the response service area, and the elevations to be associated with each of them shall be determined. Second, any regions and any classes of response stations to be used shall be defined. Third, the appropriate transmitter configuration to be used in each interference study shall be determined. Fourth, the equivalent power of each of the representative transmitters shall be determined and used in the various required interference studies. The parameters used in the studies shall be provided in a prescribed electronic form as described later in this document.

Defining Grid of Points for Analysis

3. Since it is impossible to know *a priori* where response stations will be located, a grid of points is used to represent statistically, in a relatively small number of locations, the potentially much larger number of response stations that are likely to be installed in the areas surrounding each of the points. Once defined, the same grid of points shall be used by all parties conducting interference analyses involving the subject response station system.

4. Defining the representative grid of points to use in all the interference studies required in Rule Sections 21.909 and 74.939 begins by geographically defining the response service area (RSA) of the response station hub (RSH). This may be done using either a list of coordinates or a radius from the response station hub location or from the RSA reference point defined below when the hub is located outside the RSA. When coordinates are used, straight lines shall interconnect one location with the next in the order given in the list, and the last location described shall be connected to the first location by a straight line. When a radius from the response station hub location or the RSA reference point is used, the value shall be expressed in kilometers, with any fractional part expressed as a decimal value to two places. The boundaries described are administrative and serve to circumscribe the area in which response station transmitters may be located. When the response station hub is located outside the RSA, the reference point shall be that point, measured in degrees, minutes, and seconds to the nearest one-tenth, that is simultaneously midway between the eastern- and western-most extremes and midway between the northern- and southern-most extremes of the RSA. The same method for determining the reference point shall be used regardless of whether the RSA is defined as a radius or as a group of points. It should be noted that, when the response station hub is located outside the RSA and depending upon the shape of the RSA, the reference point also might fall outside the RSA using this method. The same consideration applies to Basic Trading Area and Partitioned Service Area reference points as defined later.

5. The characteristics of any sectors in the RSH receiving antenna also must be described in two ways: geographically, so as to limit the locations from which response stations will transmit to each sector, and

electrically, by providing data on the electrical field response of the antenna pattern in each sector. Sectors may overlap one another geographically. The geographic boundaries of a sector shall be defined using either a list of coordinates or a list of bearings. Electrical field response data shall be relative to the direction of maximum response of the sector antenna and shall be provided every one (1) degree completely around the antenna. Both azimuth and elevation field patterns shall be supplied for each polarization to be used with a given antenna type. The geographic orientation of each sector to the nearest one-tenth degree and the polarization in each sector also shall be specified. When response stations share channels or sub-channels by transmitting simultaneously on them, the maximum number of response stations that will be permitted to transmit simultaneously within each sector must be specified.

6. The RSA may be subdivided into regions to allow different characteristics to be used for response stations in different portions of the RSA. (For details on regions and their use, see the section below on Defining Regions and Classes for Analysis.) Any regions to be used when analyzing interference must also be described in a manner similar to that used to describe the RSA itself. Analysis of the regions involves use of one or more classes of response station characteristics. For each such class, a combination must be specified of the maximum antenna height, the maximum equivalent isotropic radiated power (EIRP), and the worst case antenna pattern that will be used in practice in installations of response stations associated with that class within the respective regions. (For details on classes and their use, see the section below on Defining Regions and Classes for Analysis.) When response stations share channels or sub-channels by transmitting simultaneously on them, the maximum number of response stations associated with each class that will be permitted to transmit simultaneously within each region and each sector must be specified.

7. To define the grid of points, a line is first established surrounding the RSA, 0.8 km outside the RSA boundary line. This is termed the analysis line and will be used in determining that an adequate number of grid points representing transmitters is being used in the interference analyses. A starting point is defined at the northernmost point on the analysis line having the same longitude as the reference point, no matter whether that reference point is within or outside the RSA. A series of analysis points is then spaced along the analysis line with the starting point being one of those points. The analysis points must occur with a spacing no greater than every 0.8 km along the analysis line or every 5˚degrees (as seen from the response station hub or RSA reference point), whichever yields the largest number of analysis points. When an RSA has a non-circular shape, the choice of distance along the analysis line or angle from the response station hub or RSA reference point must be made for each portion of the line so as to maximize the number of analysis points in that portion. The analysis points are to be described by their geographic coordinates. (The results of this method are that, for a circular RSA, a minimum of 72 analysis points will be used, and that, for portions of the analysis line of any RSA more than 9.22 km from the response station hub or RSA reference point, the distance method will be used.)

8. Next, the grid of points is defined within the RSA to statistically represent the response stations. The grid uses uniform, square spacing of the points, as measured in integer seconds of latitude and longitude, with the first square surrounding the RSH or RSA reference point and with its points equidistant from it. The lines connecting the points on one side of any grid square point true north, east, south, or west. The grid is defined so as to include all points within or on the boundary of the RSA, with the exception described in paragraph 9 below. Note that when the RSA reference point is outside the RSA, it is still the case that only points actually within the RSA are to be included. The result is that the grid can be defined by only two values the coordinates of the hub or RSA reference point and the separation between adjacent grid points in seconds combined with the description of the RSA boundary.

9. Any points falling at locations within the RSA at which it would be physically impossible to install a response station (such as in the middle of a lake, but not the middle of a forest) are removed from the analysis. The points of the grid so inactivated are to be described by their geographic coordinates.

10. The grid of points is then divided into two groups. The division is to be done using a checkerboard pattern so that alternating points along the east-west and north-south axes belong to opposite groups and points along any diagonal line belong to the same group.

11. The combination of the grid of points within the RSA and the points on the analysis line is next used to determine that the number of grid points is truly representative of a uniform distribution of response station transmitters within the RSA. This is done by conducting a power flux density analysis from each grid point within the RSA to each point on the analysis line. For this analysis, a single response station should be assumed to be located at each grid point, that response station having the combined worst case antenna pattern without regard to polarization of all response station classes assigned to that grid point and the maximum EIRP of any response station class assigned to that grid point. (For details on the method for determining the combined worst case antenna pattern, see the section below on Defining Regions and Classes for Analysis.) The response station antennas all should be oriented toward the response station hub.

12. The analysis of grid point adequacy should be done using free space path loss over flat earth only and should not include the effects of terrain in the calculation of received signal levels. At each point on the analysis line, the power flux density from all grid points in each group of the checkerboard pattern should be aggregated. This is done by converting power received from each assumed transmitter from dBW/m^2 to W/m^2, summing the power in W/m^2 from all transmitters in each group, and then converting the sum back to dBW/m^2.

13. After the aggregated power flux density from each of the two groups has been calculated, the received power flux densities from the two groups are compared at each of the points on the analysis line. The power flux densities from the two groups must be within 3˚dB of one another at each of the points on the analysis line. In addition, there must be no closer spacing of grid points that allows a difference of greater than 3˚dB between the groups. If the power flux densities of both groups are within 3 dB at every analysis point, a sufficient number of grid points is included for use in further analyses. If they are not within 3 dB at every analysis point, a larger number of grid points (i.e., closer spacing of grid points) must be used so that the 3˚dB criterion is met. If calculation of the spacing of grid points proceeds from larger to smaller spacings, the minimum spacing that should need to be investigated to check for smaller spacings not meeting the 3 dB criterion is 50 percent of the spacing at which the 3 dB criterion is first met.

14. In cases in which sectorized response station hubs are used, a further test is required to assure that an adequate number of grid points is used. In addition to meeting the requirements of the preceding paragraph, each sector must contain a minimum number of grid points. When the hub is within the RSA, the number of grid points within each sector shall be equal to or greater than the distance from the hub to the furthest point in the sector, expressed in kilometers, divided by three. When the hub is not within the RSA, the number of grid points within each sector shall be equal to or greater than the difference between the distances from the hub to the nearest point and to the furthest point in the sector, expressed in kilometers, divided by three. In both cases, there shall be a minimum of five active grid points per sector, and rounding shall always be to the next higher integer. Should an insufficient number of grid points fall within any sector after meeting the 3 dB criterion, the point spacing for the entire RSA must be decreased until this additional requirement is satisfied.

15. Once the geographic locations of the grid points are determined, the elevations to be attributed to each must be decided. This is done by creating a geographic square uniformly spaced around each grid point having a width

and a height equal to the spacing between grid points and oriented in the same directions as the lines between grid points used to lay out the grid structure. Each such square is then examined with respect to all of the data points of the U.S. Geological Survey (USGS) 3-second database falling within or on the edge of the square to find the elevation of the highest such data point, expressed in meters. That elevation is ascribed to the associated grid point and shall be used for the elevation of that grid point in all further and future analyses of the response station system.

16. The geographic coordinate system used in the USGS 3-second database is based on the World Geodetic System 1972 (WGS-72) ellipsoid and the corresponding1983 North American Datum (NAD-83). All coordinates used in carrying out the analyses required in this methodology, appearing in applications for response station hubs, and reported in the files required to be submitted or served in conjunction with such applications shall be based upon use of NAD-83. It should be noted that the Commission historically required use of NAD-27 for applications in the MDS and ITFS services and that the values in the FCC s database have been based upon use of NAD-27. As of the opening of the one-week filing window for applications for response station hub licenses, the Commission will accept only coordinates based upon use of NAD-83 for applications for all classes of stations in these services. Those following this methodology or filing applications for any other purpose in these services are advised that NAD-27 data from previously existing sources must be converted to NAD-83 in order to carry out the requirements specified herein and in the related Rules.[1]

Defining Regions and Classes for Analysis

17. To provide flexibility in system design, regions may optionally be created within response service areas. Regions may be of arbitrary size, shape, and location. The territory within a region must be contiguous. Regions within a single RSA shall not overlap one another. Within regions, response stations are apt to be randomly distributed and for analysis purposes are to be assumed to be uniformly distributed. Except as described in the next paragraphs, regions are to be defined by their boundaries in the same manner as are response service areas. (For details on describing boundaries, see the section above on Defining Grid of Points for Analysis.)

18. It is permissible to define regions that are nested circular areas. In this case, the innermost region will truly be circular. The remaining regions will be annular rings having an inner and an outer radius. The inner radius will be the outer radius of the region just inside the particular region. The outer radius will be that specified in the File Format for the region under consideration. Nested regions will be determined by their having identical center points. Circular regions can be specified that fall within other regions and subtract from them but that do not share a common center point; in these situations, the non-circular geographic boundary definitions method must be used, as discussed in the next paragraph.

