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Contents

Foreword

This European Telecommunication Standard (ETS) has been produced by the Satellite Earth Stations and Systems (SES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

Every ETS prepared by ETSI is a voluntary standard. This ETS contains text concerning type approval of the equipment to which it relates. This text does not make this ETS mandatory in its status as a standard. However, this ETS can be referenced, wholly or in part, for mandatory application by decisions of regulatory bodies.

Transposition dates	
Date of latest announcement of this ETS (doa):	31 December 1994
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1 Scope

The scope of this European Telecommunication Standard (ETS) is to provide minimum specifications for the standardisation of the characteristics of Transportable Earth Stations (TESs) used for Satellite News Gathering (SNG) which can be either an unforeseen or pre-planned activity. The TES can be either vehicle mounted or packed for transportation. The TES can be capable of transmitting either video or audio or both simultaneously. The TESs considered in this ETS are those designed to operate whilst stationary as defined in subclause 3.2.

This earth station should include a capability to receive signals from the satellite for antenna pointing purposes and to monitor its own transmission where the satellite transmission beam permits. The receive equipment could also be used in the process of two-way communication to control and co-ordinate operation.

SNG earth stations have the following characteristics:

- operating in the Ku-band allocated to the Fixed Satellite Services (FSS), 12,75 - 13,25 GHz (Earth-Space), 13,75 - 14,50 GHz (Earth-Space), 10,70 - 11,70 GHz (Space-Earth) and 12,50 - 12,75 GHz (Space-Earth). Frequencies could be selected from throughout the entire frequency range or be restricted to a range completely enclosed within those bands. These bands are partly shared between FSS and Fixed Service (FS);

- in these frequency bands linear polarization is normally used and the system operates through satellites with 3 degree spacing;

- designed for attended operation;

- antenna diameter not exceeding 5,0 m or equivalent corresponding aperture.

  NOTE: At present the Radio Regulations restrict the use of the 13,75 - 14,00 GHz band to earth stations having an antenna diameter of 4,5 m or greater and having a transmitting eirp between 68 dBW and 85 dBW.

The equipment considered in this ETS comprises both the antenna sub-system and the associated transmit and receive sub-systems.

This ETS does not contain any requirement, recommendation or information about the method of modulation. Such modulation could result in the transmission being either analogue or digital, or both simultaneously.

This ETS does not contain any requirement, recommendation or information about the baseband signals used in the modulation process. Such baseband signals could be pure analogue, digital or a mixture of analogue and digital.

This ETS does not contain any requirement, recommendation or information about the operation of the equipment.

This ETS deals with two types of specification:

- specifications defined in order to protect other users of the frequency spectrum, both satellite and terrestrial, from unacceptable interference. In addition these specifications are specified for the purposes of electrical safety, structural safety, Radio Frequency (RF) radiation safety and solar radiation protection as well as protection from harmful interference.

- specifications related to characteristics which depend on operational conditions and which contribute mainly to the quality of reception of the two-way communication and monitoring paths by providing the SNG TES with minimum interference protection from other radio systems.

2 Normative references

This ETS incorporates, by dated or undated references, provisions from other publications. These normative 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 ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] EN 60950 (1992): "Safety of information technology equipment including electrical business equipment".

[2] IEC 81(CO)6 (1981): "Standards for lightning protection of structures", Part 1 General principles.

[3] IEC 510-2-1 (1978) with modification of 1989: Part 2 "Measurements for sub-systems" Section One "General" and Section Two "Antenna (including feed network)".

[4] IEC 510-1-2 (1984): Part 1 "Measurements common to sub-systems and combinations of sub-systems" Section Two "Measurements in the RF range".

[5] CISPR Publication 22 (1985) as amended by CISPR/G (Central Office 09) (1992): "Limits and methods of measurement of radio interference characteristics of information technology equipment".

[6] ITU-R Recommendation 732 (1990): "Method for statistical processing of Earth station antenna side-lobe peaks".

[7] IEC 801-3 (1984): "Electromagnetic compatibility for industrial-process measurement and control equipment" Part 3 "Radiated electromagnetic field requirements".

[8] EN 55011 (1986): "Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment".

[9] CISPR Publication 16 (1987): "CISPR specification for radio interference measuring apparatus and measurement methods".

