

Source: Document [4/32](#)

Subject: Replacement of Recommendation ITU-R SNG.1710

Document 4/BL/2-E

23 October 2013

English only

Radiocommunication Study Group 4

DRAFT NEW RECOMMENDATION ITU-R S.[GENACC]-0

Access procedures for fixed-satellite service occasional use¹, transmissions to geostationary-satellite orbit space stations, in the 4/6 GHz and 11-12/13/14 GHz FSS bands

Scope

This Recommendation provides access procedures for fixed-satellite service (FSS) occasional use (OU), transmissions to geostationary-satellite orbit space stations, in the 4/6 GHz and 11-12/13/14 GHz FSS bands. An occasional use transmission is a telecommunication application in the fixed-satellite service where the transmission lasts a limited period of time ranging from minutes to months.

The ITU Radiocommunication Assembly,

considering

- a)* that the number of FSS earth stations used for OU carrier transmissions in the 4/6 GHz and 11-12/13/14 GHz FSS bands is increasing;
- b)* that OU transmissions are often characterized by frequent changes in earth station antenna pointing, frequency, power level, polarization sense, carrier bandwidth and modulation technique;
- c)* that the proliferation of the use of OU transmitting earth stations, and their frequent changes in link parameters, has caused an increase in unintentional interference to other satellite users;
- d)* that a procedure for OU carrier transmissions from fixed-satellite service earth stations can reduce the opportunity for unintentional interference to other satellite users;
- e)* that some OU operators may have equipment and operational differences that can result in certain portions of the general procedure in Annex 1 being inapplicable;
- f)* that satellite resources will be more efficiently used if an appropriate access procedure is used,

¹ The term “occasional use” is defined in Annex 1.

recognizing

that RR No. **18.1** states “No transmitting station may be established or operated by a private person or by any enterprise without a license issued in an appropriate form and in conformity with the provisions of the Radio Regulations by or on behalf of the government of the country to which the station in question is subject (however, see Nos. **18.2**, **18.8** and **18.11**)”,

recommends

that operators of OU fixed-satellite service earth stations in the bands listed in *considering a*) and licensed or authorized in an appropriate form to operate by or on behalf of the government of the country where the earth stations are located, should use the general access procedure described in Annex 1 as a basis for more specific and detailed practices that are to be followed when accessing a GSO FSS satellite.

ANNEX 1

Access procedures for fixed-satellite service occasional use, transmissions to geostationary-satellite orbit space stations, in the 4/6 GHz and 11-12/13/14 GHz FSS bands

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1 Introduction

An occasional use transmission is a telecommunication application in the fixed-satellite service where the transmission lasts a limited period of time ranging from minutes to months. These transmissions are not part of those within a geostationary satellite network where earth stations are under the automated control of a central station, such as transmissions within a centrally-managed VSAT network. Occasional use (OU) transmissions are often characterized by frequent changes in earth station antenna pointing, frequency, power level, polarization sense, carrier bandwidth and modulation technique.

A fixed-satellite service earth station under the OU transmissions designation is an earth station that transmits video, audio, and/or data and also has the following characteristics:

- the earth station is used for more than one type of carrier transmission during a one year period; or
- the earth station antenna may move off a space station and back on to a space station between transmissions, or may be stowed and deployed between transmissions, or may be pointed at different space stations during normal use; or
- earth station transmission equipment is replaced or reconfigured as part of normal operations. Reconfiguration would include, but not be limited to, changing frequency, modulation mode, replacing waveguide; or
- the earth station is radiating a carrier for the first time at a particular frequency and/or on a particular geostationary space station; and
- the earth station is not under positive central control, meaning some or all of the following settings are adjusted by the station operator: antenna azimuth, elevation, and polarization, modem frequency, power, and bandwidth, and frequency conversion and amplifier gain.

Satellite news gathering (SNG) and fixed-location teleport earth stations that do not transmit constantly over a multi-year period are two examples of OU earth stations.