19. It is also permissible to define regions that are nested non-circular areas. In this case, one region must be completely contained within another. The normal procedure for defining each region using pairs of coordinates shall be followed. Grid points that are within the inner region shall be ascribed to it, while grid points outside the inner region shall be ascribed to the outer region. It is permissible to define multiple inner regions that either

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[1] Conversion from NAD-27 to NAD-83 shall be done using the algorithm incorporated in the NADCON software, version 2.1 or later, as specified in the Federal Register for August 10, 1990, Volume 55, Number 155, page 32681, and available formatted for IBM PC-compatible computers from the National Oceanic and Atmospheric Administration at: NOAA, NGS, N/NGS12, 1315 East West Highway, Station 9202, Silver Spring, MD 20910-3282, phone number (800) 638-8972.

are nested within one another or that are separate from one another. Nested regions must be completely contained within the next outer regions; separate regions may touch one another but may not overlap.

20. It is further permissible to define regions that, in total, do not completely cover the area of the associated RSA. The regions involved in this situation can be either circular or non-circular. Any portion of the RSA not covered by a defined region shall be ascribed to Region 00, and at least one class of station also shall be assigned to Region 00 if it exists. Thus grid points that fall between non-concentric circular regions, that fall between defined non-circular regions, or that fall outside the largest of a concentric group of regions would all be ascribed to Region 00. Region 00 would then be treated in the same fashion as any other region insofar as the association of classes of stations, the definition of grid points, and the like.

21. Within each region, at least one class of response station with defined characteristics must be specified to match the interference predicted to be caused with the types of installations to be made. The classes are to be used in interference analyses and to provide limitations on the installations that may be made in the related region. The characteristics of each such class of response stations shall include the maximum height above ground level (AGL) for antennas, the maximum equivalent isotropic radiated power (EIRP), and the combined worst-case antenna radiation pattern —for each polarization when both are used —for all response stations of that class to be installed. When response stations share a channel by transmitting simultaneously (see section below on Determining Transmitter Configuration), for each class of response stations within each region, the maximum number of such response stations that may transmit simultaneously on any channel or sub-channel shall be specified.

22. Specification of the maximum number of simultaneously transmitting response station transmitters shall be on a power spectral density basis. The number to be specified is the number of transmitters that may simultaneously operate within any portion of the channel, no matter how finely divided. The maximum EIRP that may be emitted by any individual response station must be limited proportionately to the fraction of the channel that the response station occupies, resulting in a maximum radiated power spectral density (as expressed in dBm/m^2/Hz) that is constant across the channel. The total number of individual response stations that may operate within a licensed channel at any one instant will depend upon the subchannelization scheme used. For example, if an entire 6˚MHz channel is dedicated to response station operation and if the maximum number of simultaneously transmitting stations within a response station hub antenna sector is specified as 50, then 50 response stations could all occupy the entire channel at the specified maximum EIRP. On the other hand, if the 6˚MHz channel were divided into ten sub-channels of 600 kHz each, then each sub-channel could support 50 response stations, for a total of 500, each transmitting with a maximum of one-tenth the specified maximum EIRP. Carrying the example one step further, the same 6 MHz channel could simultaneously support 10 response stations using the entire channel width and full specified EIRP and also 40 response stations on each of 10 sub-channels, totaling 400, each transmitting with one-tenth the specified maximum EIRP, for a grand total of 410 simultaneously operating response stations. The subchannelization scheme may be changed without notice to the Commission or to other licensees so long as values, i.e., actual and equivalent, specified for the total number of stations and the radiated power spectral density (in dBm/m^2/Hz) are not exceeded at any time for any portion of the channel.

23. The combined worst-case antenna azimuth radiation pattern is required to be specified collectively for all of the classes of response stations located at each grid point (in the procedure above, in the section on Defining Grid of Points for Analysis, for confirming that the required number of grid points is specified) and individually for each of the classes defined for each region of the RSA. In the case of the collective pattern used to determine

adequacy of the number of grid points, if both polarizations are used in the system, the horizontally- and vertically-polarized azimuth patterns of each antenna should be treated as deriving from separate antennas and should be combined with one another and with the patterns from all the other antennas at that grid point. In the cases of the individual patterns for each class used for interference analyses, if both polarizations are used in the system, the horizontally- and vertically-polarized combined worst-case azimuth patterns should be determined separately for all classes defined. Similarly, the cross-polarized worst-case patterns should be determined for each polarization.

24. These combined worst-case patterns are derived by setting the maximum forward signal power of all antenna types to be used within the class or classes to the same value and then using the highest level of radiation in each direction from any of the antennas as the value in that direction for the combined antenna pattern. The same method is used to determine both plane- and cross-polarized patterns, which are used separately in interference analyses. The combined worst-case plane- and cross-polarized patterns for each class will be used in all of the interference studies and are not to be exceeded in actual installations of response stations within a class to which the pattern applies.

Determining System Configuration

25. Several factors in the configuration of a system determine whether or not transmitters located at specific grid points could cause interference to particular neighboring systems. In order to simplify the study of interference to those neighbors, the system configuration is taken into account so as to reduce the number of calculations required by eliminating the study of interference from specific grid points when possible. The main factor that determines whether to eliminate certain grid points from consideration is terrain blockage.

26. When grid points are completely blocked from line-of-sight to all of a neighboring system, they can be eliminated from the aggregation of power used in calculating interference to that system. To determine whether to eliminate a grid point for this reason, a shadow study can be conducted from each grid point in the direction of the neighboring system. Separate studies can be conducted for classes of response stations that have different maximum heights above ground. If there is no area within the protected service area and no registered receiving location of the neighboring system to which a particular class of station at a grid point has line-of-sight, it can be eliminated from the calculations that determine the power of interfering signals at the neighbor s location. Alternatively, lack of line-of-sight can be evaluated from each class at each grid point to each location analyzed within the neighboring system (see section below on Calculating Aggregated Power from Transmitters), and grid points can be eliminated on a location-by-location basis, if that process is more easily implemented. (It should be noted that elimination from analysis of grid points not having line-of-sight effectively also eliminates activation for undesired response station signals of the non-line-of-sight [NLOS] mode by the propagation model defined later. The NLOS mode can still be activated for desired signals by the model in the various required analyses of interference to neighboring systems.)

27. There are two ways in which a large number of response stations can share channels: They can take turns using the channels so that only one transmitter will be turned on at any particular instant on each channel or sub-channel being received by a separate receiver in the system (commonly called TDMA), or they can transmit at the same time and use special filtering techniques at the receiver to separate the signals they are sending simultaneously to that receiver (commonly called CDMA). These two cases will result in different levels of power being radiated into neighboring systems, and therefore they must be analyzed slightly differently.

28. In the case of response stations that take turns using a channel or sub-channel, the grid point and class of station that produces the worst case of interference to each analyzed location in the neighboring system must be determined for each group of response stations that share a channel (e.g., within a response station hub receiving antenna sector). In this case, the interfering signal source can be treated as a single transmitter occupying the full bandwidth of the channel or sub-channels used from that location and having a power level equal to the aggregate of the power transmitted on all of the sub-channels, if sub-channels are used.

29. In the case of response stations that simultaneously share a channel or sub-channel, the grid point and class of station that produces the worst case of interference to each analyzed location in the neighboring system must be determined for each group of response stations that share a channel (e.g., within a response station hub receiving antenna sector). In this case, the interfering signal source can be treated as a single grid point at which are located all of the simultaneously transmitting transmitters, occupying the full bandwidth of the channel or sub-channels used from that location, and having a power level equal to the aggregate of the power transmitted by all of the response stations transmitting simultaneously on all of the sub-channels, if sub-channels are used.

30. In cases of shared-channel operation in which the number of simultaneously transmitting response stations of a class is limited by a region that crosses sector boundaries, the number of such response stations considered within some sectors may be limited so that the total included in the analysis in all sectors does not exceed the total permitted for the region. The objective in analyzing these cases is to find the worst case situation with regard to the maximum number of simultaneously transmitting transmitters, assigning them collectively to the locations at which they cause the most interference to each location analyzed within neighboring systems, while respecting the limits imposed on the number of such transmitters by sector and by region. A statement describing in detail the process or algorithm followed in selecting the number and classes of response stations analyzed at each grid point shall be appended to the application and distributed as a standard ASCII text file along with the data file described below in the section on the File Format.

31. An example of the case just described of shared-channel operation with the number of simultaneously transmitting transmitters limited both by region and by sector is one in which a region comprises an annular ring that stretches from half the radius to the full radius of a circular RSA. The region has a limit of 200 simultaneously transmitting transmitters of a particular class, and each of 20 sectors is limited to 20 simultaneously transmitting transmitters. If the worst case interference from each sector were caused by the subject class and all were used in analyzing interference to a neighboring system, the result would be the use of 400 such response stations (20 x 20) in the analysis, while the region is limited to 200. Consequently, the 10 regions (10 x 20 meets the limit of 200) causing the most interference to the neighbor would be selected, and, in the other 10 sectors, the classes of station causing the second largest amount of interference to the neighbor would be selected for use in the analysis. In choosing the secondary interfering response station classes, the same type of limitations would have to be observed. The process for making these selections based on the appropriate limitations would have to be followed for each analyzed point in the neighboring system.

Calculating Aggregated Power from Transmitters

32. The final major step in calculating interference from response station transmitters is the calculation of the equivalent isotropic radiated power (EIRP) to be attributed to each of the selected grid points in the various interference studies so as to be representative of the number of response stations that are expected to be in operation simultaneously within the RSA. When analyzing systems in which the response stations take turns using a channel or sub-channels, this means, for each location analyzed in the system to be protected, selecting

the grid point and class of station within each sector that radiates the strongest signal to that location and aggregating the power from all such selected grid points and classes, using the maximum EIRP (for all sub-channels taken together), the maximum antenna height, and the worst case antenna pattern for a single station of that class at each selected grid point.

33. For systems in which response stations simultaneously share the channel or sub-channels to each receiver at each hub, substantially the same analysis is performed. The difference is that the maximum number of simultaneously transmitting response stations within each sector is placed at each selected grid point, in turn. The maximum EIRP (for all sub-channels taken together) for each regional class at each grid point, expressed in dBW, is converted to Watts. The EIRP is then multiplied by the number of simultaneously transmitting transmitters in the regional class assigned to that grid point, and the resulting EIRP in Watts is converted back to dBW. When the number of simultaneously transmitting transmitters within a sector in the class and at the grid point that causes the most signal to be propagated to a location in the neighboring system does not equal the number of simultaneously transmitting transmitters permitted in that sector, the grid point and class of station that cause the next largest amount of signal to be so propagated shall be used to account for the remaining number of simultaneously transmitting transmitters permitted in the sector, and so on as necessary. At each location analyzed within the neighboring system, the power received from the selected grid points within each sector is aggregated through conversion from dBW to Watts, addition of power levels, and conversion back to dBW. In each case, the values so calculated are the aggregated powers of all the simultaneously transmitting response station transmitters sharing the same channel(s) or sub-channel(s), from all sectors, for use as the undesired signal levels in interference analyses.

