

PROCEDURES FOR OPERATION OF EARTH STATIONS ON VESSELS (ESVs)

The VI meeting of the Permanent Consultative Committee II: Radiocommunications including Broadcasting,

CONSIDERING:

- a) That WRC-03 adopted changes to the Table of Frequency Allocations to allow for communication between earth stations on vessels (ESV) and space stations in the fixed-satellite service in the bands 5 925-6 425 MHz and 14-14.5 GHz;
- b) That WRC-03 approved Resolution 902, “Provisions relating to earth stations located on board vessels which operate in fixed-satellite service networks in the uplink bands 5 925-6 425 MHz and 14-14.5 GHz” providing technical and regulatory guidelines for the operation of ESVs;
- c) That subject to Resolution 902 (WRC-03), ESVs may operate in the fixed-satellite service bands listed in *considerings a) and b)* on a co-primary basis with terrestrial services;
- d) That in Region 2, the 5925-6425 MHz uplink band used by ESVs includes allocations to terrestrial services, and is heavily used by fixed service systems;
- e) That in Region 2, the 14.4-14.5 GHz portion of the 14-14.5 GHz uplink band used by ESVs includes allocations to terrestrial services;
- f) That in Region 2, the ESV downlink bands 3 700-4 200 MHz, 10.95-11.2 and 11.45-12.2 GHz are also allocated to the fixed and mobile service and in-motion ESVs should not claim protection from interference from any authorized terrestrial stations to which frequencies are either already assigned or may be assigned in the future;
- g) That the emissions of ESVs operating with ESV hub earth stations licensed by CITEL Administrations are controlled by a network control facility through an ESV hub earth station, without regard to the vessel’s country of registration;
- h) That notwithstanding *considering g)* the emissions of ESVs may also be authorized by the vessel’s country of registration through an ESV terminal license;
- i) That pursuant to Resolution 902 (WRC-03), there is a need to subject ESVs to certain limitations in order to prevent harmful interference to authorized systems in the terrestrial services and fixed-satellite service;
- j) That all CITEL countries, including those that neither operate ESV networks nor have terrestrial or fixed-satellite service systems and networks in the bands used by ESVs, would benefit if common procedures could be developed for the operation of ESV networks and the use of ESVs;

NOTING:

¹ PCC.II-RADIO/doc. 895/05

That by means of Resolution PCC.II/RES.10 (II-03), a Sub-working Group was created within the Working Group Relative to Satellite Systems to provide Fixed and Mobile Services, with the objective of developing procedures that could be used by CITEL Administrations for authorizing ESVs to use the bands 5925 – 6425 MHz and 14-14.5 GHz.

RECOMMENDS:

1. That CITEL Administrations, when authorizing ESV network hub earth station operations within their territory and/or ESV terminal operations on board their registered vessels in the 5925-6425 MHz and/or 14-14.5 GHz bands, take into account the need to protect co-primary services in those bands from harmful interference, using measures that include:

- a) Technical and operational requirements on ESV operations consistent with Resolution 902 (WRC-03); and
- b) As set forth in the Annex, seeking agreement from concerned Administrations before operating ESVs within the specified minimum distances of those Administrations' territories, to protect those Administrations' co-frequency terrestrial fixed and mobile service operations from harmful interference.

2. That for purposes of *recommends 1.* above, and to ensure adequate protection of co-frequency terrestrial and fixed-satellite service systems from harmful interference, CITEL Administrations authorizing ESV network hub earth station operations within their territory or ESV terminal operations on board their registered vessels in the 5925-6425 MHz and 14-14.5 GHz bands follow the procedures for use of ESVs that are set forth in the Annex to this recommendation;

3. That, with a view to identifying possible frequencies in those bands for ESV use that would avoid potential interference, CITEL Administrations consider the possibility to make available their data base of terrestrial stations operating in the 5925-6425 MHz or 14-14.5 GHz bands or determine those that could be affected by ESV operations;

4. That CITEL Administrations take into account that the operation within the territory, including territorial waters, of a CITEL Administration, of an ESV network in the bands 5925-6425 MHz and 14-14.5 GHz in accordance with the provisions set forth in the Annex is adequate to protect co-frequency terrestrial and fixed-satellite service operations from harmful interference;

INSTRUCTS THE EXECUTIVE SECRETARIAT:

To send present Recommendation to CITEL's Administration Members.