The possible changes in link parameters listed above can give rise to unintentional interference due to illumination of the wrong geostationary space station, illumination of adjacent space stations at power density levels that exceed inter-satellite coordination agreements, or illumination of the correct space station at an incorrect frequency, power level, polarization sense, or bandwidth, or with spurious signals. It is the objective of this Recommendation to provide guidance to occasional use earth station operators, geostationary satellite operators and regulators on the avoidance of this unintentional interference.

This Annex defines a General Access Procedure (GAP) for OU earth station operators accessing geostationary space stations operating in the fixed-satellite service (FSS) frequency bands. While equipment configuration or operational conditions may in some instances limit the applicability of the procedure and require augmentation with more detail, careful attention in making use of the applicable portions of the GAP should significantly reduce the possibility of unacceptable interference to other satellite users.

The access procedure described in this document is not intended to apply to the normal operation of networks that have transmitting earth stations under the control of a centralized access management and control system after initial commissioning.

This document, and the procedures contained within, assumes that readers and operators have been trained on basic satellite communication systems. This document is intended to provide some easy-to-follow practices to enable OU operators to transmit to geostationary space stations without interfering with other users on the target satellite or with users on any other nearby satellites.

2 Definitions

The following definitions apply throughout this document.

Access	Method by which transmission to a geostationary satellite is established.
CW	Continuous Wave, an un-modulated RF transmission.
DSNG	Digital Satellite News Gathering.
FEC	Forward Error Correction. A method for correcting transmissions errors at the receive site.
FM	Frequency Modulation.
FSS frequency bands	For the purpose of this document, the following is a list of frequency bands allocated to the FSS and used by geostationary satellite networks: <ul style="list-style-type: none">– 4/6 GHz (widely referred as C-band);– 11-12/13/14 GHz (widely referred as Ku-band).
GAP	General Access Procedure: this refers to the entire contents of this Annex.
GPS	Global Positioning System: a satellite based system that provides location information.
GSM	Global System for Mobile Communications. Standard for 2G cellular mobile communications.
IF	Intermediate Frequency. Frequency range used at satellite earth stations to route signals between components, e.g., between modulators and upconverters, between downconverters and demodulators. The most common IF frequencies used are 70 MHz, 140 MHz, L-band (from 950 MHz to 2 200 MHz).
OU	Occasional Use (OU) refers to satellite ground facilities and satellite transponder bandwidth, purchased or utilized on a temporary or as-needed basis. Typically these resources are offered beginning in 5 minute segments, progressing up to multiple hours, days, weeks or even months, and used for non-fulltime and/or short-duration transmissions. Transmissions within a geostationary-satellite orbit FSS network where earth stations are under the automated control of a central station, such as transmissions within a centrally-managed VSAT network, are not considered OU transmissions for the purposes of this Recommendation. OU services are generally utilized in cases such as disasters, breaking news events, sport or entertainment events, or other transmission requirements that may require facilities and satellite capacity to accommodate a short term need. OU services are typically made available by satellite owner/operators as well as resellers who maintain facilities and transponder capacity to supply end-users requiring these services.
SAC	Satellite Access Center: an organization responsible for the coordinated access to satellite space segment. This organization can be managed by the satellite operator or by another organization approved by the satellite operator for this function.

SFD	Saturation Flux Density: the carrier power density required to saturate a transponder.
SNG	Satellite News Gathering.
UTC	Coordinated Universal Time: primary time standard by which the world regulates clocks and time.

3 Equipment selection

Where applicable, all equipment used for OU satellite access should comply with the following ITU-R Recommendations:

ITU-R S.465 – Reference radiation pattern of earth station antennas in the fixed-satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz.

ITU-R S.524 – Maximum permissible levels of off-axis e.i.r.p. density from earth stations in geostationary-satellite orbit networks operating in the fixed-satellite service transmitting in the 6 GHz, 13 GHz, 14 GHz and 30 GHz frequency bands.

ITU-R S.731 – Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz.

It is particularly important that earth station antenna systems have the performance and size consistent with the calculated link budgets to minimize interference to/from adjacent geostationary satellites. Further, the use of the earth stations must be in compliance with domestic regulations, terrestrial coordination requirements as well as inter-satellite coordination agreements with geostationary and non-geostationary satellites applicable to the specific FSS allocated band, in which the earth station operates, and technical specifications and operational limits imposed by the satellite operator.

