TECHNICAL BASIS for REGULATION

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Satellite Earth Stations and Systems (SES); Satellite News Gathering (SNG) Transportable Earth Stations (TES) operating in the 11-12/13-14 GHz frequency bands

ETSI

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Foreword

This draft Technical Basis for Regulation (TBR) has been produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for Public Enquiry.

Introduction

The Council Directive in respect of satellite earth station equipment (93/97/EEC) [1] which supplements the Council Directive on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity (91/263/EEC) [2] concerns the harmonisation of conditions for the placing on the market of such equipment.

Two classes of standards are applicable to satellite earth station equipment. European Telecommunication Standards (ETSs) give the full technical specifications for this equipment, whereas Technical Bases for Regulation (TBRs) give the essential requirements under the Satellite Earth Station Directive (93/97/EEC) [1] and the Telecommunications Terminal Equipment Directive (91/263/EEC) [2] for placing such equipment on the market. Receive-only equipment, not intended for terrestrial connection to the public telecommunications network, may be put into use. Nothing in this TBR is construed to prevent the use of Community internal production control procedures as set out in the annexes to the two Directives for such receive-only equipment. This TBR is based on ETS 300 327 (see annex B, bibliography).

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1 Scope

This TBR specifies those technical requirements under Articles 4.1 to 4.5 of Council Directive 93/97/EEC [1] that apply to satellite earth station equipment that is capable of operation in one or more of the following frequency ranges:

- 10,70 to 11,70 GHz (Space - to - Earth, shared);
- 12,50 to 12,75 GHz (Space - to - Earth, exclusive);
- 12,75 to 13,25 GHz (Earth - to - Space, shared);
- 13,75 to 14,25 GHz (Earth - to - Space, exclusive);
- 14,25 to 14,50 GHz (Earth - to - Space, shared);

of the Fixed Satellite Service (FSS).

These requirements are taken from: ETS 300 327 (see annex B, bibliography).

This TBR does not contain the essential requirements under article 4.6 for interworking via the public telecommunications network in justified cases, and does not provide any guarantee of correct interworking between satellite earth station equipment.

This TBR specifies the requirements for satellite earth station equipment that:

- is capable of being used either for transmission only, or for transmission and reception (transmit-receive), or for reception only (receive-only), of radio-communications signals in any of the bands specified above;

- is not within the scope of other Ku-band TBRs (TVRO, VSAT, LMES);

- has a diameter of 5,0 m or less;

- is not purpose built satellite earth station equipment intended for use as part of the public telecommunications network.

This TBR applies to all satellite equipment as described above, irrespective of whether the satellite earth station equipment provides additional interfaces, telecommunications services or functions. However additional TBRs may also apply.

2 Normative references

This TBR incorporates by dated or undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of any of these publications apply to this TBR only when incorporated into it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] Council Directive 93/97/EEC (1993) supplementing Directive 91/263/EEC in respect of satellite earth station equipment.

[2] Council Directive 91/263/EEC (1991) on the approximation of the laws of Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity.

[3] prETS 300 673 (1996): "Radio Equipment and Systems (RES); Electromagnetic Compatibility standard for 4/6 GHz and 11/12/14 GHz Very Small Aperture Terminal (VSAT) equipment and 11/12/13/14 GHz Satellite News Gathering (SNG) Transportable Earth Stations (TES) equipment".

NOTE: This TBR also contains a number of informative references which have been included to indicate the sources from which various material has been derived, hence they do not have an associated normative reference number. Details of these publications are given in annex B (bibliography).

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this TBR, the following definitions apply:

carrier-off: That state where the equipment is electrically powered and the transmit sub-system is not switched to the antenna.

carrier-on: That state where the equipment is transmitting at the normal operating EIRP.

cross polarisation discrimination: The ratio of the on-axis co-polar gain to the cross-polar gain in a given direction, at a transmit or receive frequency. It is usually expressed in dB.

nominated bandwidth: The bandwidth of the SNG TES radio frequency transmission is nominated by the manufacturer. The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified spurious radiation limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. The nominated bandwidth is within the transmit frequency band within which the SNG TES operates.

Satellite News Gathering (SNG) TES: Equipment capable of transmitting television signals and associated audio or programme audio only towards a satellite positioned on the geostationary orbit. The modulation method may be either analogue or digital. Such transmissions are point-to-point or point-to-multipoint but not for general broadcast reception.

The SNG TES usually comprises seven main parts, which are defined below, and all power, interconnecting and other cables required for proper operation of the equipment as follows:

1) the antenna sub-system, which converts the incident electromagnetic wave into a guided wave and vice versa and which includes any mounting that may be required;

2) the transmit sub-system, which is composed of the frequency translation equipment and the high power amplifier;

3) the receive sub-system, which consists of the low noise amplifier and the frequency translation equipment;

4) the ground communications sub-system, which consists of user defined modulation and demodulation, either analogue or digital, and associated baseband equipment;

5) the monitoring and control sub-system which consists of user defined test equipment together with a transmitter identification system and a facility for two way communication for control purposes if required;

6) the power sub-system, which consists of any power generation equipment that may be required;

7) the transportation sub-system, which consists of either a vehicle for vehicle mounted SNG TES or flight cases for "flyaway" SNG TES.

spurious radiation: Any radiation outside the nominated bandwidth.