3 Abbreviations and definitions

3.1 Abbreviations

For the purposes of this ETS, the following abbreviations apply.

ATIS	Automatic Transmitter Identification System
SNG	Satellite News Gathering
TES	Transportable Earth Station
ETS	European Telecommunication Standard
FSS	Fixed Satellite Services
IEC	International Electrotechnical Commission
CISPR	International Special Committee on Radio Interference
ITU-R	International Telecommunications Union - Radiocommunications Sector
EN	European Standard
eirp	equivalent isotropically radiated power
RF	Radio Frequency
EUT	Equipment Under Test
TEM	Transverse Electro-Magnetic
HPA	High Power Amplifier
LNB	Low Noise Block (low noise amplifier and down converter)
MSS	Mobile Satellite Services
rms	root mean square

IRPA/INIRC	International Non-Ionizing Radiation Committee of the International Radiation Protection Association

3.2 Definitions

For the purposes of this ETS the following definitions apply:

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.

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.

Nominated bandwidth: the nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a density greater than the specified spurious levels, and to take into account the transmit carrier frequency stability. The bandwidth of the SNG TES radio frequency transmission is nominated by the manufacturer.

NOTE: This parameter is to allow flexibility regarding adjacent channel interference levels which will be taken into account by operational procedures depending on the exact transponder assignment situation.

Spurious radiation: any radiation outside the nominated bandwidth of the transmitted carrier.

Carrier-off: that state where the equipment is electrically powered and the transmit sub-system is not switched to the antenna. The ground communications sub-system may or may not be driving the transmit sub-system.

4 Test report

The test report shall contain:

- the value of the nominated bandwidth declared by the manufacturer;

- the results of the tests.

5 Safety

5.1 Mechanical construction

Purpose:

Protection of operating personnel, the public and goods from insecure structures.

Specification:

The antenna sub-system, including all structural and attached components, shall be designed to support the following main loads due to:

- the weight of the antenna and structural components;

- the wind speed;

- the weight of the expected snow and ice;

- the shock generated by transportation.

At the wind speeds stated the following criteria shall apply:

- up to 50 m/s (180 km/h) none of the components shall be torn away;

- up to 30 m/s (108 km/h) permanent distortion shall not occur.

Above the wind speed specified by the manufacturer at which the antenna is to be stowed, this stowage should have taken place.

Verification:

Conformance shall be determined by numerical analysis, possibly supported by practical tests. The effect of the maximum wind load on the antenna sub-system shall be first computed using a numerical analysis method, e.g. finite elements method by computer taking into account the intrinsic properties of the materials. In the second step, the computed loads shall be applied to the structure. This second step may be performed either by practical tests or by a recognised numerical analysis that can be proved to give the same results.

The purpose of the first numerical analysis is two-fold:

1) to show compliance with the specification under nominated conditions;

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

    - reflector mounting legs fixing point;

    - reflector - struts;

    - struts - LNB and/or HPA.

Test procedure:

The computations needed to derive the field of forces and torques and the equivalent static stresses shall be carried out for the following conditions:

- wind direction: in steps of 45°, in the horizontal plane;

- elevation angle of the antenna: at both minimum and maximum in turn;

- wind speed: up to 180 km/h.

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 = $1{,}013 \times 10^5$ Pa).

It shall be verified with the computed results that the break point limits are not exceeded for any self contained element. The computed equivalent static loads shall be applied at any critical fixing point of the assembly. During the load conditions, the antenna sub-system distortion shall be measured or computed, and recorded.

The test report shall contain:

- the computation method used;

- a description of the test performed, if practical tests are carried out;

- the result of the safety margin calculation;

- results of the measurements or calculations on the mechanical loads transmitted from the antenna sub-system to the attachment devices;

    - and for the pointing stability (see subclause 7.2) and polarization alignment stability (see subclause 7.5);

- results of the measurements or the calculations of the mechanical distortion.

5.2 Electrical safety

Purpose:

Protection of the operating personnel and the public from electric shock.

Specification:

The electrical safety of the equipment shall be in accordance with the applicable parts of EN 60950 [1], the introduction, Clauses 1 to 3 inclusive and Clause 5. These Clauses deal with fundamental design requirements, wiring, connections and supply.

Verification:

Conformance shall be determined according to EN 60950 [1] verification methods.