Whenever possible, a spectrum analyzer that is capable of monitoring signals throughout the uplink and downlink path should be available.

4 Procedures

Any geostationary satellite access requires four primary parameters to be correctly configured: earth station antenna alignment, including transmit polarizer settings, if applicable; frequency, modulation, and bandwidth settings; time of transmission; and power level. All four of these basic parameters need to be correctly calibrated and set prior to access in order to ensure that unacceptable interference is not caused to another geostationary satellite operator or user.

4.1 General OU access procedure

The following procedure should be considered as a minimum sequence of actions to be taken before any satellite access occurs.

With the understanding that the station is appropriately licensed or authorized to operate in the country where it has been deployed, the first step in the procedure involves making sure the transmission parameters are correct. There are some frequency ranges that are restricted to specific geographic locations. The satellite operators are very aware of any restrictions imposed on shared frequency transmissions. Therefore, all transmission parameters should already be verified by the satellite access center prior to transmitting.

4.1.1 Understand the parameters of the transmission

- Have all of the following information readily available before proceeding – it will be needed when contacting the satellite operator or Satellite Access Center (SAC).
- Know the name of the uplink earth station operator, phone number, company, earth station registration code if applicable, technical contact, satellite, frequency/transponder/polarization, assigned transmission time, expected power level.
- Prepare a link budget or use transmission parameters as approved by the satellite operators. Link budget tools are available online or through the satellite operators or SACs. There is also a chart in Attachment 1 that may be used to estimate the appropriate power requirement based on bandwidth and antenna size. In all cases, the satellite operator should confirm the transmission parameters to ensure that the allocated transponder power and bandwidth are not exceeded and are in compliance with regulatory and coordination limits.

4.1.2 Ensure equipment and cabling are functioning

- Verify that the equipment is functioning as designed – the earth station antenna is not dented, soiled, or covered with ice or snow; cable terminations are clean and secure; unused RF inputs should have terminators installed; waveguides are not cracked and do not contain water; waveguide pressurizer/dehydrator is working properly and is not indicating abnormally high leakage.
- All transmitting equipment is operating normally, but with the final stage either muted or connected to non-radiating RF termination (dummy load).
- Modulator is set to CW mode.
- Equipment is switched on and warmed up for at least fifteen (15) minutes before the start of testing. The SAC may request that testing begin up to 10 minutes prior to booked time slot.

4.1.3 Setup for transmission

- Ensure an unobstructed line-of-sight from the earth station to the geostationary satellite – no buildings, trees, power lines, etc. between the earth station and the line of sight to the satellite(s) to be used with adequate radial clearance.
- All applicable safety requirements and guidelines, as determined by a regulatory body, the satellite operator, the SAC, and/or the OU operator, for RF transmissions should be adhered to.
- Ensure the earth station antenna is secure, stable, and isolated from vehicle suspension motion, such as by means of jacks, outriggers, and limiting personnel access.
- Accurately point the transmitting earth station antenna on a satellite beacon or known traffic carrier found on the downlink signal from the correct geostationary satellite (see antenna pointing and cross-pol below).
- Activate carrier ID on the modulator, the encoder, or a carrier ID embedder, if available.
- Set polarity or cross-pol, if linear polarity (see antenna pointing and cross-pol below).
- Set center frequency, modulation, and bandwidth settings.
- Be ready at the correct time of day, as scheduled with the satellite operator. This means to be ready up to 10 minutes prior to booked time slot, in case the space segment is available and the operator authorizes early access.

- Except for the last device, set the appropriate power level, as discussed in section 4.4.3, for all equipment that includes an adjustable power control. The last device with adjustable power control should be set to minimum power.