Transportable Earth Station (TES): An earth station that can be relocated at any time to a different fixed operating location but is not intended to operate during the relocation period.

A TES does not operate in any of the Mobile Satellite Services (MSS), e.g. LMSS (Land), AMSS (Aeronautical) and MMSS (Maritime). These are referred to as Mobile Earth Stations (MES).

3.2 Abbreviations

For the purposes of this TBR, the following abbreviations apply:

AMSS	Aeronautical Mobile Satellite Services
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
ETS	European Telecommunication Standard
EUT	Equipment Under Test
FSS	Fixed Satellite Service
LMES	Land Mobile Earth Station
LMSS	Land Mobile Satellite Services
MES	Mobile Earth Station
MMSS	Maritime Mobile Satellite Services
MSS	Mobile Satellite Services
SNG	Satellite News Gathering
TBR	Technical Basis for Regulation
TES	Transportable Earth Station
TVRO	TeleVision Receive-Only
VSAT	Very Small Aperture Terminal

4 Requirements

4.1 Off-axis EIRP density

4.1.1 Justification

Protection of other satellite and terrestrial systems.

4.1.2 Specification

The off-axis EIRP in any 40 kHz band within the nominated bandwidth in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$33 - 25 \log \phi$	dBW	where	$2{,}5° \le \phi \le 7{,}0°$
+12	dBW	where	$7{,}0° < \phi \le 9{,}2°$
$36 - 25 \log \phi$	dBW	where	$9{,}2° < \phi \le 48°$
- 6	dBW	where	$48{,}0° < \phi \le 180°$

In addition the cross-polarised component in any direction ϕ degrees from the antenna main beam axis shall not exceed the following limits:

$23 - 25 \log \phi$	dBW	where	$2{,}5° \le \phi \le 7{,}0°$
+2	dBW	where	$7{,}0° < \phi \le 9{,}2°$

4.1.3 Conformance tests

Conformance tests shall be carried out as per subclause 5.1.1 with the results being computed in accordance with subclause 5.1.2.

4.2 Off-axis spurious radiation

4.2.1 Justification

Protection of other terrestrial and satellite radio services.

4.2.2 Specification

1) The spurious radiation over the frequency range from 30 MHz to 960 MHz shall not exceed limits in table 1.

Table 1: Spurious radiation limits below 960 MHz

Frequency range MHz	Quasi-peak limits dBµV/m
30 to 230	30
230 to 960	37

The lower limits shall apply at the transition frequency.

2) For the carrier-off state, the off-axis spurious EIRP from the SNG TES, in any 100 kHz band, shall be not exceed the limits given in table 2, for all off-axis angles greater than 7°:

Table 2: Limits of spurious EIRP with carrier-off

Frequency range (GHz)	EIRP (dBpW)
0,96 - 10,7	48
10,7 - 21,2	54
21,2 - 40,0	60

The lower limits shall apply at the transition frequencies.

3) For the carrier-on state, the off-axis spurious EIRP from the SNG TES, shall be not exceed the limits given in table 3, for all off-axis angles greater than 7°:

Table 3: Limits of spurious EIRP with carrier-on

Frequency range (GHz)	Measurement bandwidth	EIRP (dBpW)
0,96 - 3,40	100 kHz	49
3,40 - 10,7	100 kHz	55
10,7 - 11,7	100 kHz	61
11,7 - 21,2	100 kHz	78
21,2 - 25,5	100 kHz	67
25,5 - 29,0	20 MHz	78
29,0 - 40,0	100 kHz	67

The lower limits shall apply at the transition frequency.

In the frequency band from 25,5 GHz to 29,0 GHz, for any 20 MHz band within which more than one discrete spurious signal is present, then the powers of each of these spurii shall be added in watts and the total shall not exceed the specified limit.

4) The limits in specifications 1) to 3) above are applicable to the complete SNG TES equipment.

4.2.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.2.

4.3 On-axis spurious radiation

4.3.1 Justification

To limit the level of interference to satellite radio services.

4.3.2 Specification:

In the transmit band outside the transmit carrier nominated bandwidth the EIRP spectral density of the spurious radiation, but excluding the multi-carrier intermodulation products due to earth station non-linearities, shall not exceed 4 dBW in any 4 kHz band.

The on-axis spurious radiation outside the transmit band is limited to the specification given in subclause 4.2 by taking into account the on-axis antenna gain.

NOTE: Intermodulation and spectral density limits due to intermodulation products inside the transmit band are to be determined by system design, subject to satellite operator specifications.

4.3.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.3.

4.4 Transmit antenna polarisation discrimination

4.4.1 Justification

Protection of signals on the orthogonal polarisation.

4.4.2 Specification

4.4.2.1 -1 dB contour

The polarisation discrimination of the antenna system in the transmit frequency band shall exceed 28 dB within the -1 dB contour of the main beam.

NOTE: Some satellite operators may require a higher ratio.

4.4.2.2 -10 dB contour

The polarisation discrimination of the antenna system in the transmit frequency band shall exceed 25 dB within the -10 dB contour of the main beam.

NOTE: Some satellite operators may require a higher ratio.

4.4.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.4.

4.5 ElectroMagnetic Compatibility (EMC)

There are no specific EMC requirements under this TBR however ETS 300 673 [3] contains the EMC requirements for SNG TESs.