34. In calculating the aggregate EIRP or received signal power, the interfering signals may be treated as emanating from response stations occupying the full channel and utilizing the maximum allowed EIRP. In practice, as described previously in the section on Defining Regions and Classes for Analysis, subchannelization may be used so long as the power spectral density limits are respected. Interference protection may also be calculated using appropriate adjustments to the required protection ratios based on the relative bandwidths of the desired and undesired signals. In either case, the maximum number of simultaneously transmitting response stations shall be limited on a power spectral density basis to the number specified.

35. In a system using both polarizations, the response stations represented by each grid point are to be assumed to use the polarization of the response station hub antenna sector in which they are located. The appropriate horizontal or vertical combined worst-case antenna pattern is to be used in interference studies depending upon the polarization of the sector in which each grid point is located. In a system using only one polarization, the effect of antenna sectors can be ignored and the choice between horizontal and vertical polarization patterns made identically for all grid points.

36. Finally, the aggregate power of each active regional class at each active grid point is used in conducting the required interference studies described in the relevant Rules. For this purpose, a study grid is established in each neighboring system to be evaluated. The study grid is constructed in a manner similar to that for the grid of points within the RSA. First, a reference point must be established for the 35-mile Protected Service Area, Basic Trading Area (BTA), or Partitioned Service Area to be studied. For a 35-mile Protected Service Area, the reference point is either the transmitter location or the pre-established FCC reference point if the transmitter has been moved. For a BTA or Partitioned Service Area, the reference point is the point, measured in degrees, minutes, and seconds (to the nearest one-tenth second), that is midway between the eastern- and western-most extremes of the BTA and midway between the northern- and southern-most extremes of the BTA or Partitioned Service Area. (It should be noted that, depending upon the shape of the BTA or Partitioned Service Area, the reference point might fall outside the BTA or Partitioned Service Area.) Next a series of orthogonal east-west and

north-south lines is constructed having 1.5 km spacing. The lines surrounding the reference point shall be located 0.75 km from the reference point at their nearest points to the reference point. The east-west lines shall be parallel to the lines of latitude. Where there is an overlap between the RSA and the Protected Service Area, BTA, or Partitioned Service Area to be studied, additional lines may be used, spaced equidistant from one another and from the 1.5 km-spaced lines (i.e., lines with a spacing in km of 0.75, 0.5, 0.375, 0.25, etc). The study points shall be at the intersections of the orthogonal line structure.

37. Signals from the potentially interfering system shall be evaluated at the study points. The signal level at each of the study points is calculated using the terrain-based propagation analysis tool specified below to determine the signal level incident at that point from each regional class at each grid point within an RSA. The signals from the potentially interfering system to be evaluated are the aggregate of the signals from all RSAs within the system. In addition, if the channels are partially or completely shared with primary or booster transmitters, the interference contributions of those stations must be aggregated with those of the response stations. Signal aggregation is performed by first converting dBW/m^2 to W/m^2, adding the power levels obtained, and converting from W/m^2 back to dBW/m^2. If the system under study is a 35-mile Protected Service Area, then the relevant D/U ratios must be obtained or the appropriate minimum signal levels protected when the desired signal falls below a prescribed threshold. (That threshold is described in the next paragraph.) For a Protected Service Area, the directional characteristics of the FCC reference antenna are applied to each of the incident signals prior to aggregation. If the system under study is a BTA or Partitioned Service Area, then the signal level at all study points within the BTA or Partitioned Service Area must meet the –73 dBW/m^2 requirement, and the directional characteristics of the FCC reference antenna are not applied, as the antenna characteristics in this instance are irrelevant.

38. In conducting analyses of interference from response, booster, and/or primary stations included in two-way systems to neighboring 35-mile Protected Service Areas or registered receive sites, neighboring receivers shall be protected by the appropriate D/U ratio so long as the desired signal exceeds a defined signal level, but lower signal levels need be protected only to a minimum level that depends upon the frequency relationship between the signals. For co-channel desired signals below 45 dB S/N, the defined signal level shall be deemed protected when the undesired signal is at or below the noise floor level for the bandwidth involved, as calculated per Equation 2 below. For adjacent channel desired signals below 45˚dB S/N, the defined signal level shall be deemed protected when the undesired signal is at or below 45 dB above the noise floor. Thus for a 6 MHz channel, the minimum co-channel undesired signal level that must be maintained would be -136.2 dBW or -106.2 dBm; the minimum adjacent channel undesired signal level that must be maintained would be —91.2dBW or —61.2dBm. These studies shall be conducted based exclusively upon the levels of the desired and undesired signals without consideration of the receiver noise figure.

39. Similar methods shall be used in conducting the various desired-to-undesired (D/U) signal ratio studies for co-channel and adjacent channel interference.[2] In all of these studies, the analysis shall use the aggregate power of each regional class at each grid point, the worst case plane- or cross-polarized antenna pattern, as appropriate, for each regional class, with the antennas at each grid point aimed toward the response station hub, and the maximum antenna height above ground specified for each regional class at each grid point.

Protection to Response Station Hubs

40. The applicant for a new or modified main station, high-power booster or response station hub is required to demonstrate protection to any previously proposed or licensed response station hub within 160.94 km (100 miles) of the proposed facilities. Two methods are available for demonstrating such protection. The applicant

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[2] When dissimilar bandwidths are used by the desired and undesired stations, methods for adjusting the required D/U ratios are provided respectively in: 21.902(b)(7)(ii) for MDS analysis of co-channel stations, 21.902(b)(7)(iii) for MDS analysis of adjacent channel stations, 74.903(a)(6)(ii) for ITFS analysis of co-channel stations and 74.903(a)(6)(iii) for ITFS analysis of adjacent channel stations. Those rules are cross-referenced in 21.909(d)(3)(iv) and (v) and 74.939(d)(3)(iv) and (v), which discuss compliance by applicants for response station hubs with the 45 dB and 0 dB D/U requirements.

can demonstrate that the proposed facility will not increase the effective power flux density of the undesired signals generated by the proposed facility and any associated main stations, booster stations or response stations at the response station hub antenna for any sector. Alternatively, the applicant can demonstrate that the proposed facility will not increase the noise floor at the response station hub antenna for any sector by more than 1 dB for co-channel signals and 45 dB for adjacent channel signals. The applicant can invoke the alternative protection method only once per response station hub sector. The methods to be used in making such demonstrations follow.

41. As is discussed in the section below on the File Format, an applicant for a response station hub will have specified the geographic coordinates of the hub location and, for each sector, (1)˚the height of the antenna above ground level (AGL) and above mean sea level (AMSL), (2)˚the hub receiving antenna pattern (both in azimuth and elevation, both co- and cross-polarized), (3)˚the hub receiving antenna gain in the main lobe (in dBi), (4)˚the azimuth of the main lobe, (5)˚ any mechanical tilt utilitized, (6)˚the direction of any mechanical tilt utilized, and (7)˚the polarization of the receiving antenna. Those specified characteristics shall be utilized for purposes of demonstrating interference protection to the hub.

42. The level of interference caused to a response station hub by the aggregate power of the proposed new or modified MDS or ITFS facility and any associated main stations, booster stations, and response stations shall be independently determined for each sector. The resulting summation is then used for comparisons between old and new values when the applicant is attempting to demonstrate that the effective power flux density of the undesired signals has not increased, or for comparison against the specified receiver degradation threshold when the applicant is attempting to demonstrate that the proposed facility will not increase the noise floor by more than the permissible amount.

43. In calculating the effective power flux density value, the effective isotropic radiated power (EIRP) radiated in the direction of the protected response station hub from each associated main, booster, and/or response station (as represented by the selected grid points described earlier in the section Four Major Steps for Response Station Interference Analysis) of the applicant shall first be determined. The power arriving at the response station hub shall be analyzed using the propagation analysis tool described in the following section on that subject. The propagation model will select between the line-of-sight (LOS) and non-line-of-sight (NLOS) modes described later for each interfering signal when making the required analyses. The aggregation of power from all related sources shall take account of the angular displacement of each particular source from the peak of the main lobe of the receiving antenna and the relative polarization of each interfering signal source.

44. To determine the effective power flux density, the following formula shall be used:

$$PFD_{EFF} = 10\log_{10} \sum_{1}^{n} 10^{\frac{ISi + G_{REL}i}{10}} \qquad (1)$$

Where

PFD_{EFF} = $Effective\ Power\ Flux\ Density\ (dBW/m^2)$

n = $Number\ of\ Interfering\ Signal\ Sources\ (units)$

ISi = $Interfering\ Signal\ Power\ Flux\ Density\ of\ ith\ Source\ (dBW/m^2)$

$G_{REL}i$ = $Relative\ Gain\ of\ Hub\ Sector\ in\ Direction\ of\ ith\ Source\ (dB)$

$(Relative\ to\ peak\ of\ main\ lobe, the\ value\ of\ which\ is\ 0\,dB)$

$(Includes\ antenna\ discrimination\ \&\ polarization\ effects)$

45. When the applicant is attempting to demonstrate that its proposed facility and all its associated facilities will not increase the effective power flux density of the undesired signals at each response station hub sector

antenna, it is necessary to ascertain that the predicted effective power flux density from the proposed facility and all associated facilities does not exceed the value predicted from any previously authorized associated facilities at each response station hub sector antenna. When the applicant is attempting to demonstrate that the proposed facility and all associated facilities will not impermissibly increase the noise floor, an additional step is required to ascertain that the predicted value of the effective power flux density does not exceed the allowed threshold values for both co-channel and adjacent channel signals.

46. To calculate the relationship of the effective power flux density to the threshold values for co-channel and adjacent channel signals, the level of the noise floor of the hub receiver first must be figured. It is given by the formula:

$$P_{THERMAL} = 10\log\left\lfloor k\left(T+273\right)BW\right\rfloor \qquad (2)$$

Where
$P_{THERMAL}$ = *Noise Power from Thermal Sources* (dBW)
k = *Boltzmann's Constant* $\left(1.380662x10^{-23}\right)$
T = *Noise Temperature* $\left(degrees\ Celsius\right)$
BW = *Bandwidth* $\left(Hz\right)$

47. With a typical noise temperature of 17.2 deg. C and a bandwidth of 6 MHz, Equation 2 yields a thermal noise power of -136.2 dBW.