4.1.4 Transmit with permission only

- Earth station operator should not proceed with any transmissions, without authorization/license issued by or on behalf of the government of the country where the earth stations are deployed or operated.
- In systems that do not have central control of transmission (non-closed systems), call the appropriate SAC – if the SAC cannot be contacted, the earth station operator should not proceed with any transmissions.
- Verbally or electronically confirm the uplink polarity, frequency, and bandwidth that will be used before transmitting – the SAC will verify that the parameters are correct.
- Set the frequency and bandwidth for the test transmission. This may be at the normal service frequency or at a special test frequency assigned by the SAC, and it may initially be a CW transmission.
- Enable the earth station transmission to the geostationary satellite only when authorized by the SAC.
- Set power levels only as authorized by the SAC– signal distortion and/or transponder intermodulation interference will occur if inter-device or uplink power levels are set too high.
- Adjust transmit antenna pointing and polarization only as authorized and instructed by the SAC (note however that small antennas can generally be more accurately pointed with receive balancing than transmit peaking).
- Change modulator from CW to Modulate only when authorized by the SAC.
- Contact the SAC to end transmission on time or when instructed by the SAC – if more time is needed, contact the SAC as soon as possible and do not extend transmission time unless a confirmation of the extension is obtained prior to the end of the originally scheduled end transmission time.
- The SAC will provide detailed peaking instructions to ensure proper alignment of the antenna and its polarizer, if it has one. In general the polarizer for the transmit earth station is adjusted so as to reduce the interference onto geostationary satellite transponders operating with the opposite polarization on the satellite. The final position of the polarizer may not be the same as the polarization setting used to obtain the lowest received cross-pol signal from a beacon or another carrier on the same satellite using the same transmit antenna.
- Any instructions issued from the SAC must be adhered to immediately and completely.

4.2 Pre-transmission antenna pointing and cross-polarization alignment

Do not manually move an earth station antenna while transmitting. An auto-tracking antenna controller, however, when functioning properly, may move an antenna while transmitting.

- If possible, peaking of the earth station antenna should occur while the satellite is in the center of its station-keeping box if the transmit antenna used is fixed or will be operated with a non-tracking controller, otherwise peaking can be done at any time and tracking enabled to make sure that the earth station antenna stays peaked on the satellite at all times.

- Use online calculators or other information provided by the geostationary satellite operators to determine the satellite centre-of-box timing information as well as look angles for the particular earth station uplink site that will be used.
- If the earth station antenna has an active and functioning satellite tracking system ensure it is disabled before peaking the antenna.
- Preset the polarization - if using linear polarization, rotate the feed by the satellite's polarization angle as viewed from the specific earth station site in the correct rotation direction, taking into account if the site longitude is east or west of the satellite, and adding 90 degrees if necessary to account for horizontal vs. vertical downlink. This setting should result in minimizing the noise floor in between transponders, because the center frequency of a transponder on one polarity often, but not always, falls within the guard band between two other transponders on the other polarity. Under no circumstances should polarization be adjusted solely by maximizing the strength of a received signal.
- Ensure that the earth station antenna is pointed at the correct geostationary satellite by comparing the satellite's spectral signature for the transponder to be accessed and/or others near it, to that which is provided by the geostationary satellite operator or by making sure that the beacon frequencies and their polarizations observed on the spectrum analyzer match the information provided by the satellite operator, or by decoding known signals. Use of more than one technique for satellite identification is recommended wherever feasible.
- Antenna pointing:
 - i) If available, use a spectrum analyzer to monitor the geostationary satellite downlink signal level. Tuning the spectrum analyzer to the satellite beacon is typically preferred; however, any stable, continuous downlink carrier may be monitored on the spectrum analyzer for pointing purposes. Choose a signal and spectrum analyzer bandwidth and averaging settings which result in at least 6 dB (preferably at least 10 dB) carrier-to-noise ratio and low variance in level readings at beam center. Alternatively, use a signal meter with positive carrier identification and C/N readout and choose a signal that results in at least 6 dB margin to loss-of-lock at beam center.
 - ii) When the correct signal is identified, perform an initial peaking by adjusting azimuth and elevation for maximum received level. Ensure that you are not peaking the signal on an antenna sidelobe. (As the earth station antenna is moved from beam center on a single axis, there should be three different RF maxima, or peaks, at different antenna pointing locations. The earth station antenna main lobe can be found at the location between the first and third peak and will be of higher amplitude relative to the side lobes.) For each axis, find the position of the peak amplitude on the antenna by maximizing the received carrier signal level found in the main lobe of the antenna.
 - iii) For large antennas, accurate final pointing may be performed by very carefully maximising the signal level while making fine azimuth and elevation adjustments. However, if the antenna diameter is 1.5 meters or less (Ku-band) or 3.8 meters or less (C-band) simple peaking will not result in pointing that is sufficiently accurate to minimize adjacent satellite interference. In these cases, the beam must be centered by equalizing the reduction of signal strength for equal angular adjustment on each side. (This technique is commonly described as "beam balance" or "dithering.") During this process the signal should be