4.6 Pointing accuracy and stability

4.6.1 Justification

Protection of signals to and from both the same and adjacent satellites.

4.6.2 Specification

a) The SNG TES shall not show any sign of distortion and the pointing shall not need adjustment whilst being used in a wind speed which is less than that specified by the manufacturer at which the antenna shall be stowed.

b) The antenna mount shall allow the position of the antenna transmit main beam axis to be maintained with an accuracy better than the antenna 3 dB off-axis angle, at any frequency in the equipment operating band, over the full range of azimuth and elevation movement available to the antenna.

c) It shall be possible for the antenna polarisation angle to be fixed to an accuracy of better than ± 1° over a total range of at least 180°.

d) The SNG TES shall not show any sign of distortion and the polarisation shall not need realignment whilst being used in a wind speed which is under that specified by the manufacturer at which the antenna shall be stowed nor from any accidental mechanical action.

4.6.3 Conformance tests

Conformance tests shall be carried out in accordance with subclause 5.5.

5 Test methods

The values of measurement uncertainty associated with each measurement parameter apply to all of the test cases described in this TBR. The measurement uncertainties shall not exceed the values shown in table 4.

Table 4: Measurement uncertainty

Measurement parameter	Uncertainty
RF frequency	± 10 kHz
RF power	± 0,75 dB
Conducted spurious	± 4 dB
Radiated spurious	± 4 dB
Antenna gain	± 2 dB
Polarisation discrimination	± 2 dB

All technical characteristics and operational conditions declared by the manufacturer shall be entered in the test report.

5.1 Off-axis EIRP density

5.1.1 Test method

Conformance shall be determined from:

a) measurement of maximum RF power density entering the antenna feed for the different modulation schemes declared by the manufacturer;

b) measurement of transmit antenna gain pattern.

To ascertain the off-axis EIRP it is necessary to know the transmit power density and antenna transmit radiation pattern. To ascertain the radiation pattern it is necessary to know the antenna transmit gain.

The following three measurement procedures shall, therefore, be performed:

procedure a) transmitter output power density (dBW/40 kHz);
procedure b) antenna transmit gain (dBi);
procedure c) antenna transmit radiation patterns (dBi).

5.1.1.1 Transmitter output power density

For the purposes of this TBR, transmitter output power is defined as the maximum power delivered by the transmitting equipment to the antenna flange.

For the purposes of this test the EUT is defined as the SNG TES excluding the antenna from the antenna flange.

5.1.1.1.1 Test site

There are no requirements for the test site to be used for this test.

5.1.1.1.2 Method of measurement

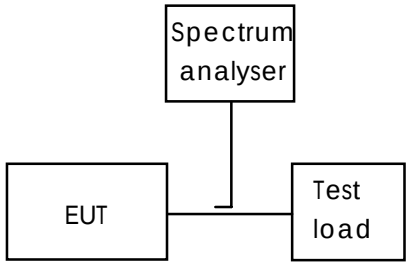

Figure 1: Test arrangement - transmit output power density measurement

a) The EUT shall be connected to a test load as shown in figure 1.

b) With the carrier being modulated, the maximum power supplied to the antenna flange shall be measured in dBW/40 kHz. The coupling factor of the test coupler at the test frequency and the attenuation of any necessary waveguide adapter shall be taken into account. The resolution bandwidth of the spectrum analyser shall be set as close as possible to the specified measuring bandwidth. If the resolution bandwidth is different from the specified bandwidth then bandwidth correction shall be performed.

5.1.1.2 Antenna transmit gain

5.1.1.2.1 General

For the purposes of this TBR, the antenna transmit gain is defined as the ratio, expressed in decibels (dB), of the power that would have to be supplied to the reference antenna, i.e. an isotropic radiator isolated in space, to the power supplied to the antenna being considered, so that they produce the same field strength at the same distance in the same direction. Unless otherwise specified the gain is for the direction of maximum radiation.

For the purposes of this test the EUT is defined as that part of the SNG TES which comprises the antenna and its flange. The antenna includes the reflector(s), feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point.

5.1.1.2.2 Test site

This test shall be performed on either an outdoor far-field test site or compact test range. However if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field.

