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Spectrum Management

Client Procedures Circular

The Presentation of Graphical Data Required under Appendices 3 and 4 of the International Telecommunication Union Radio Regulations

Canada

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Principle

To specify the graphical data forms required to include with the information required in effecting coordination of frequency assignments planned for operation in the space services.

Mandate

The Department, in discharging its obligations under the Convention of the ITU and the Regulations, requires adherence to the provisions therein that apply to the international coordination and notification of satellite networks eligible for licensing in Canada.

Policy

Before issuing a licence in accordance with the *Radiocommunication Act*, the Department will ensure that domestic licensing requirements as well as domestic and international coordination requirements have been met.

Procedure

This procedure is in compliance with the provisions of the ITU *Radio Regulations* and meets the automated data capture and data digitization requirements of the Radiocommunication Bureau's (formerly the IFRB) Graphic Interference Management System (GIMS), as specified in the IFRB Circular-letter No. 769, the basis for this document. This procedure is intended to provide guidance regarding space station or earth station data, or both, that need be specified in graphical form. Submission of incomplete forms to the Bureau would delay the completion of the coordination/ notification process that is compulsory under the ITU *Radio Regulations*. Successful completion of this process is a prerequisite for the registration of frequency assignments in the Master International Frequency Register (MIFR) and thus their protection from harmful interference.

Introduction

Appendices 3 and 4 of the *Radio Regulations* stipulate that the following data shall be notified, as appropriate, in graphical form:

a) the measured radiation diagrams of earth station antennas;
b) the horizon elevation diagrams of earth stations;
c) the service areas of satellite networks;
d) the antenna gain contours of geostationary space stations;
e) the diagram of the antenna gain of geostationary space stations towards the geostationary-satellite orbit; and
f) the antenna radiation pattern of space stations.

The experience gained in using the Graphic Interference Management System (GIMS) for digitizing the diagrams submitted by administrations prompts the following comments regarding the rules that should be applied when preparing the original graphical data.

1. **Map Projections, Formats and Layout**

1.1 In general, the GIMS permits direct recognition of the projection and digitizing of service areas and space station antenna gain contours presented on a map in the following most common projections:

a) orthomorphic (full or partial satellite view);
b) cylindrical equidistant (plate carrée);
c) Mercator;
d) cylindrical equal area (Lambert); and, exceptionally,
e) equidistant conical with one standard parallel (Ptolemy). This projection is suitable only for the Northern Hemisphere.

The individual projections can be recognized in particular by the form and distribution of distances between the lines of geographical latitude. Typical characteristics of these projections are illustrated in **Figures 1 to 5** by means of displaying two identical circular spot beams having different boresights.

When none of the above projections is suitable, an administration may present any other projection. In such cases, as well as for the five projections listed above, it is essential that the following conditions be met:

1.2 In order to ensure adequate recognition of a map in any projection, it is necessary to present it **with at least four lines of latitude and four lines of longitude** forming the geographical longitude/latitude graticule, appropriately labelled.[1]

1.3 Diagrams should, wherever possible, be submitted in A3 format (297 mm x 420 mm) to facilitate digitization, as long as copying does not cause undue distortion. Smaller diagrams are acceptable, but they should preferably not be smaller than A4 format (210 mm x 297 mm). Diagrams

[1] Diagrams on which the geographical longitude/latitude graticule is replaced by another coordinate reference system , for example, one in which the azimuth/elevation angles are referred to the sub-satellite point, are not acceptable.

larger than A3 format will be too big for the digitizing tablet used. In addition, whenever possible, contours should be shown as continuous lines. For antenna gain contours, there should be a clear indication of their respective gain values relative to the maximum gain.

1.4 Full or partial satellite view diagrams should be presented as the radial projection from the satellite at its nominal geographical longitude on the geostationary-satellite orbit onto a plane perpendicular to the axis from the centre of the Earth to the satellite. In other words, the centre of the circle representing the full satellite view of the Earth, known as the sub-satellite point, should have the nominal geographical longitude of the satellite. The geographical graticule should be drawn for the above condition as it appears from the geostationary satellite.[2] When the area of interest covers only a part of the Earth's surface, as in the case of a spot beam, a partial satellite view which covers not much more than the area containing the -20 dB antenna gain contour(s) is preferable, in order to increase the size of the diagram for easier interpretation.