dropped by at least 6 dB on each side, and then centered, for both azimuth and elevation. In addition, if the antenna mechanism has more than 0.05 degrees hysteresis (backlash), the procedure must always be performed in the same direction, after resetting the hysteresis by sufficient reversal of direction. Training programs such as provided by the Global VSAT Forum give instruction in beam-balance pointing technique.

- If the earth station antenna has an active and functioning satellite tracking system, peaked settings should be saved and recorded before re-enabling tracking.

If using linear polarization, and a spectrum analyzer is available, confirm the polarization adjustment by making minor adjustments to minimize the noise floor in between transponders. The center frequency of a transponder on one polarity sometimes falls within the guard band between two other transponders on the other polarity.

In that case, during cross-pol adjustments the signal level should be maximized on one polarity and minimized on the other at a particular center frequency. If in doubt, confirmation of the correct frequency to be used should be obtained from the SAC.

After the polarization has been preset and the antenna has been pointed, contact the SAC to arrange for uplink cross-pol testing and access. The SAC will generally ask you to bring up a CW carrier starting at a low level on a specific test frequency. During the test, never exceed the level authorized by the SAC. During uplink cross-pol testing, the cross-pol alignment of the transmit signal will be checked by the SAC, and fine polarization adjustment may be required. The SAC may also ask you to peak the signal with azimuth and elevation. If using a small antenna (as defined above) and you have performed an accurate beam centering (balancing or dithering) then advise the SAC that accurate antenna pointing has already been performed more accurately than can generally be ascertained by observation of signal strength at the SAC. Nevertheless, always follow the directions from the SAC.

After uplink cross-pol testing is complete, the SAC will authorize access on the assigned uplink frequency. The SAC will generally require the carrier to be initiated at a low level and increased gradually until the SAC observes it at the correct level in the transponder. In some cases, the SAC may request that the carrier be initiated CW and then modulation turned on once it has been measured at the SAC. If the uplink cross-pol test was made on the opposite polarity than the access uplink, switch to the opposite-polarity feed port or rotate the feed by 90 degrees with at least 1 degree precision. In all cases, follow the SAC directions regarding power level, modulation, and frequency.

4.2.1 Inclined satellites

Because inclined satellites are not stationary, getting and staying peaked on an inclined satellite requires additional skill and the proper equipment. Operators should be properly trained before transmitting to an inclined satellite. Use of an earth station antenna controller that has the ability to track satellites using the 11 ephemeris parameter set, the 2 line NORAD element set, and/or a beacon receiver is preferable whenever possible. In such case, make sure the input to the beacon receiver does not saturate this receiver, so that any drop in signal level is detectable.

There are occasions when transmitting to an inclined satellite without the use of a tracking-enabled antenna controller can be successfully accomplished. Those occasions occur when the motion of the satellite through the earth station antenna main lobe is sufficiently slow and of sufficiently low angular motion as not to require re-pointing during a short transmission. For this to occur, the antenna must be peaked immediately before the transmission is to take place. The width of the antenna main lobe and the inclination angle of the satellite will determine the time required before the antenna must be manually repositioned.