ANNEX TO RECOMMENDATION PCC.II/REC. 14 (V-05)

Procedures for Use of ESVs in the Bands 5925-6425/3700-4200 MHz and 14-14.5/10.95-11.2 and 11.45-12.2 GHz

A Overview

The following provisions contain the recommended provisions that licensing Administrations, license holders, and CITEL Administrations should apply or rely upon with regard to the operation within Region 2 of ESVs in the fixed-satellite service bands at 5925-6425/3700-4200 MHz and 14-14.5/10.95-11.2 and

11.45-12.2 GHz. These measures are designed to facilitate the introduction and regular use of ESVs within Region 2 while ensuring that such stations follow the applicable and appropriate guidelines (consistent with Resolution 902 (WRC-03)) and thus do not present any potential to cause unacceptable interference to the services of other concerned Administrations.

For purposes of this Annex, the term “licensing Administration” refers either to: a CITEL Administration authorizing ESV network hub earth station operations using the 5925-6425/3700-4200 MHz and/or 14-14.5/10.95-11.2 and 11.45-12.2 GHz bands in its territory and/or a CITEL Administration authorizing ESV terminal operations in the same band or bands within Region 2 on board its registered vessels. ESV hub earth stations are earth stations located on the territory of a CITEL Administration that are used to control, through network control facilities, the operation of ESV terminals on board vessels that are affiliated with the ESV network when communicating with the hub earth station. The ESVs so affiliated with the ESV network can, but need not be, on vessels registered to the CITEL Administration where the hub is located.

For purposes of this Annex, a CITEL Administration is considered to be a concerned Administration for those frequencies in which it has fixed or mobile services assigned on a primary basis in the uplink band employed by the ESV operator (all or part of the 5925-6425 MHz and 14-14.5 GHz bands).

ESVs in motion should not claim protection from harmful interference from any authorized terrestrial stations or lawfully operating satellites to which frequencies are either already assigned, or may be assigned in the future in the 3700-4200 MHz (space-to-Earth), 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) frequency bands.

Section B below contains provisions for the use of ESVs in the 5925-6425/3700-4200 MHz bands. Section C below contains provisions for the use of ESVs in the bands 14-14.5/10.95-11.2 and 11.45-12.2 GHz. Section D below contains operational measures applicable to all ESVs to avoid causing unacceptable interference.

B Provisions for ESVs transmitting in the 5925-6425 MHz Bands

The following provisions apply for the use of ESVs in the 5925-6425 MHz band:

1. Minimum Distance

The minimum distance from the baseline, as officially recognized by the coastal State² beyond which ESVs can operate without the prior agreement of any concerned Administration, as defined above, is 300

² For purposes of this recommendation, “baseline” means the line from which maritime zones are measured, and is a combination of the low-water line (low-tide elevation) and closing lines across the mouths of inland water bodies. The baseline is defined by a series of baseline points. The baseline points are not just the low-water marks of the shore of the mainland, but also include islands and low-tide elevations (i.e., natural rocks). Baseline points are ambulatory (i.e., not stationary), and thus require official adjustment from time-to-time.

km (or a lesser distance if one has been established in the national regulations of the concerned Administration) in the 5 925-6 425 MHz band taking into account the following technical limitations:³

	5 925-6 425 MHz
Tracking accuracy of ESV antenna	±0.2° peak
Maximum ESV e.i.r.p. spectral density toward the horizon	17 dB(W/MHz)
Maximum ESV e.i.r.p. toward the horizon	20.8 dBW
Maximum off-axis e.i.r.p. density *	See section B.2 below
Minimum gross tonnage of vessels for ESV operation	300 gross tons
Minimum angle of antenna elevation	5°**

* In the case that the e.i.r.p. off-axis levels in an FSS intersystem coordination agreement that is applicable to an FSS network with which an ESV will communicate are more stringent than the levels provided below, the ESV will be limited to operating at the more stringent off-axis e.i.r.p. density levels in the relevant FSS intersystem coordination agreement(s). To the extent that ESVs operating in the band 5925-6425MHz do not both 1) meet the off-axis e.i.r.p. density levels provided below; and 2) complete any applicable coordination obligations prior to the commencement of operations, then they must use an antenna with a diameter of at least 2.4 m.

** Upon a showing that the emission path will be seaward and away from land masses or upon a special showing of need for lower angles by the applicant, an Administration's licensing authority may consider authorizing emissions at angles between 3° and 5° in pertinent directions. In certain instances, it may be necessary for the licensing Administration to specify minimum angles greater than 5° because of interference considerations. Even in cases where angles less than 5° are requested, any relevant restrictions on e.i.r.p. and e.i.r.p. density toward the horizon – i.e., the values from Resolution 902 (WRC-03) – should apply.