5.1.1.2.3 Method of measurement

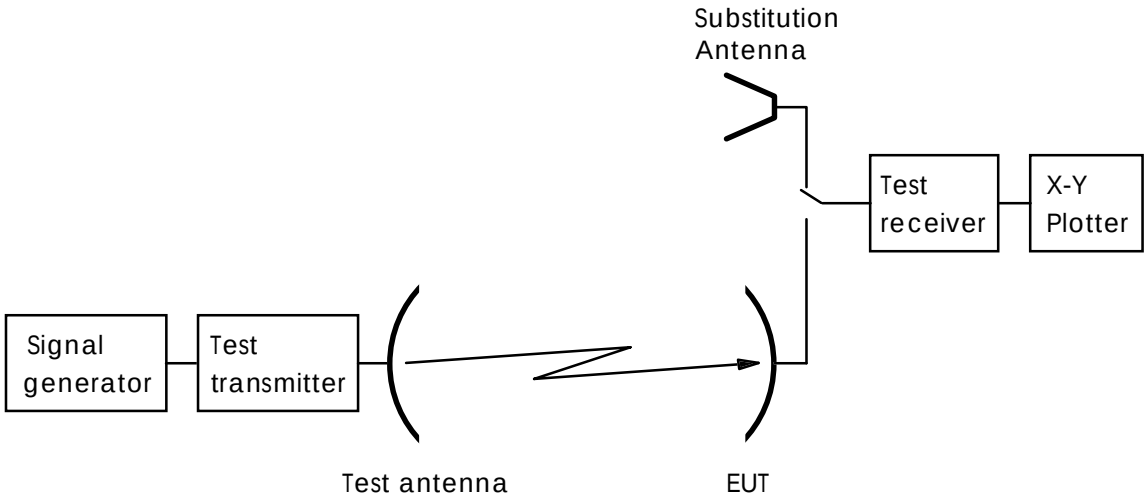

Figure 2: Test arrangement - antenna transmit gain measurement

a) The test arrangement shall be as shown in figure 2 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) A test signal at 5 MHz above the bottom of the lowest frequency band declared by the manufacturer shall be transmitted in the E-plane by the test transmitter through the test antenna. The E-plane shall be vertical.

c) The EUT shall be aligned to maximise the received signal and the X-Y plotter adjusted to give the maximum reading on the chart.

d) The EUT shall be driven in azimuth in one direction through 10°.

e) The pattern measurement is then obtained by driving the EUT in azimuth back through boresight to 10° the other side with the plotter recording the results.

f) The EUT shall be replaced by the substitution antenna and the received signal level maximized.

g) This level shall be recorded on the X-Y plotter.

h) The substitution antenna shall be driven in azimuth as in d) and e).

j) The gain of the EUT shall be calculated from:

$$G_{EUT} = L_1 - L_2 + C$$

where:

G_{EUT} is the gain of the EUT (dBi);
L_1 is the level obtained with the EUT (dB);
L_2 is the level obtained with the substitution antenna (dB);
C is the calibrated gain of the substituted antenna at the test frequency (dBi).

k) The tests in b) to j) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

l) The tests in b) to j) shall be repeated with the frequency changed to 5 MHz below the top of the lowest frequency band declared by the manufacturer.

m) Not used.

n) The tests in b) to l) may be performed simultaneously.

p) The tests in b) to n) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

q) The tests in b) to n) shall be repeated with the test signal being transmitted in a plane at + 45° to the H-plane.

r) The tests in b) to n) shall be repeated with the test signal being transmitted in a plane at - 45° to the H-plane.

s) The tests in b) to r) shall be repeated for all frequency bands declared by the manufacturer.

5.1.1.3 Antenna transmit radiation patterns

5.1.1.3.1 General

For the purposes of this TBR, the antenna transmit radiation patterns are diagrams relating field strength to the angle of the direction pointed by the antenna at a constant large distance from the antenna.

For the purposes of this test, the EUT is defined as that part of the SNG TES which comprises the antenna and its flange. The antenna includes the parabolic reflector, feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point.

5.1.1.3.2 Test site

This test shall be performed on either an outdoor far-field test site or compact test range. However if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field.

5.1.1.3.3 Method of measurement

Figure 3: Test arrangement - antenna transmit radiation pattern measurement

a) The test arrangement shall be as shown in figure 3 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) A test signal at 5 MHz above the bottom of the lowest frequency band declared by the manufacturer shall be transmitted in the E-plane by the test transmitter through the test antenna. The E-plane shall be vertical.

c) The EUT shall be aligned to maximise the received signal and the X-Y plotter adjusted to give the maximum reading on the chart.

d) The EUT shall be driven in azimuth through 180°.

e) The transmit pattern measurement is then obtained by driving the EUT in azimuth through 360° with the plotter recording the results.

f) The tests in b) to e) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

g) The tests in b) to e) shall be repeated with the frequency changed to 5 MHz below the top of the lowest frequency band declared by the manufacturer.

h) The tests in b) to g) may be performed simultaneously.

j) The tests in b) to h) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

k) The tests in b) to h) shall be repeated with the test signal being transmitted in a plane at +45° to the H-plane.

l) The tests in b) to h) shall be repeated with the test signal being transmitted in a plane at -45° to the H-plane.

m) The tests in b) to l) shall be repeated between the angles of 2,5° and 9,2° either with the EUT rotated through 90°, or the test antenna or the polarisation subsystem of the EUT rotated by 90° to give the cross-polar measurement.

n) The tests in b) to m) shall be repeated for all frequency bands declared by the manufacturer.

5.1.2 Computation of results

The results shall be computed by producing a "mask" to the specified limits with the reference level being equal to the sum of the transmitter output power density and the gain of the antenna. This reference shall then be placed on the maximum point of the plot obtained from the transmit radiation pattern measurement, so as to ascertain that the off-axis EIRP density is within the mask, and thus conforming to the specification.

5.2 Off-axis spurious radiation

5.2.1 Test method

The test below 960 MHz shall be performed with the EUT comprising the SNG TES up to the antenna flange. The test above 960 MHz shall be performed with the EUT comprising the SNG TES up to the antenna flange for procedures a) and c) but including the antenna for procedure b). The interconnections cable between the various units shall be the same types as supplied by the manufacturer.

The EUT shall be terminated with matched impedance at the terrestrial ports if there is no associated equipment connected to such port.