4.3 Avoiding retransmission of nearby RF signals

Retransmission of local terrestrial signals (such as FM, GSM, Wi-Fi, wireless devices) may occur if terrestrial signals are coupled into the earth station uplink equipment due to insufficient shielding, incorrect connector attachment, or inadequate care during installation. The frequency ranges and equipment interconnect points that are most commonly susceptible to retransmissions are those in the IF range and interconnects between the modulator and the upconverter. It is important that good electrical grounding, properly shielded cable, proper connectors and attachment methods, proper terminations on unused equipment inputs, and frequency band blocks or filters as required, are used on all transmission systems. Wireless devices, including cell and cordless phones, wireless computer networks should not be used inside the transmit earth station RF equipment room.

4.4 Additional considerations for fixed earth stations

If any sort of earth station antenna movement or maintenance is conducted, then re-pointing the antenna is critical. Earth station antenna alignment should be checked periodically, especially after an earthquake, severe weather, satellite repositioning, significant electrical event, or other major event that could affect the antenna positioning.

4.4.1 Modulation settings

Digital modulators have a number of modulation settings that must be configured. The primary ones are: center frequency, modulation type, bit rate, symbol rate, bandwidth, scrambling, FEC, and roll off. Analog modulators primary settings are: center frequency deviation, energy dispersal settings, and sub carriers. Regardless of the type of transmission, ensure that the modulator is in CW mode with RF output muted before accessing the satellite. Make sure the modulator bandwidth settings are correct so that the bandwidth occupied when modulation is activated is equal to or less than that which is allocated.

4.4.2 Time of day

Assigned start and end booking times for a transmission should be confirmed in UTC. The transmission should be planned to fall within the time booked. If, for whatever reason, the transmission time is going to change, then the SAC or satellite capacity provider must be notified in advance and provide a verbal or electronic confirmation of the time change(s) as soon as possible to minimize disruptions to other users. If possible, cease transmission 30 seconds or more prior to the end of the booked transmission window in the event there is additional traffic that is planned for the following adjacent time slot.

4.4.3 Power levels

The amount of power required to successfully fulfill a transmission requirement should be estimated by means of a link budget. The link budget is calculated based on modulation type, frequency band, bandwidth, amplifier to antenna loss, antenna gain, atmospheric loss, satellite gain, downlink losses, and receiver sensitivity. Power level adjustment can be made at the modulator, the upconverter, and the amplifier. Each device should be adjusted properly by trained/certified personnel so that there are no spurious signals, intermodulation products, or spectral regrowth. When properly set, transmit spectral regrowth and intermodulation products are kept to a minimum. As a rule of thumb, the High Power Amplifier (HPA) should be operated with at least 3 dB (single carrier) and 8 dB (multiple carrier aggregate power) output backoff from the maximum output power rating of the HPA, unless an engineering analysis supports higher operating levels while remaining within distortion specifications for the transmission plan. Any power adjustments should be accomplished using only the HPA, unless the HPA has a fixed gain, and under the instruction of the SAC during the initial level setting and at any time later on during normal

operation. This includes any planned redundancy changes. In general all redundant devices should be adjusted at the time of the initial service activation so as to ensure that the transmitted signal level between all redundant chains remains within ± 0.5 dB. The satellite operator determines the final carrier level.

There is also a chart in Attachment 1 that may be used to estimate the typical power requirement based on bandwidth and antenna size. Note that it is provided as reference general example and may not apply to every use scenario.

4.5 Additional considerations for transportable earth stations

It is critical to ensure that transportable earth stations are physically secured, level, and as stable as possible during the entire transmission. Transmission from long bridges, during high winds, and other phenomena that might move the earth station should be avoided. Also ensure that any pedestrian traffic remains clear from the path of the RF beam.

4.6 Determining location of the earth station and the satellite

The first step involved with earth station antenna pointing is to determine the location of the transportable earth station and the pointing angles needed to find the geostationary satellite. GPS systems make the determination of the location much easier. Determining the pointing angles for the earth station antenna depends on physical factors, such as how level the ground is and the direction the vehicle is parked. Magnetic compass readings may need to be adjusted to true north based on the current location's magnetic declination. Some antenna controllers will take these readings into account, yet it is important to be aware of possible pointing angle calculation errors. Therefore, finding the correct satellite and accurately pointing the earth station antenna using the methods above is extremely important.