48. Factors in the calculation of the equivalent power flux density of the thermal noise power are the noise figure of the receiver input stage(s) and the cable losses between antenna and receiver input. For consistency, the noise figure shall be set at 2.5°dB, and the cable losses shall be set at 1°dB. The wavelength of the received signal also becomes a factor; it shall be expressed in meters and can be taken as 0.13915 meters for the 2.150-2.162 GHz band and as 0.11538 meters for the 2.5-2.7 GHz band. The equivalent total power flux density of the thermal noise power plus the effective power flux density of the interfering signal(s) then is given by:

$$PFD_{EQUIV} = 10\log_{10}\left[10^{\frac{PFD_{EFF}}{10}} + 10^{\frac{P_{THERMAL}+L_C+NF-G_{ANT}-10\log_{10}\left(\frac{\lambda^2}{4\pi}\right)}{10}}\right] \qquad (3)$$

Where
PFD_{EQUIV} = *Equivalent Total Power Flux Density* (dBW/m^2)
L_C = *Cable Losses* $(dB$, *set to a value of* $1\ dB)$
NF = *Noise Figure* $(dB$, *set to a value of* $2.5\ dB)$
G_{ANT} = *Receiving Antenna Gain* (dBi)
λ = *Wavelength* (m) $(0.13915\ m$ *at 2.16 and* $0.11538\ m$ *at 2.6 GHz*$)$

49. When applicants invoke the alternative hub protection method by demonstrating protection to the noise floor of a response station hub, compliance with the limits for co-channel and adjacent channel interference from the proposed facilities to the response station hub can be determined by first calculating the equivalent total power flux density with the effective power flux density of the interference set to zero and then re-computing using the true effective power flux density. (To be mathematically correct in setting the interference value to zero, either the first term inside the parentheses in Equation 3 can be set to zero, or the PFD_{EFF} value can be set to a very low value at least 30 dB below $P_{THERMAL}$.) The two values found should not differ by more than 1°dB for co-channel interference nor by more than 45°dB for adjacent channel interference.

Propagation Model

50. When analyzing interference from or to any response, booster, or primary stations included in two-way systems to or from other stations, the propagation model described below shall be used, taking into account the effects of terrain and certain other factors. The model is derived from basic calculations described in NTIS Technical Note 101.[3] It is intended as a tool for analysis of wide area coverage of microwave transmissions, and it is available built into commercial propagation analysis software packages that are widely used by the MDS/ITFS industry for coverage and interference prediction.[4]

51. In the model described, two loss terms are computed the free space path loss based solely on distance and the excess path loss (XPL) that derives from terrain obstacles and other elements in the environment. Among the inputs required for some implementations of the model are location and time variability factors. Other factors for such items as clutter and foliage losses can be considered by some software versions, but they will not be used in analyzing the systems considered herein.

52. The excess path loss portion of the calculation considers several conditions that impact signal propagation. These include whether the path is "line of sight" for the direct ray, whether there is 0.6 first Fresnel zone clearance, or whether the path is totally obstructed. When the first Fresnel zone is partially obstructed, an additional loss up to 6 dB is included by the model. When the path is totally obstructed, the path loss is calculated using the Epstein-Peterson method[5] that considers the diffraction losses over successive terrain obstacles. In this case, each obstacle is treated separately, with the preceding obstacle (or the transmitter, in the first instance) considered to be the transmitter and the succeeding obstacle (or the receiver, in the last instance) considered to be the receiver.

53. Some software implementations of the methods described herein may provide for setting parameters for both location and time variability in terms of the percentage of the locations or of the time that signals meet or exceed studied levels. For purposes of analyzing the interference from response stations and to response station hubs, both the location and the time variability factors shall be set to 50˚percent in all cases. When available as a parameter, the confidence level shall be set to 50˚percent.

54. The methods defined in this Propagation Model require the establishment of geographic lines between paired transmitter and receiver locations, with elevation values determined at sample points along the lines. For consistency in implementation, the locations of the sample points along each line are defined to be spaced at 0.25 km intervals, beginning from the transmitter location and ending at the 0.25 km point just prior to the actual receiver location. The study itself shall end at the actual receiver location. The elevation of points along the line shall be obtained through bilinear interpolation of the elevation values of the surrounding four grid levels of the USGS 3-second database.

Propagation Model Outline

55. For the purposes of this Methodology, the propagation model has three basic elements that affect the predicted field strength at the receiver:

1) Line-of-Sight (LOS) mode, using basic free-space path loss
2) Non-line-of-sight (NLOS) mode, using multiple wedge diffraction
3) Partial first Fresnel zone obstruction losses applicable to either mode

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[3] "Transmission Loss Prediction for Tropospheric Communication Circuits," Technical Note 101, NTIS Access Number AD 687-820, National Technical Information Service, US Department of Commerce, Springfield, VA.

[4] An example of such a software implementation is the Free Space + RMD™ method included in some products of EDX Engineering, Inc.

[5] J. Epstein and D.W. Peterson. "An experimental study of wave propagation at 850 Mc.," Proc. IRE, vol. 41, no. 5, pp. 595-611, May, 1953.

56. The LOS and NLOS modes are mutually exclusive — a given path between a transmitter and a receiver is either LOS or not. The fundamental decision as to whether a path is LOS is based on the path geometry. That decision is described in the next subsection, which also defines the LOS mode for the model.

Line-of-Sight (LOS) Mode

57. The determination of whether a path between a transmitter and a receiver is LOS is made by comparing the depression angle of the path between the transmitter and receiver with the depression angle to each terrain elevation point along the path. The depression angle from transmitter to receiver is computed using an equation of the form:

$$\theta_{t-r} = \frac{h_r - h_t}{d_r} - \frac{d_r}{2a} \qquad (4)$$

where:

θ_{t-r} is the depression angle relative to horizontal from the transmitter to the receiver in radians

h_t is the elevation of the transmit antenna center of radiation above mean sea level in meters

h_r is the elevation of the receive antenna center of radiation above mean sea level in meters

d_r is the great circle distance from the transmitter to the receiver in meters

a is the effective earth radius in meters taking into account atmospheric refractivity

58. The atmospheric refractivity is usually called the K factor. A typical value of K is 1.333, and using the actual earth radius of 6340 kilometers, a would equal 8451 kilometers, or 8,451,000 meters. For the purpose of these Rules, K = 1.333 shall be used.

59. Using an equation of the same form, the depression angle from the transmitter to any terrain elevation point can be found as:

$$\theta_{t-p} = \frac{h_p - h_t}{d_p} - \frac{d_p}{2a} \qquad (5)$$

where:

θ_{t-p} is the depression angle relative to horizontal for the ray between the transmitter and the point on the terrain profile

h_p is the elevation of the terrain point above mean sea level in meters

d_p is the great circle path distance from the transmitter to the point on the terrain path in meters

h_t and a are as defined above following Equation (4).

60. The variable θ_{t-p} is calculated at every point along the path between the transmitter and the receiver and compared to θ_{t-r}. If the condition $\theta_{t-p} > \theta_{t-r}$ is true at any point, then the path is considered NLOS and the model formulations in the subsection on Non-Line-of-Sight (NLOS) Mode below are used. If $\theta_{t-p} \le \theta_{t-r}$ is true at every point, then the transmitter-receiver path is LOS and the formulations in this subsection apply.

61. For LOS paths, if the geometry is such that a terrain elevation point along the path between the transmitter and receiver extends into the 0.6 first Fresnel zone, then an additional loss ranging from 0 to 6°dB is included for partial Fresnel zone obstruction. This calculation is presented next.

Attenuation Due to Partial Obstruction of the Fresnel Zone

62. When a path is LOS but terrain obstacles are close to obstructing the path, additional attenuation will occur. This attenuation due to a near miss of obstacles on the path can be taken into account by including a loss

term in the LOS formulation which is based on the extent to which an obstacle penetrates the first Fresnel zone. From diffraction theory, when the ray just grazes an obstacle, the field on the other side is reduced by 6 dB (half the wavefront is obstructed). When the clearance between the obstacle and the ray path is 0.6 of the first Fresnel zone, the change in the field strength at the receiver is 0 dB, and with additional clearance a field strength increase of 6 dB can occur owing to the in-phase contribution from the ray diffracted from the obstacle. For additional clearance, an oscillatory pattern in the field strength occurs.

63. In the model described, if the ray path clears intervening obstacles by at least 0.6 of the first Fresnel zone, then no adjustment to the receiver field will occur. For the case when an obstacle extends into the 0.6 first Fresnel zone, a loss factor ranging from 0 to 6 dB is applied based on a linear proportion of how much of the 0.6 First Fresnel zone is penetrated. This Fresnel zone path loss or attenuation term can be written as:

$$A_{Fresnel} = 6.0\left[1.0 - \frac{C_{obs}(d_p)}{R_{FR}(d_p)}\right] \text{ dB} \tag{6}$$

where:

$C_{obs}(d_p)$ is the height difference in meters between the ray path and the terrain elevation at distance d_p along the path

$R_{FR}(d_p)$ is the 0.6 first Fresnel zone radius at distance d_p along the path

64. The values $C_{obs}(d_p)$ and $R_{FR}(d_p)$ are calculated taking into account the effective earth radius using the K factor. The 0.6 first Fresnel zone radius is given by

$$R_{FR}(d_p) = 0.6\left[547.533\sqrt{\frac{d_p(d_r - d_p)}{f d_r}}\right] \text{ meters} \tag{7}$$

where f is the frequency in MHz and all distances are in kilometers.

65. The use of the partial Fresnel zone obstruction loss from 0 dB at 0.6 clearance to 6 dB at grazing also provides a smooth transition into the NLOS mode in which knife-edge diffraction loss just below grazing will start at 6 dB and increase for steeper ray bending angles to receiving locations in the shadowed region. Note that this attenuation factor is found only for the terrain profile point that extends farthest into the 0.6 first Fresnel zone, not for every profile point which extends into the 0.6 first Fresnel zone.

Summary of Calculation of Field Strength at the Receiver Under LOS Conditions

66. The formulations for computing the field strength at the receiver under LOS conditions can be summarized with the following equation:

$$E_r = 74.77 - 20\log(d_r) + P_T - A_{Fresnel} \text{ dB}\mu\text{V/m} \tag{8}$$

where E_r is the field strength at the receiver in dBμV/m, d_r is the distance from transmitter to receiver in kilometers, and $A_{Fresnel}$ is the partial Fresnel zone obstruction loss from Equation (6). The term P_T is the equivalent isotropic radiated power (EIRP) in dBW in the direction of the receiver.

67. In terms of path loss between two antennas with gains of 0 dBi in the path direction, Equation (8) can be written as:

$$L_{LOS} = 32.45 + 20.0\log f + 20\log d_r + A_{Fresnel}\,\mathrm{dB} \qquad (9)$$

where L_{LOS} is the line-of-sight path loss in dB, f is frequency in MHz, and d_r is the distance from transmitter to receiver in kilometers.