For frequencies between 80 MHz and 1 GHz the measuring antenna shall be a balanced dipole which shall be resonant in length. For frequencies below 80 MHz it shall have a length equal to the 80 MHz resonant length and shall be tuned and matched to the feeder by a suitable transforming device. For frequencies above 1 GHz the antenna shall be a horn radiator of known gain/frequency characteristics. When used for reception the antenna and any associated amplification system shall have an amplitude/frequency response within ± 2 dB of the combined calibration curves across the measurement frequency range considered for the antenna. The antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarisation and at the specified height.

5.2.1.1 Below 960 MHz

5.2.1.1.1 Test site

The test shall be performed either in an open area test site, a semi-anechoic chamber or an anechoic chamber. Ambient noise levels shall be at least 6 dB below the applicable unwanted emissions limit.

The test site shall be flat, free of overhead wires and nearby reflecting structures, sufficiently large to permit aerial placement at the specified measuring distance and provide adequate separation between aerial, test unit and reflecting structures.

A metal ground plane shall be inserted on the natural ground plane and it shall extend at least 1 m beyond the perimeter of the EUT at one end and at least 1 m beyond the measurement antenna at the other end.

The distance between the EUT and measuring antenna shall be 10 m.

5.2.1.1.2 Measuring receivers

Measuring receivers shall conform to the following characteristics:

- the response to a constant amplitude sine wave signal shall remain within ± 1 dB across the frequency range of interest;

- quasi-peak detection shall be used in a -6 dB bandwidth of 120 kHz;

- the receiver shall be operated at more than 1 dB below the compression point during tests/measurements.

5.2.1.1.3 Procedure

a) The EUT shall be with the antenna removed and replaced by a dummy load.

b) The EUT shall be in the carrier-on state.

c) The EUT shall be rotated through 360° and the measuring antenna height simultaneously varied from 1 m to 4 m above the ground plane.

d) All spurious radiation shall be noted and measured in frequency and level.

5.2.1.2 Above 960 MHz

The spectrum analyser resolution bandwidth shall be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth, bandwidth correction shall be performed for the noise-like wideband spurious radiation.

The test shall be performed in three stages for both the carrier-off and carrier-on states:

Procedure a): Identification of the significant frequencies of spurious radiation;

Procedure b): Measurement of radiated power levels of identified spurious radiation;

Procedure c): Measurement of conducted spurious radiation radiated through the antenna flange.

5.2.1.2.1 Identification of the significant frequencies of spurious radiation

5.2.1.2.1.1 Test site

The identification of frequencies emitting from the EUT shall be performed in an anechoic chamber with the test antenna close to the EUT and at the same height as the volume centre of the EUT.

5.2.1.2.1.2 Procedure

a) The EUT shall be with the antenna removed and replaced by a dummy load.

b) The EUT shall be in the carrier-off state.

c) The receivers shall scan the frequency band whilst the EUT revolves.

d) The EUT shall be rotated though 360° and the frequency of any spurious signals noted for further investigation.

e) The tests in c) to d) shall be repeated with the test antenna being in the opposite polarisation.

f) The tests in c) to e) shall be repeated in the carrier-on state whilst transmitting a modulated carrier at maximum power.

5.2.1.2.2 Measurement of radiated power levels of identified spurious radiation

5.2.1.2.2.1 Test site

The measurement of each spurious radiation noted during the test procedure in subclause 5.2.1.1.2 of the test shall be performed on a test site that is free from reflecting objects, i.e. either an open-area test site or a semi-anechoic chamber.

5.2.1.2.2.2 Procedure

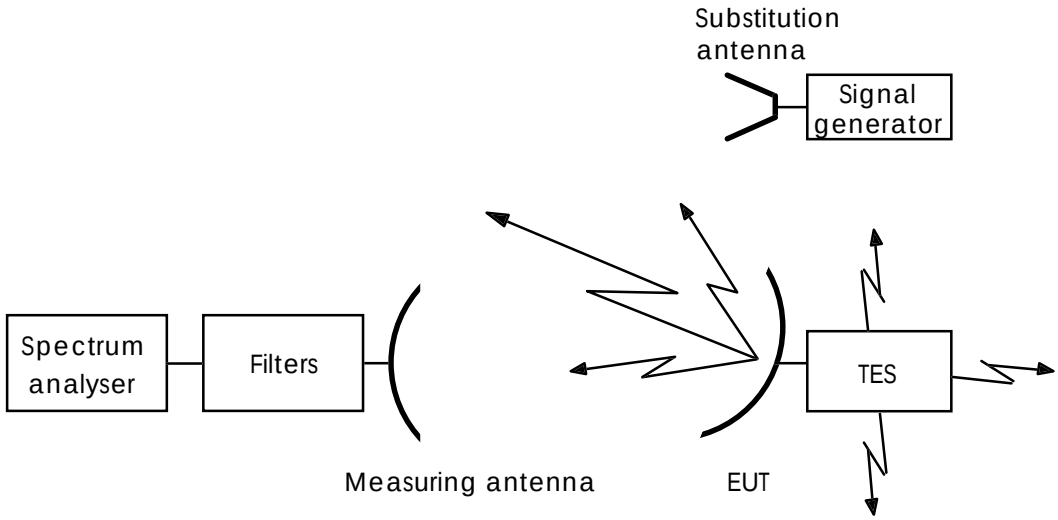

Figure 4: Test arrangement - Spurious radiation measurement

a) The test arrangement shall be as shown in figure 4.