Note: Section B.4 below applies with regard to emissions from ESVs within the minimum distances of a concerned Administration.

2. Off-Axis e.i.r.p. Spectral Density Levels

As agreed in Resolution 902 (WRC-03), CITEL Administrations that do not adopt the stricter limits proposed here, should ensure that the off-axis e.i.r.p. spectral density values do not exceed those permitted under Resolution 902 (WRC-03), Annex 2

For earth stations on board vessels operating in the 5 925-6 425 MHz band:

³ The minimum distance beyond which prior agreement is not required for the 5925-6425 MHz band is set in this Annex at 200 km, rather than at the 300 km distance in Resolution 902 (WRC-03) because, as a technical matter, there is no prospect for harmful interference to a terrestrial fixed service assignment from an ESV with the referenced technical characteristics operating more than 200 km from the baseline.

- (1) The off-axis e.i.r.p. spectral density for co-polarized signals, emitted from the ESV, in the plane of the geostationary satellite orbit as it appears at the particular earth station location (*i.e.*, the plane determined by the focal point of the antenna and the line tangent to the arc of the geostationary satellite orbit at the position of the target satellite), should not exceed the following values:

26.3 – 25log(θ) dBW/4kHz	$1.0^\circ \leq \theta \leq 7.0^\circ$
5.3 dBW/4kHz	$7.0^\circ < \theta \leq 9.2^\circ$
29.3 – 25log(θ) dBW/4kHz	$9.2^\circ < \theta \leq 48^\circ$
-12.7 dBW/4kHz	$48^\circ < \theta \leq 180^\circ$

- (2) In all other directions, the off-axis e.i.r.p. spectral density for co-polarized signals emitted from the ESV should not exceed the following values:

29.3 – 25log(θ) dBW/4kHz	$1.0^\circ \leq \theta \leq 48^\circ$
-12.7 dBW/4kHz	$48^\circ < \theta \leq 180^\circ$

- (3) For $\theta > 7^\circ$, the values given in paragraph (a)(1) of this Section should not be exceeded by more than 10% of the earth station antenna sidelobes, provided that no individual sidelobe exceeds the criteria given by more than 3 dB.

- (4) In all directions, the off-axis e.i.r.p. spectral density for cross- polarized signals emitted from the ESV should not exceed the following values:

16.3 – 25log(θ) dBW/4kHz	$1.8^\circ \leq \theta \leq 7.0^\circ$
-4.7 dBW/4kHz	$7.0^\circ < \theta \leq 9.2^\circ$

Where θ is the angle in degrees from the axis of the main lobe.

NOTES:

- 1) *For non-circular ESV antennas, the major axis of the antenna should be aligned with the tangent to the geostationary satellite orbital arc at the target satellite point, to the extent required to meet specified off-axis e.i.r.p. criteria.*
- 2) *The foregoing off-axis e.i.r.p. spectral density values are appropriate for a two-degree spacing environment, instead of the three-degree spacing environment that is contemplated for the off-axis e.i.r.p. spectral density values in Resolution 902 (WRC-03).*

3. Licensing Provisions for Networks of ESVs Comprised of a Hub Station(s) and One or More Types of ESV Terminals

To the extent that a CITEL Administration seeks to become a licensing Administration for ESV terminals or to authorize within its territory an ESV hub earth station (including ESV network control facility) for an ESV network that will operate within Region 2, they should ensure compliance with the technical requirements for ESV terminals using either their national regulations or the following provisions:

a) Applications for ESV operations in the 5925-6425 MHz band communicating with geostationary satellites in the fixed-satellite service should include, in addition to whatever minimum requirements apply to non-ESV earth station applications, for each ESV terminal type:

- (1) A series of e.i.r.p. density charts or tables, calculated for a production ESV earth station antenna, based on measurements taken on a calibrated antenna range at 6.0 GHz, with the off-axis e.i.r.p. envelope set forth above superimposed, as follows:
 - (i) showing off-axis co-polarized e.i.r.p. spectral density in the azimuth plane, for off-axis angles from minus 10° to plus 10° and from minus 180° to plus 180°.
 - (ii) showing off-axis co-polarized e.i.r.p. spectral density in the elevation plane, at off-axis angles from 0° to plus 30°.
 - (iii) showing off-axis cross-polarized e.i.r.p. spectral density in the azimuth plane, at off-axis angles from minus 10° to plus 10°.
 - (iv) showing off-axis cross-polarized e.i.r.p. spectral density in the elevation plane, at off-axis angles from minus 10° to plus 10°.