4.7 Additional considerations for auto deploy earth stations

Auto deploy earth stations are a subset of transportable earth stations that automatically determine the location of the earth station, find a known satellite, and calibrate themselves so that earth station antenna pointing does not require manual peaking. However, it is still essential to conduct a manual check and ensure the antenna is pointed at the correct satellite before transmitting. In addition, unless the earth station has been certified or type accepted to automatically point and align its polarization with sufficient accuracy to meet all requirements, the operator should confirm accurate azimuth and elevation pointing using the methods above, and perform an uplink cross-pol check with the SAC.

Like any transportable earth station, it is critical to ensure that auto deploy earth stations are level or adjusted for non-level mounting (when the system does not or cannot automatically handle non-level mounting), and physically secured during the entire transmission, which also includes ensuring any pedestrian traffic and cars/trucks or any moving or fixed objects remains clear from the path of the RF beam.

Transmission from long bridges, during high winds, and other phenomenon that might move the earth station must be avoided. The system should be checked, before transmission begins, to verify that the antenna is pointed in the same direction that the satellite would be – towards the equator.

It is expected that this type of system would be software controlled and that the implementation would ensure the GAP is adhered to. Safety considerations are paramount and all automated system checks must incorporate user guidance.

With auto deploy systems, it is still necessary to contact the SAC before accessing the satellite, and to follow the GAP, to ensure that the antenna and service are correctly setup.

ATTACHMENT 1 TO ANNEX 1

Guidelines for power requirements for earth stations

The following table provides typical power requirements for earth stations that transmit carriers with the identified bandwidth and antenna size to a typical satellite. Please note that the entries in the following table are only guidelines and the actual power employed should be verified through a suitable link budget calculation and in cooperation with the satellite access center. Specific power levels depend on transmission path losses (including atmospheric), the gain of the antenna at the user location, the sensitivity of the satellite, the transponder gain setting, the power output of the satellite, the frequency, the modulation, the bandwidth, and the counterpart receiving station characteristics.

Estimated HPA power (in Watts, per carrier) for earth stations with an antenna of specified diameter								
	13-14 GHz FSS band						6 GHz FSS band	
Antenna diameter	1.2 m	1.8 m	2.4 m	3 m	3.8 m	4.5 m	3.8 m	4.5 m
Carrier bandwidth								
3 MHz	18.5	8.2	4.6	3.0	1.8	1.3	18.4	13.2
6 MHz	36.9	16.4	9.2	5.9	3.7	2.6	36.8	26.4
9 MHz	55.4	24.6	13.8	8.9	5.5	3.9	55.2	39.6
12 MHz	73.8	32.8	18.4	11.8	7.4	5.2	73.6	52.8
18 MHz	110.7	49.2	27.6	17.7	11.0	7.9	110.4	79.2
24 MHz	147.6	65.6	36.8	23.6	14.7	10.5	147.2	105.6
36 MHz	221.4	98.4	55.2	35.4	22.1	15.7	220.8	158.4
36 MHz (saturated)	Note 2	Note 2	276.7	177.4	110.7	78.8	1 106.6	793.9

NOTES:

- 1) Total GSO space station transponder bandwidth of 36 MHz with a 3 dB loss from the HPA to the antenna flange.
- 2) Power output exceeds maximum uplink power limits.
- 3) A link budget analysis must be conducted for every transmission.
- 4) The saturation flux-density (SFD) is referenced to the uplink geographical locations.
- 5) This table is not to be used as a reference to downsize the earth station transmit antenna without seeking the permission from the satellite operator. Severe interference to adjacent GSO satellites may occur if the satellite operator is not contacted and requested to evaluate any earth station transmit antenna downsizing (note the required increase to the flange power so as to keep the signal level constant on the satellite).
- 6) Analysis of off-axis e.i.r.p. spectral density as a function of maximum allowed transmit power, bandwidth, and antenna size and pattern characteristics must be conducted to ensure compliance with all applicable regulations and satellite operator requirements.