b) The EUT shall be installed such that the various units are placed in their normal operating positions relative to each other. Any interconnection cables shall be maintained by non-metallic means at a height between 0,5 m and 1,0 m. The main beam of the antenna shall have an angle of elevation of 7° and be oriented away from the geostationary orbit, or be inhibited by placing RF absorbing panels in that direction.

c) The measuring antenna shall be positioned at a distance of 10 m from the EUT. The measuring antenna shall be adjusted in height and the EUT rotated, whilst the EUT is in the appropriate carrier condition, for a maximum response on the associated spectrum analyser at each spurious frequency previously identified, this response level shall be noted. The measuring antenna shall never enter the 7° off-axis cone around the main beam direction.

d) The investigation shall be repeated with the measuring antenna in the opposite polarisation and the response level similarly noted.

e) The EUT shall be replaced by the substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned and the distance between the antennas shall be 10 m.

f) The substitution and measuring antennas shall be aligned in the polarisation which produced the larger response between the EUT and the test antenna.

g) The output of the generator shall be adjusted so that the received level is identical to that of the previously noted largest spurious radiation.

h) The output level of the signal generator shall be noted. The EIRP of the spurious radiation is the sum, in dB, of the signal generator output plus the substitution antenna isotropic gain minus the interconnection cable loss.

5.2.1.2.3 Measurement of conducted spurious radiation at the antenna flange

5.2.1.2.3.1 Test site

There are no requirements for the test site to be used for this test.

5.2.1.2.3.2 Procedure

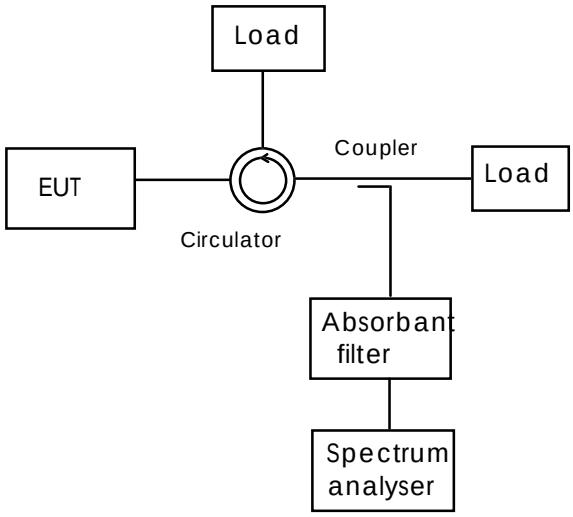

Figure 5: Test arrangement - conducted spurious radiation

a) The test arrangement shall be as shown in figure 5.

b) The frequency range 960 MHz to 40 GHz shall be investigated for spurious radiation, excluding intermodulation products whilst in the carrier-on state with the carrier being modulated and at maximum power.

c) To obtain the off-axis spurious EIRP the maximum measured antenna transmit gain for off-axis angles greater than 7°, or its worst case assumed (i.e. 8 dBi for off-axis angles greater than 7°), shall be added to any figure obtained in the above measurement and any correction or calibration factors summated with the result.

d) The test shall be repeated in the carrier-off condition.

5.3 On-axis spurious radiation

5.3.1 Test method

5.3.1.1 General

For SNG TES equipment for which measurements at the antenna flange are possible and agreed by the manufacturer, the measurements shall be performed at the antenna flange.

For SNG TES equipment for which measurements at the antenna flange are not possible or not agreed by the manufacturer, the measurements shall be performed with a test antenna.

5.3.1.2 Method of measurement at the antenna flange

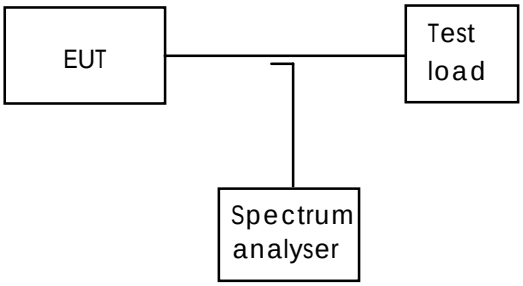

Figure 6: Test arrangement - on-axis spurious radiation measurements at the antenna flange

a) The EUT shall be connected to a test load as shown in figure 6.

b) Whilst continuously transmitting a modulated carrier at maximum power the operating frequency ranges declared by the manufacturer shall be investigated.

c) The spectrum analyser resolution bandwidth shall be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth, bandwidth correction shall be performed for noise-like wideband spurious radiation.

d) To obtain the on-axis spurious power level that would be transmitted, the antenna isotropic transmit gain shall be added to any figure obtained in the above measurement and any correction or calibration factor summated with the result.

e) The antenna gain shall be as measured in subclause 5.1.1.2.