Non-Line-of-Sight (NLOS) Mode

68. The mechanism for deciding when to use the LOS mode and when to use the NLOS mode is described at the beginning of the subsection on Line-of-Sight Mode above. When the model elects to use the NLOS formulations to follow, it means that one or more terrain or other features obstructs the ray path directly from the transmitter to the receiver. In this case, the free space field strength is further reduced for the attenuation caused by the obstacles. For the model defined here, the calculation of obstruction loss over an obstacle is done by assuming the obstacle is a perfect electrical conductor rounded obstacle with a height equal to the elevation of the obstruction and a radius equal to 1 meter. This approximation has been shown to be effective in modeling hills and other terrain obstructions, which do not behave as knife edges in practice. Diffraction loss in this model is calculated assuming individual obstacles on the path can be modeled as isolated rounded obstacles. The losses from multiple isolated obstacles are then combined.

Diffraction Loss

69. The loss over an individual rounded obstacle is primarily a function of the parameter v that is related to the path clearance over the obstacle. The total diffraction loss, $A(v,\rho)$, in dB, is the sum of three parts — $A(v,0)$, $A(0,\rho)$, and $U(v,\rho)$. The equations to calculate the total and the three parts are given below:

$$A(v,\rho) = A(v,0) + A(0,\rho) + U(v,\rho) \qquad (10)$$

$$A(v,0) = 6.02 + 9.0v + 1.65v^2 \quad \text{for } -0.8 \le v \le 0 \qquad (11)$$

$$A(v,0) = 6.02 + 9.11v - 1.27v^2 \quad \text{for } 0 < v \le 2.4 \qquad (12)$$

$$A(v,0) = 12.953 + 20\log_{10}(v) \quad \text{for } v > 2.4 \qquad (13)$$

$$A(0,\rho) = 6.02 + 5.556\rho + 3.418\rho^2 + 0.256\rho^3 \qquad (14)$$

$$U(v,\rho) = 11.45v\rho + 2.19(v\rho)^2 - 0.206(v\rho)^3 - 6.02 \quad \text{for } v\rho \le 3 \qquad (15)$$

$$U(v,\rho) = 13.47v\rho + 1.058(v\rho)^2 - 0.048(v\rho)^3 - 6.02 \quad \text{for } 3 < v\rho \le 5 \qquad (16)$$

$$U(v,\rho) = 20v\rho - 18.2 \quad \text{for } v\rho > 5 \qquad (17)$$

where the curvature factor is

$$\rho = 0.676R^{0.333} f^{-0.1667}\left(\frac{d}{d_1 d_2}\right)^{0.5} \qquad (18)$$

70. The obstacle radius R and the distances d, d_1, and d_2 are in kilometers, and the frequency f is in MHz. The distance term d is the path length from the transmitter (or preceding obstacle) to the receiver (or next obstacle), d_1 is the distance from the transmitter (or preceding obstacle) to the obstacle, and d_2 is the distance from the obstacle to the receiver (or next obstacle). When the radius is zero, the obstacle is a knife-edge, and $A(v,\rho) = A(v,0)$.

71. The parameter v in the equations above takes into account the geometry of the path and can be thought of as the bending angle of the radio path over the obstacle. It is computed as:

$$v = \sqrt{\frac{2d\tan(\alpha)\tan(\beta)}{\lambda}} \qquad (19)$$

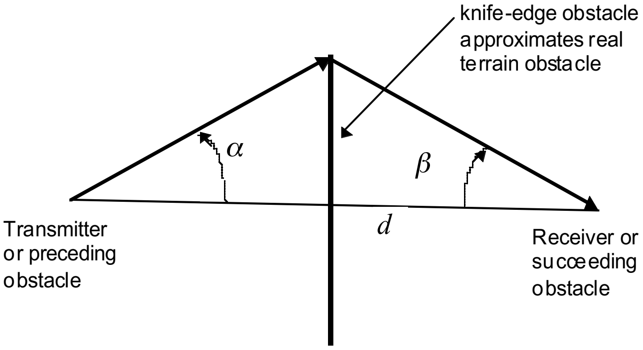

Figure 1. Geometry for computing ν

where d is the path length from the transmitter (or preceding obstacle) to the receiver (or next obstacle), α is the angle relative to a line from the transmitter (or preceding obstacle) to the receiver (or next obstacle), and β is the angle relative to a line from the receiver (or next obstacle) to the transmitter (or preceding obstacle). The distance d and the wavelength λ are in the same units as one another, e.g., kilometers. The definitions of α and β are shown in Figure 1. For the multiple obstacle case, obstacles are treated successively as transmitter-obstacle-receiver triads to construct the path geometry and bending angle ν over each obstacle. The value of ν is then used to calculate the diffraction loss over each obstacle. The resulting obstacle losses are summed to arrive at the total obstacle diffraction loss for the path.

Summary of Calculation of Field Strength at the Receiver Under NLOS Conditions

72. The field strength at the receiver in the NLOS mode can then be written as:

$$E_r = 74.77 - 20\log(d_r) + P_T - A_{diff} \ \text{dB}\mu\text{V/m} \qquad (20)$$

where E_r is the field strength at the receiver in dBμV/m, d_r is the distance from transmitter to receiver in kilometers, and P_T is the equivalent isotropic radiated power (EIRP) in dBW in the direction of the receiver. The term A_{diff} is defined as:

$$A_{diff} = \sum_{n=1}^{n_{obs}} A_n(\nu, \rho) \ \text{dB} \qquad (21)$$

where $A(\nu, \rho)$ is defined in Equation (10) and n_{obs} is the number of obstructions in the path.

73. The corresponding path loss between antennas with 0 dBi gain in the path direction can be written as:

$$L_{NLOS} = 32.45 + 20.0\log f + 20\log d_r + A_{diff} \ \text{dB} \qquad (22)$$

where L_{NLOS} is the non-line-of-sight path loss in dB, f is frequency in MHz, and d_r is the distance from transmitter to receiver in kilometers.

File Format

74. To facilitate the exchange of data on two-way MDS and ITFS systems permissible under Parts 21 and 74, a file format is herein described for the submission of requisite technical data to be provided to the Commission and to all parties that must be served with notice of the applications and/or engineering studies. The media shall be either 3_-inch floppy disks or CD-ROMs. The media and basic formatting of that media are defined either by ISO/IEC Standards 9293,[6] 9529-1,[7] and 9529-2[8] for 3_-inch floppy disks[9] or ISO Standard 9660[10] for CD-ROMs.

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[6] ISO/IEC 9293: 1994, Information Technology — Volume and File Structure of Flexible Disk Cartridges for Information Interchange

[7] ISO/IEC 9529-1:1987, Information Processing Systems— Data Interchange on 90 mm (3.5 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 15916 ftprad on 80 Tracks on Each Side — Part 1: Dimensional, Physical and Magnetic Characteristics.

75. A file structured according to the file format shall be submitted individually for each Response Station Hub (RSH) and associated Response Service Area (RSA), i.e., there shall be only one RSH/RSA combination defined per file. It is permissible to store multiple such files on a single disk so long as each file is completely contained on a single disk, i.e., files may not span disks. In addition to the files structured according to the following format, each disk that contains a file describing an RSH/RSA combination that is part of a system shall include a copy of an Index File that lists all of the files related to the system. The Index File shall be in ASCII coding and shall list the file names, dates and times of storage, and sizes in bytes of the files associated with all the Response Station Hubs in the system. Furthermore, all the disks related to the system shall be labeled with their specific contents, including the data required in the Index File for the particular files contained on each disk. Each label shall also indicate the total number of disks in the series and the sequence number of the disk on which it appears. The Index File name shall consist of the name of the licensee or applicant (which may be abbreviated, but which must be consistently abbreviated in the same way by a single licensee or applicant) followed by a hyphen, followed by the name of the city where the system is located. This shall be followed by a decimal point and the extension idx.

76. The remainder of this document outlines the format of technical information regarding each Response Service Area (RSA) to be submitted with each MDS/ITFS two-way application. The data shall appear in a number of sections for the purpose of grouping similar items within the file. Data shall be coded in an ASCII-formatted,[11] comma-delimited file. Carriage return (0Dh) and line feed (0Ah) characters shall be placed at the end of each line in the file, as is normal when using standard text editors. To help in identifying data, where file sections are formatted as tables, the first entry in each row within a table shall be a sequence number indicating the position of the row within the table. To the extent possible, the sequence number shall be representative of the type of data contained on the row, such as the number of degrees of azimuth or elevation.

77. A generic example of the required file construction appears at the end of this section and may be used as a template for the submission of data. As shown there, section titles shall appear on a separate line in square brackets [ ] and shall be separated from the preceding sections and from the data within their own sections by a blank line. Headers shall appear on the top line of the data contained within a section. Headers may contain data and may also help with both human and machine readability.

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[8] ISO/IEC 9529-2:1987, Information Processing Systems — Data Interchange on 90 mm (3.5 in) Flexible Disk Cartridges Using Modified Frequency Modulation Recording at 15916 ftprad on 80 Tracks on Each Side — Part 2: Track Format

[9] The cited ISO/IEC standards describe disks having a formatted capacity of 1.44 Mbytes. It is intended to allow the use of disks of other capacities (such as 720 kBytes) based upon the same techniques as and compatible with the disks described in the specified standards.

[10] ISO 9660: 1988, Information Processing — Volume and File Structure of CD-ROM for Information Interchange

[11] ANSI X3.4-1986 (R1992), Coded Character Set — 7-Bit American National Standard Code for Information Interchange

78. Units of measure that are to be utilized for all information supplied in the file are:

Latitude – Degrees, Minutes, Seconds (DD,MM,SS.S) (to 1 decimal place in seconds)[12]
Longitude – Degrees, Minutes, Seconds (DDD,MM,SS.S) (to 1 decimal place in seconds)[12]
Azimuth or Bearing – Degrees (to 1 decimal place)
Radius – Kilometers (to 2 decimal places)
Ground Elevation – Meters AMSL (to 0 decimal places)
Antenna Height – Meters AGL (to 0 decimal places)
Electrical Beam Tilt – Degrees (to 1 decimal place)
Mechanical Beam Tilt – Degrees (to 1 decimal place)
Azimuth of Mechanical Beam Tilt – Degrees (to 1 decimal place)
Power (EIRP) – dBW (to 2 decimal places)
Antenna Gain – dBi (to 2 decimal places)

Frequency – MHz (to 3 decimal places)

1. General Information

Section Title: General Info

Entries:
File Name
Licensee/Applicant name
City/State of hub location
Coordinates of hub location
Ground Elevation of hub location (meters)
Call sign of station being modified/file number of application being amended
City/State of station being modified

79. The File Name included in this section of the data file shall be the name originally given to the data file when it was created. This will assure that, even should the name of the data file be changed, it can be identified by its original name. It is this name that shall be included in the Index File required to appear on each disk of the set of files describing a complete system. The File Name shall be constructed from the call sign originally assigned for downstream service and modified for two-way upstream service followed by a hyphen, followed by a six-digit number giving the latitude of the RSH, followed by another hyphen, followed by a seven-digit number giving the longitude of the RSH. The name of the data file shall be completed by appending a decimal point followed by the extension “dat” to the name as defined above. When a file is updated as a result of modifications to a license or amendments to an application, the file name shall be modified by appending a hyphen and a letter before the decimal point and the extension. The letter shall be incremented with each successive revision to the file, beginning with “a” and progressing through “z.” Should higher values be required, double letters “aa” through “zz” shall be used, incrementing the second letter and then the first. When a call sign for an existing downstream service does not exist, the identifier of the authorization document from the Commission assigning the subject channel to the applicant shall be used in its place.