Or

- (2) A series of gain charts or tables, for a production earth station antenna, measured on a calibrated antenna range at 6.0 GHz, with the Earth station antenna gain envelope set forth in Sections (a) and (b) of the Attachment to the Annex superimposed, for the same planes and ranges enumerated in paragraphs (a)(1)(i) through (a)(1)(iv) of this Section, that, combined with input power density, demonstrates that off-axis e.i.r.p. spectral density envelope set forth above will be met.

Or

- (3) A certification that the antenna conforms to the gain pattern criteria of Sections (a) and (b) of the Attachment to the Annex that, combined with input power density, demonstrates that the off-axis e.i.r.p. spectral density envelope set forth above will be met.

(b) There should be an exhibit included with the application describing the geographic area(s) in which the ESVs will operate.

4. Agreements with Concerned Administrations for the Use of Frequencies by ESVs Operating in the 5925-6425 MHz Band

a) Before an ESV commences operations in the 5925-6425 MHz (Earth-to-space) band within 300 km (or a lesser distance if one has been established in the national regulations of the concerned Administration) from the baseline of a concerned Administration, an ESV licensing Administration should obtain agreement from the concerned Administration with respect to specific frequencies for ESV use, to protect existing and authorized terrestrial systems. The agreement should be based upon the guidance provided in the ITU-R Recommendations applicable to ESV use, and on mutually agreed criteria. A summary of the principal terms of the agreement should be maintained by and made available from the participating Administrations.

b) The ESV licensing Administration should ensure that ESV terminals automatically cease emissions if the ESV terminal operates in violation of the terms of the agreement referenced in Section B.4(a) above, including, but not limited to, conditions related to speed of the vessel or if the ESV travels

outside the coordinated area, if within 300 km (or a lesser distance if one has been established in the national regulations of the concerned Administration) from the baseline of the ESV licensing Administration.

C Provisions for ESVs in the 14-14.5/10.95-11.2 and 11.45-12.2 GHz Bands

The following provisions apply for the use of ESVs in the 14-14.5/10.95-11.2 and 11.45-12.2 GHz bands:

1. Minimum Distance

The minimum distance from the baseline, as officially recognized by the coastal State,⁴ beyond which ESVs can operate without the prior agreement of any concerned Administration, as defined above, is 125 km in the 14-14.5 GHz band taking into account the following technical limitations:

	14-14.5 GHz
Tracking accuracy of ESV antenna	±0.2° peak
Maximum ESV e.i.r.p. spectral density toward the horizon	12.5 dB(W/MHz)
Maximum ESV e.i.r.p. toward the horizon	16.3 dBW
Maximum off-axis e.i.r.p. density *	See section C.2 below
Minimum gross tonnage of vessels for ESV operation	None
Minimum angle of antenna elevation	5°**
<p>* In the case that the e.i.r.p. off-axis levels in an FSS intersystem coordination agreement that is applicable to an FSS network with which an ESV will communicate are more stringent than the levels provided below, the ESV will be limited to operating at the more stringent off-axis e.i.r.p. density levels in the relevant FSS intersystem coordination agreement(s). The minimum antenna diameter should be 1.2 meters for 14-14.5 GHz band ESVs unless the ESV meets the off-axis e.i.r.p. density levels provided below and completes any applicable terrestrial agreement with concerned Administrations prior to the commencement of operations.</p> <p>** Upon a showing that the emission path will be seaward and away from land masses or upon a special showing of need for lower angles by the applicant, an Administration's licensing authority will consider authorizing emissions at angles between 3° and 5° in pertinent directions. In certain instances, it may be necessary for the licensing Administration to specify minimum angles greater than 5° because of interference considerations. Even in cases where angles less than 5° are requested, any relevant restrictions on e.i.r.p. and e.i.r.p. density toward the horizon would – i.e., the values from Resolution 902 (WRC-03) – apply.</p>	

Note: Section C.4 below applies with regard to emissions from ESVs within the minimum distances of a concerned Administration.

2. Off-Axis e.i.r.p. Spectral Density Levels

⁴ See note 1.