5.3.1.3 Method of measurement with a test antenna

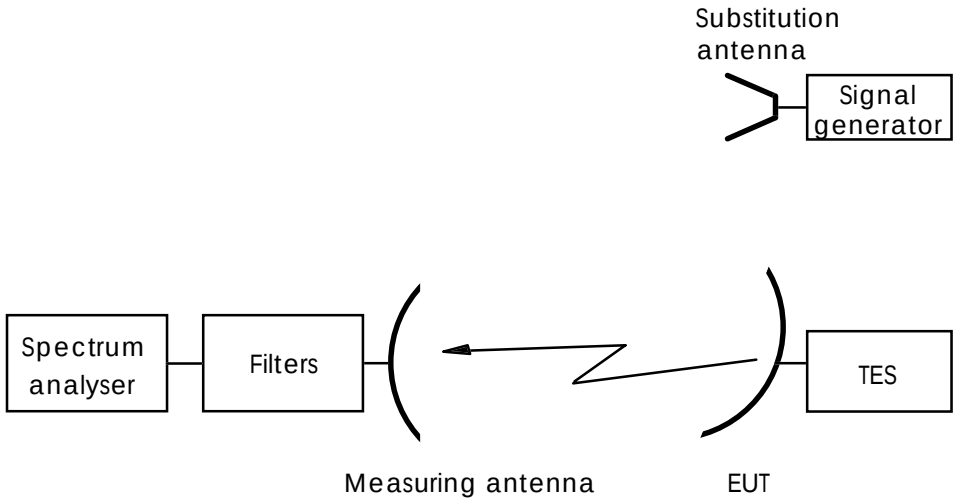

Figure 7: Test arrangement - on-axis spurious radiation measurements with a measuring antenna

a) The test arrangement shall be as shown in figure 7.

b) The spectrum analyser resolution bandwidth shall be set to the specified measuring bandwidth or as close as possible. If the resolution bandwidth is different from the specified measuring bandwidth, bandwidth correction shall be performed for noise-like wideband spurious radiation.

c) The EUT shall be installed such that the various units are placed in their normal operating positions relative to each other. Any interconnection cables shall be maintained by non-metallic means at a height between 0,5 m and 1,0 m. The main beam of the antenna shall have an angle of elevation of 7° and be oriented away from the geostationary orbit, or be inhibited by placing RF absorbing panels in that direction.

d) Whilst continuously transmitting a modulated carrier at maximum power the operating frequency ranges declared by the manufacturer shall be investigated.

e) The measuring antenna shall be positioned at a distance of 10 m from the EUT. The measuring antenna shall be adjusted in height and polarisation and the EUT rotated for a maximum response on the associated spectrum analyser at each spurious frequency previously identified. This response level shall be noted. The measuring antenna shall never enter the 7° off-axis cone around the main beam direction.

f) The EUT shall be replaced by the substitution antenna to which is connected a signal generator. The main beam axes of the measuring and substitution antennas shall be aligned and the distance between the antennas shall be 10 m.

g) The substitution and measuring antennas shall be aligned in the polarisation which produced the larger response between the EUT and the test antenna.

h) The output of the generator shall be adjusted so that the received level is identical to that of the previously noted largest spurious radiation.

j) The output level of the signal generator shall be noted. The EIRP of the on-axis spurious radiation is the sum (in dB) of the signal generator output plus the substitution antenna isotropic gain minus the interconnection cable loss.

5.4 Transmit antenna polarisation discrimination

5.4.1 Test method

For the purposes of this test, the EUT is defined as that part of the SNG TES which comprises the antenna and its flange. The antenna includes the parabolic reflector, feed, support struts and an enclosure of equal weight/distribution to any electrical equipment normally housed with the feed at the antenna focal point.

5.4.1.1 Test site

This test shall be performed on either an outdoor far-field test site or compact test range. However if the near-field scanner technology to convert near-field measurements to far-field results is proven and sufficiently accurate by reference to tests taken in both regions then antenna measurements may be taken in the near field.

5.4.1.2 Method of measurement

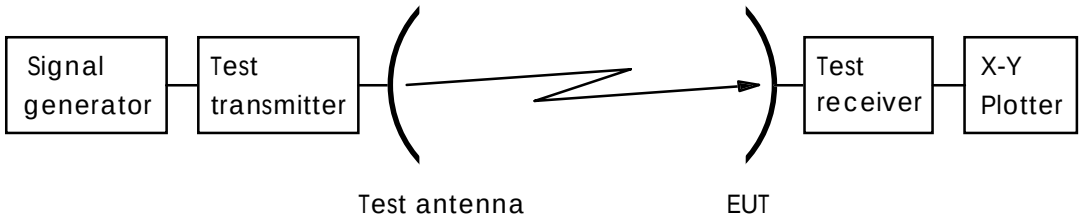

Figure 8: Test arrangement - transmit polarisation discrimination

a) The test arrangement shall be as shown in figure 8 with the EUT connected to the test receiver. A signal proportional to the angular position from the servo mechanism shall be applied to the X-axis and the signal level from the test receiver shall be applied to the Y-axis of the plotter.

b) A test signal at 5 MHz above the bottom of the lowest frequency band declared by the manufacturer shall be transmitted in the E-plane by the test transmitter through the test antenna in the E-plane. The E-plane shall be vertical.

c) The EUT shall be aligned so that maximum deflection is obtained on the X-Y plotter.

d) This deflection shall be adjusted to the maximum reading on the chart.

e) The EUT shall be driven in azimuth until the level has dropped by 10 dB.

f) The EUT shall then be driven in azimuth through boresight to a corresponding offset on the other side with the X-Y plotter recording the level.

g) The EUT shall be returned to boresight.