80. The name either of the licensee or of the applicant, if not the licensee, filing the application with which the file is connected shall be included in the General Info section. The designation on the line that contains this information shall be either “Licensee” or “Applicant,” as appropriate.

2. Geographic Boundary Definitions – Circular Areas

Section Title: Circular Geographic Areas

Header: RSA Circular (0 or 1), Regions Circular (00 or RR, where RR = total # of circular regions)

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[12] All coordinates shall be based on use of the U.S. Geological Survey (USGS) 3-second database and shall be referenced to the 1983 North American Datum (NAD-83).

Entries: 00, RSA Reference Latitude, RSA Reference Longitude, RSA Radius (omit RSA Radius if RSA is non-circular)

01, Region 01 Center Latitude, Region 01 Center Longitude, Region 01 Radius
02, Region 02 Center Latitude, Region 02 Center Longitude, Region 02 Radius
:
:
RR, Region RR Center Latitude, Region RR Center Longitude, Region RR Radius

81. The geographic area of an RSA or region may be described by a circle having a defined center point location and a radius. If the RSA is circular, then RSA Circular = 1, otherwise RSA Circular = 0.

82. If there are circular regions, then Regions Circular = the number of such regions, RR. Otherwise, Regions Circular = 00.

83. The RSA reference latitude and longitude are required in all cases and appear in this section for both circular and non-circular RSAs. If the RSA is non-circular, the radius is not given. Where the hub is outside the RSA, the reference point is that point, measured in degrees, minutes, and seconds (to the nearest one-tenth second), that is midway between the eastern- and western-most extremes of the RSA and also midway between the northern- and southern-most extremes of the RSA. It should be noted that the RSA reference point could fall outside the RSA itself.

84. Circular regions may share the same center point and have different radii, their circumferences thus forming concentric circles. In this situation, the circular region with the smallest radius extends from the center point to its circumference. All the other regions constitute annular rings, the inner radii of which are the outer radii of the center region or of the next inner rings and the outer radii of which are those listed for the region. When such concentric regions exist, they shall be listed in the order of increasing radius.

85. Circular regions may be defined having boundaries that extend beyond the boundary of the RSA. In such cases, the boundaries of the regions shall be deemed to be truncated (cut off) by the boundary of the RSA. Thus no grid points beyond the RSA boundary shall be considered in interference analyses, and no response stations beyond the RSA boundary shall be installed as a result of such a region definition.

3. Geographic Boundary Definitions – Non-Circular Areas

Section Title: "Non-Circular Areas"

Header: RSA Non-Circular (0 or 1), Regions Non-Circular (00 or NN, where NN = total # of non-circular regions),

Entries: RSA Entry Title, # of boundary points defining RSA (XXX)
RSA Latitude (001), RSA Longitude (001)
RSA Latitude (002), RSA Longitude (002)
RSA Latitude (003), RSA Longitude (003)
:
RSA Latitude (XXX), RSA Longitude (XXX)
Region RR+1 Entry Title, # of boundary points defining region RR+1 (AAA)
Region RR+1 Latitude (001), Region RR+1 Longitude (001)
Region RR+1 Latitude (002), Region RR+1 Longitude (002)
Region RR+1 Latitude (003), Region RR+1 Longitude (003)
:
Region RR+1 Latitude (AAA), Region RR+1 Longitude (AAA)
Region RR+2 Entry Title, # of boundary points defining region RR+2 (BBB)
Region RR+2 Latitude (001), Region RR+2 Longitude (001)
Region RR+2 Latitude (002), Region RR+2 Longitude (002)
Region RR+2 Latitude (003), Region RR+2 Longitude (003)
:
Region RR+2 Latitude (BBB), Region RR+2 Longitude (BBB)
:
:
Region RR+NN Entry Title, # of boundary points defining region RR+NN (ZZZ)

Region RR+NN Latitude (001), Region RR+NN Longitude (001)
Region RR+NN Latitude (002), Region RR+NN Longitude (002)
Region RR+NN Latitude (003), Region RR+NN Longitude (003)
, :
Region RR+NN Latitude (ZZZ), Region RR+NN Longitude (ZZZ)

86. The geographic descriptions of an RSA in the sections for Circular Areas (Section 2) and for Non-Circular Areas are mutually exclusive. One of them shall have the RSA indicator set to 1; the other shall be set to 0. When the Non-Circular Area RSA indicator is set to 0, the RSA list header and the list of RSA coordinates shall be omitted.

87. The reference point coordinates for both types of RSA are contained in the section on Circular Areas. Where the hub is outside the RSA, the reference point is that point, measured in degrees, minutes, and seconds (to the nearest one-tenth second), that is midway between the eastern- and western-most extremes of the RSA and also midway between the northern- and southern-most extremes of the RSA. It should be noted that the RSA reference point could fall outside the RSA itself.

88. Regions of both types, i.e., circular and non-circular, are permitted within a single RSA. Regions in this non-circular section shall be numbered sequentially continuing from the last region number in the circular section, i.e., from RR+1 to RR+NN, so that all regions have unique region numbers.

89. The data for the RSA and for the region boundary descriptions list pairs of latitude and longitude coordinates in sequence, with each group of data following an entry header. The entry header includes a title that numbers the area to which its data applies and a value indicating the number of entries in the list for its area.

90. Non-circular regions may be nested within one another, the inner regions subtracting from the areas covered by the outer regions. In this situation, a region with the smallest area extends to its perimeter. All other regions have voids where the inner regions are located. When such nested regions exist, they shall be listed in the order of increasing perimeter size of interior regions until the outermost region is reached.

91. Non-circular regions may be defined having boundaries that extend beyond the boundary of the RSA. In such cases, the boundaries of the regions shall be deemed to be truncated (cut off) by the boundary of the RSA. Thus no grid points beyond the RSA boundary shall be considered in interference analyses, and no response stations beyond the RSA boundary shall be installed as a result of such a region definition.

4. Hub Sectorization Data

Section Title: Sectorization

Header: # of sectors within RSA (SS)

Entries: Sector 01, Hub Receive Antenna Pattern #, Gain, Azimuth of Main Lobe or Azimuth of Symmetry, Height AGL, Mechanical Beam Tilt, Azimuth of Mechanical Beam Tilt, Polarization, Max Simultaneous Transmitters

Sector 02, Hub Receive Antenna Pattern #, Gain, Azimuth of Main Lobe or Azimuth of Symmetry, Height AGL, Mechanical Beam Tilt, Azimuth of Mechanical Beam Tilt, Polarization, Max Simultaneous Transmitters

:

:

Sector (SS), Hub Receive Antenna Pattern #, Gain, Azimuth of Main Lobe or Azimuth of Symmetry, Height AGL, Mechanical Beam Tilt, Azimuth of Mechanical Beam Tilt, Polarization, Max Simultaneous Transmitters

92. Each sector is to be assigned a number beginning with the sector whose main lobe azimuth is pointing due north or the closest to due north, proceeding in a clockwise direction from true north, numbering each sector in succession.

93. The receiving antenna pattern used in each sector is defined in the Antenna Pattern Data section, and the association of each sector with a specific antenna pattern is made here. This pattern shall be used in the calculation of potential interference to a hub from surrounding stations.

94. The geographic definition of each sector is found in the Sector Geographic Definitions section.

95. Any mechanical beam tilt and the azimuth of any mechanical beam tilt for each hub receiving antenna are specified in this section. Tilting the antenna downward is defined using a positive number. The Azimuth of Mechanical Beam Tilt shall specify the direction having the greatest downward depression.

96. The polarization of each sector is defined as horizontal (H), vertical (V), or both (B).The maximum number of transmitters that can operate simultaneously on the channel or on each sub-channel within each sector is specified in this section. The number specified shall apply to each sub-channel with power proportioned on a power spectral density basis.

5. Grid Point Definitions

Section Title: Grid Points

Header: # of grid points (MMMM)

Entries: Point 0001: Latitude, Longitude, Elevation, Region # in which Located, Bearing to Hub, Polarization (H, V, or B), Number of associated Class(es) of Station(s), Class Designators
Point 0002: Latitude, Longitude, Elevation, Region # in which Located, Bearing to Hub, Polarization (H, V, or B), Number of associated Class(es) of Station(s), Class Designators
:
:
Point MMMM: Latitude, Longitude, Elevation, Region # in which Located, Bearing to Hub, Polarization (H, V, or B), Number of associated Class(es) of Station(s), Class Designators

97. The header specifies the total number of grid points (MMMM) defined in the Grid Point Definition Table.

98. The location of each grid point is defined by latitude and longitude. The bearing from the grid point to the hub is specified. The region in which the grid point is located is indicated using the region number assigned in the sections above giving geographic boundary definitions. Grid points not located in specifically defined regions shall be indicated as being in Region 00, which describes the remainder of the RSA. Grid points that are inactive because of the impossibility of installing response stations at their locations shall be shown as belonging to Region -- (16h,16h). Inactive grid points shall have the associated Polarization, Number of Classes, and Class Designator value positions filled with the space character (20h) as a place holder.

99. Polarization for each grid point must be specified as horizontal (H), vertical (V), or both (B). In areas where sectors having opposite polarizations overlap, it may be desirable to have the flexibility to utilize both polarizations. If so, grid points in these overlapping areas must be specified as B, both polarizations.

100. Each active grid point must be assigned at least one class of station. Assignment of multiple classes to a single grid point is also permitted.