As agreed in Resolution 902 (WRC-03), CITEL Administrations that do not adopt the stricter limits proposed here, should ensure that the off-axis e.i.r.p. spectral density values do not exceed those permitted under Resolution 902 (WRC-03), Annex 2

For earth stations on board vessels operating in the 14-14.5 GHz band:

- (1) The off-axis e.i.r.p. spectral density for co-polarized signals, emitted from the ESV in the plane of the geostationary satellite orbit as it appears at the particular earth station location (*i.e.*, the plane determined by the focal point of the antenna and the line tangent to the arc of the geostationary satellite orbit at the position of the target satellite), should not exceed the following values:

$15 - 25\log(\theta)$ dBW/4kHz	$1.25^\circ \leq \theta \leq 7.0^\circ$
-6 dBW/4kHz	$7.0^\circ < \theta \leq 9.2^\circ$
$18 - 25\log(\theta)$ dBW/4kHz	$9.2^\circ < \theta \leq 48^\circ$
-24 dBW/4kHz	$48^\circ < \theta \leq 180^\circ$

- (2) In all other directions, the off-axis e.i.r.p. spectral density for co-polarized signals emitted from the ESV should not exceed the following values:

$18 - 25\log(\theta)$ dBW/4kHz	$1.25^\circ \leq \theta \leq 48^\circ$
-24 dBW/4kHz	$48^\circ < \theta \leq 180^\circ$

- (3) For $\theta > 7^\circ$, the values given in paragraph (b)(1) of this Section should not be exceeded by more than 10% of the sidelobes, provided that no individual sidelobe exceeds the criteria given by more than 3 dB.

- (4) In all directions, the off-axis e.i.r.p. spectral density for cross-polarized signals emitted from the ESV should not exceed the following values:

$5 - 25\log(\theta)$ dBW/4kHz	$1.8^\circ \leq \theta \leq 7^\circ$
-16 dBW/4kHz	$7^\circ < \theta \leq 9.2^\circ$

Where θ is the angle in degrees from the axis of the main lobe.

NOTES:

- 1) For non-circular ESV antennas, the major axis of the antenna should be aligned with the tangent to the geostationary satellite orbital arc at the target satellite point, to the extent required to meet specified off-axis e.i.r.p. criteria.
- 2) The foregoing off-axis e.i.r.p. spectral density values are appropriate for a two-degree spacing environment, instead of the three-degree spacing environment that is contemplated for the off-axis e.i.r.p. spectral density values in Resolution 902 (WRC-03).

3. Licensing Provisions for Networks of ESVs Comprised of a Hub Station(s) and One or More Types of ESV Terminals

To the extent that a CITEL Administration seeks to become a licensing Administration for ESVs or to establish on its territory an ESV hub earth stations (including ESV network control facility) for ESVs that

will operate within Region 2, they should ensure compliance with the technical requirements for ESV terminals using either their national regulations or the following provisions:

a) Applications for ESV operation in the 14-14.5 GHz (Earth-to-space) to geostationary satellites in the fixed-satellite service should include, in addition to whatever minimum requirements apply to non-ESV earth station applicants, for each ESV earth station antenna type:

(1) A series of e.i.r.p. density charts or tables, calculated for a production earth station antenna, based on measurements taken on a calibrated antenna range at 14.25 GHz, with the off-axis e.i.r.p. envelope set forth above superimposed, as follows:

- (i) showing off-axis co-polarized e.i.r.p. spectral density in the azimuth plane, for off-axis angles from minus 10° to plus 10° and from minus 180° to plus 180°.
- (ii) showing off-axis co-polarized e.i.r.p. spectral density in the elevation plane, at off-axis angles from 0° to plus 30°.
- (iii) showing off-axis cross-polarized e.i.r.p. spectral density in the azimuth plane, at off-axis angles from minus 10° to plus 10°.
- (iv) showing off-axis cross-polarized e.i.r.p. spectral density in the elevation plane, at off-axis angles from minus 10° to plus 10°.

Or

(2) A series of gain charts or tables, for a production earth station antenna, measured on a calibrated antenna range at 14.25 GHz, with the Earth station antenna gain envelope set forth in Sections (a) and (b) of the Attachment to the Annex superimposed, for the same planes and ranges enumerated in paragraphs (b)(1)(i) through (b)(1)(iv) of this Section, that, combined with input power density, demonstrates that off-axis e.i.r.p. spectral density envelope set forth above will be met.

Or

(3) A certification that the antenna conforms to the gain pattern criteria of Sections (a) and (b) of the Attachment to the Annex that, combined with input power density, demonstrates that the off-axis e.i.r.p. spectral density envelope set forth above will be met.

b) There should be an exhibit included with the application describing the geographic area(s) in which the ESVs will operate.