1.5 Geographic entities, such as coastlines and national frontiers, originally shown on a diagram by the notifying administration are normally not processed by the system. However, when the relevant diagrams are plotted by the system after being digitized, these entities, as required, are added from the Radiocommunication Bureau world data bank.[3]

2. Space Station Antenna Gain Contours and Boresights

2.1 In the case of a space station aboard a geostationary satellite, the space station antenna gain contours shall be plotted on a map of the Earth's surface as isolines of the isotropic gain at least for -2, -4, -6, -10 and -20 dB and at 10 dB intervals thereafter, as necessary, relative to the maximum antenna gain, when any of these contours is located either totally or partially anywhere within the limit of visibility of the Earth from the given geostationary satellite. Contours beyond the limit of visibility cannot be digitized, and in cases where the -20 dB contour has not yet been reached (e.g., for antennas with global coverage) a contour at the limit of visibility and the relative gain data should be given.

2.2 In the process of carrying out (delta T)/T and C/I calculations using the space station antenna gain contours, the system performs an automatic interpolation of the gain for points between the contours in reference to the boresights, which are not required under the said Appendices. Administrations are invited to present the diagrams with the boresights and their associated antenna gains. The antenna gain, at least at one boresight, should correspond to the maximum isotropic gain. If the gain at other boresights is lower than the maximum gain, the gain at these

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[2] Diagrams on which all lines representing geographical latitude are strictly straight lines are not acceptable, because the projection is from a viewpoint in infinity and consequently, shows the contours on a part of the Earth which is not visible from the satellite.

[3] The tracing of borders does not imply any ITU position with respect to the status of a country or geographical area, or official ITU recognition of these borders.

boresights should be indicated in reference to the maximum antenna gain in the same way as for the contours.

When the boresights are not provided by administrations, they will be estimated by the Bureau before the selection of an appropriate interpolation method. In the case of complex forms of the space station antenna gain contours, the Bureau may need to create additional "boresights" having certain geometrical rather than electrical properties for increasing the accuracy of the gain interpolation method.

2.3 In the case of complex gain contours produced by a phased array of multifeed antennas used to service two or more separated service areas simultaneously, it would be preferable to present sets of antenna gain contours as separate beams for each service area.

2.4 The digitizing process filters out errors introduced by the inevitable small departures when moving the cursor along the contours. However, any crossing of contours would disable the automatic gain interpolation between the contours used in (delta T)/T and C/I calculations and is not permitted. Therefore, it is recommended that the originals of the antenna gain contours be presented on a sufficient scale to ensure that the closest contours will be **visibly separated by at least 1 mm**.

3. Service Areas

3.1 The requirements for digitizing service areas are the same as for antenna gain contours. In the case of a service area defined only by country or series of countries, the service area is either recalled from the Radiocommunication Bureau world data bank or digitized from the best currently available map and then stored in a library for later use. A service area defined by discrete points such as locations of given earth stations or test points (with, in either case, their geographical coordinates) is processed either by entering the numerical values directly or by digitizing the geographical positions. When the service area does not fall into either of these two categories, it is to be shown as a closed contour or contours on a recognizable map. One map should not contain more than two service areas.

4. Diagram of Antenna Radiation Towards the Geostationary-Satellite Orbit

4.1 Appendices 3 and 4 of the *Radio Regulations* stipulate indication (when appropriate) of the gain of a space station antenna in the direction of those parts of the geostationary satellite orbit which are not obstructed by the Earth, by means of a diagram showing estimated antenna gain versus orbit longitude.

This information should be presented as an orthogonal x-y diagram, where the orbit longitude is shown on the x-axis with the length of 360 degrees and the antenna gain, in dB, on the y-axis. Both axes should be regular and linear, and in neither case should the axis be foreshortened (See Figure 6).

4.2 In the process of digitizing the gain versus orbit longitude, the system performs an automatic validation for the longitudinal zone corresponding to the part of the orbit obstructed by the Earth and blocks any data entry within this segment. Therefore, it is essential to obtain the

respective diagrams with adequate accuracy in marking the obstructed zone.

The limits of the obstructed longitudinal zone are located ± 162.6 degrees from the nominal orbital position of the space station.

Provision of the two values of antenna gain for the points where the gain curve intersects the limits of the obstructed zone is recommended. Note also that the gain values at the two extremes of the x-axis on the diagram should be identical.

5. **Horizon Elevation Diagrams of Earth Stations**

5.1 The horizon elevation information should be presented as an orthogonal x-y diagram, where the azimuth around the earth station is shown on the x-axis in the range from 0 to 360 degrees with reference to true North and the elevation angle, in degrees, with reference to the horizontal plane on the y-axis. Both axes should be regular and linear, and in neither case should the axis be foreshortened (see Figure 7).

Figure 1
Orthomorphic projection (Full satellite view)

Figure 2
Cylindrical equidistant projection (Plate carrée)

Figure 3
Mercator projection

Figure 4
Cylindrical equal area projection (Lambert)

Figure 5
Equidistant conical projection (Ptolemy)

Figure 6
Diagram of antenna radiation towards the geostationary-satellite orbit

Figure 7
Horizon elevation diagram of an earth station