6. Sector Geographic Definitions

Section Title: Sector Definitions

Header: # of sectors (SS), Bearings or Coordinates (B)

Entries: Sector 01, Start Bearing, Stop Bearing
(Bearings) Sector 02, Start Bearing, Stop Bearing
:
Sector SS, Start Bearing, Stop Bearing

OR

Table Header: # of sectors (SS), Bearings or Coordinates (C)

Entries: Sector 01 Entry Title, # of Coordinates in Sector 01 (AAA)
Sector 01Latitude (001), Sector 01 Longitude (001)
Sector 01 Latitude (002), Sector 01 Longitude (002)
Sector 01 Latitude (003), Sector 01 Longitude (003)
:
Sector 01 Latitude (AAA), Sector 01 Longitude (AAA)
Sector 02 Entry Title, # of Coordinates in Sector 02 (BBB)
Sector 02 Latitude (001), Sector 02 Longitude (001)
Sector 02 Latitude (002), Sector 02 Longitude (002)
Sector 02 Latitude (003), Sector 02 Longitude (003)
:
Sector 02 Latitude (BBB), Sector 02 Longitude (BBB)
Sector 03 Entry Title, # of Coordinates in Sector 03 (CCC)
Sector 03 Latitude (001), Sector 03 Longitude (001)
Sector 03 Latitude (002), Sector 03 Longitude (002)
Sector 03 Latitude (003), Sector 03 Longitude (003)
:
Sector 03 Latitude (CCC), Sector 03 Longitude (CCC)
:
:
Sector SS Entry Title, # of Coordinates in Sector SS (ZZZ)
Sector SS Latitude (001), Sector SS Longitude (001)
Sector SS Latitude (002), Sector SS Longitude (002)
Sector SS Latitude (003), Sector SS Longitude (003)
:
Sector SS Latitude (ZZZ), Sector SS Longitude (ZZZ)

101. Sector geographic boundaries can be described in either of two ways: (1) as straight lines radiating out from the hub location at the specified bearings until they cross the outer boundary of the RSA, or (2) as sets of coordinates between which straight boundary lines exist that describe closed geographic areas. In either case, sectors may overlap, and, when they do, grid points in the overlap areas must be analyzed as though they were

included exclusively within each sector. When sets of coordinates are used, the last coordinate pair shall be assumed to connect to the first such pair.

102. The data for the sector boundary descriptions lists pairs of latitude and longitude coordinates in sequence, with each group of data following an entry header. The entry header includes a title that numbers the area to which its data applies and a value indicating the number of entries in the list for its area.

7. Sector Frequency Plan

Section Title: Frequency Plan

Header: # of sectors (SS)
Entries: "Sector 1," # of Response Bands (R1)
Channel Designator 1, Lower Frequency, Upper Frequency
Channel Designator 2, Lower Frequency, Upper Frequency
:
Channel Designator R1, Lower Frequency, Upper Frequency
"Sector 2," # of Response Bands (R2)
Channel Designator 1, Lower Frequency, Upper Frequency
Channel Designator 2, Lower Frequency, Upper Frequency
:
Channel Designator R2, Lower Frequency, Upper Frequency
:
:
"Sector SS," # of Response Bands (RSS)
Channel Designator 1, Lower Frequency, Upper Frequency
Channel Designator 2, Lower Frequency, Upper Frequency
:
Channel Designator RSS, Lower Frequency, Upper Frequency

103. The header specifies the number of sectors for which frequency plans are included. The number of sectors must match the number of sectors listed previously in the headers of the sections with the titles "Sectorization" and "Sector Definitions." Sector numbering matches that used for defining the sectorization and sector geographic boundaries in the earlier sections.

104. The entry for each sector begins with a line listing the sector number and the number of response bands defined within that sector. Response bands defined are the frequency ranges to be used for communication from response stations to the response station hub; they do not represent the actual subchannelization used, which can vary from time-to-time. The limits of one response band are listed on a single line. They are preceded on that line by the channel designator of the 6 MHz channel from which they are drawn (e.g., A3, F2, H1, M2A). There can be multiple response bands within a single 6 MHz channel, in which case the channel designator will appear in the list more than once. The entire 6 MHz channel also can be used, in which case its limits will be shown. Frequency bands are listed in ascending order.

105. Sector data proceeds from Sector 1 through the last sector (Sector SS) with no line spaces between the data from adjacent sectors.

8. Response Station Class Data

Section Title: "Class Info"
Header: # of classes (CL)
Entries: "Class 1," Worst Case Ant Pattern #, Max Height, Max Power, Number of Regions in Which Used, Region(s) in Which Used, Maximum Simultaneous Number within Each Region
"Class 2," Worst Case Ant Pattern #, Max Height, Max Power, Number of Regions in Which Used, Region(s) in Which Used, Maximum Simultaneous Number within Each Region
:
:
"Class CL," Worst Case Ant Pattern #, Max Height, Max Power, Number of Regions in Which Used, Region(s) in Which Used, Maximum Simultaneous Number within Each Region

106. Classes are defined by the combination of the worst case antenna pattern, the maximum height above ground level (AGL) at which the antennas may be mounted, and the maximum power (EIRP) they may emit.

107. Associated with each class description is one or more pairs of values indicating the region numbers in which the class is used and the maximum number of transmitters that may transmit simultaneously on the channel or on each sub-channel within each region. One pair is present for each region in which the particular class is used. The regions shall be listed in ascending numerical order. The maximum number of simultaneous transmitters specified shall apply to each sub-channel with power proportioned on a power spectral density basis.

9. Antenna Pattern Data (Hub Receive and Worst Case Response Station Transmit)

Section Title: Antenna Patterns

Header: # hub antenna patterns (HP), # of worst case response station transmit antenna patterns (RP)

Entries: Hub 01 Entry Title, # of Value Sets
Degrees of Azimuth, Plane Polarized dB, & Cross Polarized dB Headings
000 Degrees, Plane dB, Cross dB
001 Degrees, Plane dB, Cross dB
002 Degrees, Plane dB, Cross dB
003 Degrees, Plane dB, Cross dB
:
:
356 Degrees, Plane dB, Cross dB
357 Degrees, Plane dB, Cross dB
358 Degrees, Plane dB, Cross dB
359 Degrees, Plane dB, Cross dB
Degrees of Elevation, Plane Polarized dB, & Cross Polarized dB Headings
-90 Degrees, Plane dB, Cross dB
-89 Degrees, Plane dB, Cross dB
-88 Degrees, Plane dB, Cross dB
-87 Degrees, Plane dB, Cross dB
:
-01 Degrees, Plane dB, Cross dB
000 Degrees, Plane dB, Cross dB
+01 Degrees, Plane dB, Cross dB
:
+87 Degrees, Plane dB, Cross dB
+88 Degrees, Plane dB, Cross dB
+89 Degrees, Plane dB, Cross dB
+90 Degrees, Plane dB, Cross dB
Hub 02 Entry Title, # of Value Sets
Degrees of Azimuth, Plane Polarized dB, & Cross Polarized dB Headings
000 Degrees, Plane dB, Cross dB
001 Degrees, Plane dB, Cross dB
002 Degrees, Plane dB, Cross dB
003 Degrees, Plane dB, Cross dB
:
:
356 Degrees, Plane dB, Cross dB
357 Degrees, Plane dB, Cross dB
358 Degrees, Plane dB, Cross dB
359 Degrees, Plane dB, Cross dB
Degrees of Elevation, Plane Polarized dB, & Cross Polarized dB Headings
-90 Degrees, Plane dB, Cross dB
-89 Degrees, Plane dB, Cross dB
-88 Degrees, Plane dB, Cross dB
-87 Degrees, Plane dB, Cross dB
:

-01 Degrees, Plane dB, Cross dB
000 Degrees, Plane dB, Cross dB
+01 Degrees, Plane dB, Cross dB
:
+87 Degrees, Plane dB, Cross dB
+88 Degrees, Plane dB, Cross dB
+89 Degrees, Plane dB, Cross dB
+90 Degrees, Plane dB, Cross dB

:
:

:
Hub HP Entry Title, # of Value Sets
Degrees of Azimuth, Plane Polarized dB, & Cross Polarized dB Headings
000 Degrees, Plane dB, Cross dB
001 Degrees, Plane dB, Cross dB
002 Degrees, Plane dB, Cross dB
003 Degrees, Plane dB, Cross dB
:
:
356 Degrees, Plane dB, Cross dB
357 Degrees, Plane dB, Cross dB
358 Degrees, Plane dB, Cross dB
359 Degrees, Plane dB, Cross dB
Degrees of Elevation, Plane Polarized dB, & Cross Polarized dB Headings
-90 Degrees, Plane dB, Cross dB
-89 Degrees, Plane dB, Cross dB
-88 Degrees, Plane dB, Cross dB
-87 Degrees, Plane dB, Cross dB
:
-01 Degrees, Plane dB, Cross dB
000 Degrees, Plane dB, Cross dB
+01 Degrees, Plane dB, Cross dB
:
+87 Degrees, Plane dB, Cross dB
+88 Degrees, Plane dB, Cross dB
+89 Degrees, Plane dB, Cross dB
+90 Degrees, Plane dB, Cross dB
Response 01 Entry Title
Degrees of Azimuth, Plane Polarized dB, & Cross Polarized dB Headings
000 Degrees, Plane dB, Cross dB
001 Degrees, Plane dB, Cross dB
002 Degrees, Plane dB, Cross dB
003 Degrees, Plane dB, Cross dB
:
:
356 Degrees, Plane dB, Cross dB
357 Degrees, Plane dB, Cross dB
358 Degrees, Plane dB, Cross dB
359 Degrees, Plane dB, Cross dB
Response 02 Entry Title
Degrees of Azimuth, Plane Polarized dB, & Cross Polarized dB Headings
000 Degrees, Plane dB, Cross dB
001 Degrees, Plane dB, Cross dB
002 Degrees, Plane dB, Cross dB
003 Degrees, Plane dB, Cross dB

:
:
356 Degrees, Plane dB, Cross dB
357 Degrees, Plane dB, Cross dB
358 Degrees, Plane dB, Cross dB
359 Degrees, Plane dB, Cross dB
:
:
:
Response RP Entry Title
Degrees of Azimuth, Plane Polarized dB, & Cross Polarized dB Headings
000 Degrees, Plane dB, Cross dB
001 Degrees, Plane dB, Cross dB
002 Degrees, Plane dB, Cross dB
003 Degrees, Plane dB, Cross dB
:
:
356 Degrees, Plane dB, Cross dB
357 Degrees, Plane dB, Cross dB
358 Degrees, Plane dB, Cross dB
359 Degrees, Plane dB, Cross dB

108. The hub receiving antenna and response station transmitting antenna azimuth patterns shall be defined in 1 degree increments beginning with 0 degrees and ending at 359 degrees. Hub receiving antenna elevation patterns shall be defined in 1 degree increments beginning at —90degrees for the zenith, continuing through 0 degrees at the reference horizontal plane, and ending at +90 degrees for the nadir. All entries shall be in dB relative to the peak response, which shall be normalized to a value of 0 dB. . The peak response in the azimuth pattern shall be given at 0 degrees if there is only one peak, or the peaks shall be symmetrically placed around 0 degrees if there is more than one peak. The elevation pattern shall be given in the direction of the azimuth plane peak response, and the peak elevation response shall be shown at the depression angle below the reference horizontal plane at which it occurs, i.e. electrical beam tilt shall be built into the elevation pattern. Any rotations of the antenna pattern, either in azimuth or through mechanical beam tilt, are given in other sections.