h) The test antenna shall be aligned with the on-axis cross-polar component of the EUT.

j) The test shall be repeated between the same two angles used for the co-polar trace.

k) The plot obtained should show both co-polar and cross-polar traces.

l) The minimum transmit polarisation discrimination is the difference between the peak co-polar gain and the peak cross-polar gain between the points on the co-polar plot as stated in subclause 4.4.

m) The tests in b) and d) to l) shall be repeated with the frequency changed to the middle of the lowest frequency band declared by the manufacturer.

n) The tests in b) and d) to l) shall be repeated with the frequency changed to 5 MHz below the top of the lowest frequency band declared by the manufacturer.

p) The tests in b) to n) shall be repeated with the test signal being transmitted in the H-plane instead of the E-plane.

q) The tests in b) to n) shall be repeated with the test signal being transmitted in a plane at +45° to the H-plane.

r) The tests in b) to n) shall be repeated with the test signal being transmitted in a plane at -45° to the H-plane.

s) The tests in b) to r) shall be repeated in all frequency bands declared by the manufacturer.

5.5 Pointing accuracy and stability

5.5.1 Test method

a) Pointing stability: this test shall be performed by numerical analysis which shall be performed in two stages.

In the first stage the effects of maximum wind speed shall be computed on the outdoor unit using a numerical analysis method (finite elements method by computer) taking into account the intrinsic properties of the materials.

In the second stage the computed loads shall be applied to the structure.

The purpose of the numerical analysis is twofold:

1) to show that the fields of force and torque applied to the outdoor unit structure under nominated conditions do not reach the breakpoint limit of any element of the structure;

2) to compute equivalent static loads (force and torque) applied to the critical attachment points of the structures, e.g.:

- reflector - mounting legs fixing point;
- reflector - struts;
- LNB - struts.

Numerical analysis and load applications procedure:

1) The air related parameters, namely the kinematic viscosity used to calculate drags at the rims of the structure shall be calculated with the standard atmospheric environmental conditions (temperature = 293 K, air pressure = 1,013 x 10^5 Pascal).

2) The computations needed to derive the field of force and torque and the equivalent static stresses shall be carried out for each of the following variables:

   - elevation angle: maximum and minimum;
   - wind direction: in steps of 45° around the outdoor unit;
   - wind speed: 180 km/h.

3) It shall be verified with the simulated results that break point limits are not exceeded for any self-contained element.

4) The calculated equivalent static loads shall be applied at any identified critical fixing point of the assembly.

5) Whilst the loads are applied the outdoor unit shall be observed and any distortion noted.

6) The test report shall contain the following information:

   - the computation method used;
   - description of the test equipment;
   - description of the tests performed;
   - results of the safety margin test;
   - any signs of distortion observed;
   - results of the measurements of the deviation of the antenna position;
   - component deviation with respect to each other.

b) Pointing accuracy capability:

1) The EUT shall be inspected to ascertain whether fine adjustment facilities are available for the azimuth axis (coarse adjustment is usually provided by the positioning of the means of attachment).

2) The adjustment facilities shall be examined to determine both the angular movement possible and the means of arresting that movement.

3) The arresting facility shall be examined to determine its permanency.

4) The test shall be repeated for the elevation axis.

c) Polarisation angle alignment capability:

1) The adjustment facilities shall be examined to determine both the angular movement possible and the means of arresting that movement.

2) The arresting facility shall be examined to determine its permanency.

d) Polarisation alignment stability:

1) This test shall be performed in the same way as the test in a) of this subclause 5.5.1.

Annex A (normative): The TBR Requirements Table (TBR-RT)

Table A.1: TBR Requirements Table (TBR-RT)

TBR Reference			TBR 030		
No	**Category**	**Reference**	**TBR-R**	**Status**	**Support**
1	4.3	4.1	Off-axis EIRP density	M	
2	4.3	4.2	Off-axis spurious radiation	M	
3	4.3	4.3	On-axis spurious radiation	M	
4	4.3	4.4	Transmit antenna polarisation discrimination	M	
5	4.3	4.6	Pointing accuracy and stability	M	

Key to columns:

No TBR-RT entry number;

Category Category of essential requirement as per Article 4 of the Satellite Equipment Directive [1];

Reference Clause reference within this TBR of the supporting text for the entry;

TBR-R Title of entry within this TBR-RT;

Status Status of the entry (M = Mandatory, shall be implemented under all circumstances);

Support Does the equipment support the essential requirement of this entry; Y/N.

Annex B (informative): Bibliography

- ETS 300 327 (1994): "Satellite Earth Stations and Systems (SES); Satellite News Gathering (SNG) Transportable Earth Stations (TESs) (13-14/11-12 GHz)".

- ETS 300 456 (1995): "Satellite Earth Stations and Systems (SES); Test methods for Very Small Aperture Terminals (VSATs) operating in the 11/12/14 GHz frequency bands".

- ETR 169 (1995): "Satellite Earth Stations and Systems (SES); Common Technical Regulations (CTRs) in the satellite earth station equipment field".

- Council Directive 89/336/EEC (1989) on the approximation of the laws of Member States relating to electromagnetic compatibility.

- EN 55022 (1994): "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

History

Document history			
August 1996	Public Enquiry	PE 111:	1996-08-05 to 1996-11-29