4. Agreements with concerned Administrations for the use of frequencies by ESVs Operating in the 14.4- 14.5 GHz band

a) Before an ESV commences operation in the 14.4-14.5 MHz (Earth-to-space) band within 125 km from the baseline of a concerned Administration, an ESV licensing Administration should obtain agreement from the concerned Administration, with respect to specific frequencies for ESV use, to protect existing and authorized terrestrial systems. The agreement should be based upon the guidance provided in the ITU-R Recommendations applicable to ESV use, and on mutually agreed criteria. A summary of the principal terms of the agreement should be maintained by and available from the participating Administrations.

- b) The ESV licensing Administration should ensure that ESV terminals automatically cease emissions if the ESV terminal operates in violation of the terms of the agreement referenced in Section C.4(a) above.

D Operational measures to avoid unacceptable interference

1. The CITEL ESV licensing Administration should ensure that ESV stations do not cause unacceptable interference to the services of other Administration members following the provisions described in Sections B and C above.
2. In the event that unacceptable interference occurs, the CITEL ESV licensing Administration should eliminate the source of any interference from its station immediately upon being advised of such interference. For purposes of this provision, the CITEL ESV licensing Administration should identify a point of contact, with phone number and address, available 24 hours a day, seven days a week, with authority and ability to cease all emissions from the ESVs, either directly or through the facilities of a hub earth station through which the ESVs communicate.
3. For each ESV terminal licensed by a CITEL Administration or operating as part of an ESV network using an ESV hub earth station licensed by a CITEL Administration, a record of the ship location (*i.e.*, latitude/longitude), transmit frequency, channel bandwidth and satellite used should be time annotated and maintained by the ESV operator for a period of not less than 1 year. Records should be recorded at time intervals no greater than every 20 minutes while the ESV is transmitting. In the event that harmful interference from an ESV to a fixed service link is suspected, the ESV network operator should make this data available upon request to a coordinator, fixed system operator, fixed-satellite system operator, or the licensing authority within 24 hours of the request.
4. ESV network operators authorized by one CITEL Administration but communicating with vessels registered to another Administration should maintain detailed information on each vessel's country of registry and a point of contact for the relevant Administration responsible for licensing ESVs.

ATTACHMENT TO ANNEX

ANTENNA PERFORMANCE STANDARDS⁵

(a) The gain of any antenna to be employed in emission from an earth station in the geostationary satellite orbit fixed-satellite service (GSO FSS) should lie below the envelope defined as follows:

(1) In the plane of the geostationary satellite orbit as it appears at the particular earth station location:

29 - 25 log ₁₀ (θ) dBi	1° ≤ θ ≤ 7°
+8 dBi	7° < θ ≤ 9.2°
32 - 25 log ₁₀ (θ) dBi	9.2° < θ ≤ 48°
-10 dBi	48° < θ ≤ 180°

Where:

Theta (θ) is the angle in degrees from the axis of the main lobe and dBi refers to dB relative to an isotropic radiator. For the purposes of this section, the peak gain of an individual sidelobe may not exceed the envelope defined above for θ between 1.0 and 7.0 degrees. For θ greater than 7.0 degrees, the envelope may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the gain envelope given above by more than 3 dB.

(2) In all other directions, or in the plane of the horizon including any out-of-plane potential terrestrial interference paths:

Outside the main beam, the gain of the antenna should lie below the envelope defined by:

32 - 25 log ₁₀ (θ) dBi	1° ≤ θ ≤ 48°
-10 dBi	48° < θ ≤ 180°

Where:

θ and dBi are defined above. For the purposes of this section, the envelope may be exceeded by no more than 10% of the sidelobes provided no individual sidelobe exceeds the gain envelope given above by more than 6 dB. The region of the main reflector spillover energy is to be interpreted as a single lobe and shall not exceed the envelope by more than 6 dB.

(b) The off-axis cross-polarization gain of any antenna to be employed in emission from an earth station to a space station in the domestic fixed-satellite service should be defined by:

19 - 25 log ₁₀ (θ) dBi	1.8° < θ ≤ 7°
-2 dBi	7° < θ ≤ 9.2°

⁵ One method for satisfying the ESV off-axis e.i.r.p. density requirements is to provide antenna gain patterns that demonstrate compliance with this Attachment's antenna performance requirements, combined with input power density demonstrating that the ESV off-axis e.i.r.p. spectral density envelope will be met. (See Section B.3 and C.3 above.).