109. Full azimuth data shall be supplied for both hub and response station worst-case antenna patterns. Elevation data is required only for hub antennas. In cases where hub antenna elevation data is known only over a limited range, just the known points should be entered. For example, if elevation data is known from —10 degrees to +40 degrees of elevation only, such data should be entered, even though incomplete. At a minimum, data shall be supplied for elevation angles every degree from —10degrees to + 30 degrees. Where mechanical beam tilt is used, sufficient data shall be supplied to assure pattern inclusion to at least 5 degrees above the horizon (i.e., -5 degrees relative to the horizontal plane at the hub antenna location). Only those angles for which data is present should appear in the list, and the total number of value sets for each hub antenna pattern should be set to account for just those entries present. Headings shall not be counted in arriving at the total number. Where needed to properly model an antenna for which all values of the elevation pattern are not given, values not given shall be interpolated linearly in decibels between points for which data is given, using the sum (in decibels) of the azimuth and elevation patterns to arrive at the values between which interpolation shall be carried out.

110. When response stations operate with EIRP no greater than —6dBW per 6 MHz channel (or the bandwidth-adjusted equivalent on a power spectral density basis), they are permitted to use non-directional

antennas. Such stations shall be treated as using isotropic radiators, which shall be indicated by use of the value —1 for theworst-case antenna pattern number in the section on Class Info. No specification of the azimuth pattern of such an antenna is required in the section on Antenna Patterns.

Example File & Template

111. In the example file and template below, formatting elements and descriptive terms to be included in the submitted file exactly as shown are in `plain text`. Those items to be replaced by real data and shown here as placeholders for purposes of example are shown in *`italicized text and CAPITAL LETTERS`*.

[General Info]

File *FILE NUMBER*
Licensee **OR** Applicant *LICENSEE/APPLICANT NAME*
Hub Lat *DDMMSSS*, Hub Lon *DDDMMSSS*
Hub City *CITY, ST*
Elevation *AMSL METERS*
Call *CALL SIGN*
Stn City *CITY, ST*

[Circular Geographic Areas]

RSA *0/1*, Regions *00/RR*
00,*DDMMSSS*,*DDDMMSSS*,*KM.KM*
01,*DDMMSSS*,*DDDMMSSS*,*KM.KM*
02,*DDMMSSS*,*DDDMMSSS*,*KM.KM*
:: :::::: ::::::: ::::::
:: :::::: ::::::: ::::::
RR,*DDMMSSS*,*DDDMMSSS*,*KM.KM*

[Non-Circular Areas]

RSA *0/1*, Regions *00/NN*
RSA,*XXX*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
::::::: ::::::::
DDMMSSS,*DDDMMSSS* [Pair # XXX]
Region *RR+1*,*AAA*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
::::::: ::::::::
DDMMSSS,*DDDMMSSS* [Pair # AAA]
Region *RR+2*,*BBB*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
::::::: ::::::::
DDMMSSS,*DDDMMSSS* [Pair # BBB]
::::::: ::::::::
::::::: ::::::::
Region *RR+NN*,*ZZZ*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
DDMMSSS,*DDDMMSSS*
::::::: ::::::::
DDMMSSS,*DDDMMSSS* [Pair # ZZZ]

```
[ Sectorization]

Sectors SS
Sector,HubPat,Gain,Az,AGL,MTilt,MTiltAz,Pol,Max#Trans
01,HP,dB.dB,DDD.D,MMMM,DD.D,DDD.D,H/V/B,TTTT
02,HP,dB.dB,DDD.D,MMMM,DD.D,DDD.D,H/V/B,TTTT
03,HP,dB.dB,DDD.D,MMMM,DD.D,DDD.D,H/V/B,TTTT
:: :: :: :: ::: : :::: :: : ::: : : : : ::::
:: :: :: :: ::: : :::: :: : ::: : : : : ::::
SS,HP,dB.dB,DDD.D,MMMM,DD.D,DDD.D,H/V/B,TTTT

[ Grid Points]

Points MMMM
Pnt,Lat,Lon,Elev,Regn,Bearing,Pol,#Classes,ClassDesignators...
0001,DDMMSSS,DDDMMSSS,MMMM,R#,DDD.DD,H/V/B,###,CC1,CC2,CC3,...CC###
0002,DDMMSSS,DDDMMSSS,MMMM,R#,DDD.DD,H/V/B,###,CC1,CC2,CC3,...CC###
0003,DDMMSSS,DDDMMSSS,MMMM,R#,DDD.DD,H/V/B,###,CC1,CC2,CC3,...CC###
:::: :::::: ::::::: :: :: :::: : : : ::: ::: ::: :::     :::
:::: :::::: ::::::: :: :: :::: : : : ::: ::: ::: :::     :::
MMMM,DDMMSSS,DDDMMSSS,MMMM,R#,DDD.DD,H/V/B,###,CC1,CC2,CC3,...CC###

[ Sector Definitions]

Sectors SS, Type B
01,DD.DD,DD.DD
02,DD.DD,DD.DD
03,DD.DD,DD.DD
:: :: :: :: ::
:: :: :: :: ::
SS,DD.DD,DD.DD
```

OR

```
Sectors SS, Type C
Sector 01, Points AAA
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
::::::: ::::::::
DDMMSSS,DDDMMSSS  [ Pair # AAA]
Sector 02, Points BBB
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
::::::: ::::::::
DDMMSSS,DDDMMSSS  [ Pair # BBB]
Sector 03, Points CCC
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
::::::: ::::::::
DDMMSSS,DDDMMSSS  [ Pair # CCC]
::::::: ::::::::
::::::: ::::::::
Sector SS, Points ZZZ
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
DDMMSSS,DDDMMSSS
::::::: ::::::::
DDMMSSS,DDDMMSSS  [ Pair # ZZZ]
```

```
[ Frequency Plan]

Sectors SS
Sector 01, Response Bands R1
D1,FFFF.FFF,FFFF.FFF
D2,FFFF.FFF,FFFF.FFF
D3,FFFF.FFF,FFFF.FFF
:: :::: ::: :::: :::
R1,FFFF.FFF,FFFF.FFF
Sector 02, Response Bands R2
D1,FFFF.FFF,FFFF.FFF
D2,FFFF.FFF,FFFF.FFF
D3,FFFF.FFF,FFFF.FFF
:: :::: ::: :::: :::
R2,FFFF.FFF,FFFF.FFF
:: :::: ::: :::: :::
:: :::: ::: :::: :::
Sector SS, Response Bands RS
D1,FFFF.FFF,FFFF.FFF
D2,FFFF.FFF,FFFF.FFF
D3,FFFF.FFF,FFFF.FFF
:: :::: ::: :::: :::
RS,FFFF.FFF,FFFF.FFF

[ Class Info]

Classes CL
Class,Pattern,AGL,MaxEIRP,#Reg,Reg,Max#Tx
01,PAT,MMM,dB.dB,##,R1,##R1,R2,##R2,...RG,##RG
02,PAT,MMM,dB.dB,##,R1,##R1,R2,##R2,...RG,##RG
03,PAT,MMM,dB.dB,##,R1,##R1,R2,##R2,...RG,##RG
:: ::: ::: :: :: :: :: :::: :: ::::     :: ::::
:: ::: ::: :: :: :: :: :::: :: ::::     :: ::::
CL,PAT,MMM,dB.dB,##,R1,##R1,R2,##R2,...RG,##RG

[ Antenna Patterns]

Hub HP, Response RP
Hub 01,###Values
DegAz,Plane dB,Cross dB
000,dB.dB,dB.dB
001,dB.dB,dB.dB
002,dB.dB,dB.dB
003,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
357,dB.dB,dB.dB
358,dB.dB,dB.dB
359,dB.dB,dB.dB
DegEl,Plane dB,Cross dB
-90,dB.dB,dB.dB
-89,dB.dB,dB.dB
-88,dB.dB,dB.dB
::: :: :: :: ::
-01,dB.dB,dB.dB
000,dB.dB,dB.dB
+01,dB.dB,dB.dB
::: :: :: :: ::
+88,dB.dB,dB.dB
+89,dB.dB,dB.dB
+90,dB.dB,dB.dB
```

```
Hub 02,###Values
DegAz,Plane dB,Cross dB
000,dB.dB,dB.dB
001,dB.dB,dB.dB
002,dB.dB,dB.dB
003,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
357,dB.dB,dB.dB
358,dB.dB,dB.dB
359,dB.dB,dB.dB
DegEl,Plane dB,Cross dB
-90,dB.dB,dB.dB
-89,dB.dB,dB.dB
-88,dB.dB,dB.dB
::: :: :: :: ::
-01,dB.dB,dB.dB
000,dB.dB,dB.dB
+01,dB.dB,dB.dB
::: :: :: :: ::
+88,dB.dB,dB.dB
+89,dB.dB,dB.dB
+90,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
Hub HP,###Values
DegAz,Plane dB,Cross dB
000,dB.dB,dB.dB
001,dB.dB,dB.dB
002,dB.dB,dB.dB
003,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
357,dB.dB,dB.dB
358,dB.dB,dB.dB
359,dB.dB,dB.dB
DegEl,Plane dB,Cross dB
-90,dB.dB,dB.dB
-89,dB.dB,dB.dB
-88,dB.dB,dB.dB
::: :: :: :: ::
-01,dB.dB,dB.dB
000,dB.dB,dB.dB
+01,dB.dB,dB.dB
::: :: :: :: ::
+88,dB.dB,dB.dB
+89,dB.dB,dB.dB
+90,dB.dB,dB.dB
Response 01
DegAz,Plane dB,Cross dB
000,dB.dB,dB.dB
001,dB.dB,dB.dB
002,dB.dB,dB.dB
003,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
357,dB.dB,dB.dB
358,dB.dB,dB.dB
359,dB.dB,dB.dB
Response 02
DegAz,Plane dB,Cross dB
000,dB.dB,dB.dB
```

```
001,dB.dB,dB.dB
002,dB.dB,dB.dB
003,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
357,dB.dB,dB.dB
358,dB.dB,dB.dB
359,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
Response RP
DegAz,Plane dB,Cross dB
000,dB.dB,dB.dB
001,dB.dB,dB.dB
002,dB.dB,dB.dB
003,dB.dB,dB.dB
::: :: :: :: ::
::: :: :: :: ::
357,dB.dB,dB.dB
358,dB.dB,dB.dB
359,dB.dB,dB.dB
```