5.3 Radio frequency radiation protection

Purpose:

Protection of operating personnel and the public from RF radiation hazards.

Specification:

The equipment shall be fitted with a warning notice in a clearly visible position, indicating the region in which a radio frequency radiation level in excess of 10 W/m^2 may occur.

Verification:

Conformance shall be determined by computation or measurement of the radiation level and by visual inspection.

Test Procedure

A suggested test procedure for the determination of the 10 W/m^2 region is presented in Annex B.

5.4 Solar radiation protection

Purpose:

Protection of operating personnel and the public from solar radiation focusing effects.

Specification:

If, in conditions of sunshine, solar radiation is focused near the feed such that burning may occur, the equipment shall be fitted with a warning notice in a clearly visible position.

Verification:

Conformance shall be determined by visual inspection.

5.5 Lightning

Purpose:

To avoid dangerous potential differences between any element of the earth station and the ground.

Specification:

Means shall be provided to permit the attachment of bonding conductors of dimensions indicated in IEC 81(CO)6 [2], table 6.

Verification:

Conformance shall be determined by inspection.

6 Radio frequency

6.1 Off-axis eirp density

Purpose:

Protection of other satellite and terrestrial systems.

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 ϕ	dBW	where $2,5° \leq \phi \leq 7,0°$;
+ 12	dBW	where $7,0° < \phi \leq 9,2°$;
36 - 25 log ϕ	dBW	where $9,2° < \phi \leq 48°$;
- 6	dBW	where $48° < \phi \leq 180°$.

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

23 - 25 log ϕ	dBW	where $2,5° \leq \phi \leq 7,0°$;
+ 2	dBW	where $7,0° < \phi \leq 9,2°$.

Verification:

Conformance shall be determined from:

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

- measurement of transmit antenna gain pattern according to IEC 510-2-1 [3], subclause 8.2.2.

Test procedure:

The test procedure for the measurement of the RF power density shall be in accordance with IEC 510-1-2 [4], subclause 5.2.2.2 but using a spectrum analyser.

The measurement of the transmit gain patterns shall be made in accordance with IEC 510-2-1 [3], Clause 8, or any other recognised method that can be proved to give the same results, at 3 frequencies (low, middle and high) in each of the transmit bands declared by the manufacturer.

The documentation shall contain information of the following parameters, under which the limits for off-axis eirp shall be met:

- power;

- modulation scheme;

- geographical locations relative to satellite (e.g. for stations with an optimised sidelobe pattern in a given plane);

- antenna orientation position.

6.2 Off-axis spurious radiation

Purpose:

Protection of other terrestrial and satellite radio services.

Specification:

1) The SNG TES shall satisfy the limits for radiated interference field strength specified in CISPR Publication 22 [5] over the frequency range from 30 MHz to 960 MHz as shown in table 1.

Table 1: Limits of radiated interference field strength in the frequency range 30 MHz to 960 MHz at a test distance of 10 m

Frequency range (MHz)	Quasi-peak limits (dB(μV/m))	
	Class A	Class B
30 - 230	40	30
230 - 960	47	37

The lower limits shall apply at the transition frequency.

The applicable class, A or B, shall be designated by the manufacturer and indicated in the data sheet of the test report.

2) For the carrier-off case, the off-axis spurious eirp from the SNG TES, in any 100 kHz band, shall be below the limits shown 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 case, the off-axis spurious eirp from the SNG TES, shall be below the limits shown 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.

Verification:

Measurement of spurious radiation generated by an SNG TES under operation.

Test procedure:

A test procedure is given in Annex A for information.

6.3 On-axis spurious radiation

Purpose:

To limit the level of interference to satellite radio services.

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 and spectral spreading 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 sub-clause 6.2 by taking into account the on-axis antenna gain.

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

Verification:

Conformance shall be determined by measurement in accordance with the test procedure.

Test procedure:

The measurement shall be performed by the following method.

The power of the spurious radiation at the interface point between the antenna and the transmit sub-system shall be measured according to the measurement method in IEC 510-1-2 [4], subclause 5.2.2. The antenna on-axis gain shall be measured according to the measurement methods in IEC 510-2-1 [3], Clause 8, or any other method that can be proved to give the same results. The eirp of the spurious radiation shall be calculated from the above two measurements. The environmental conditions during the tests shall be within those for which the SNG TES is designed to operate.

6.4 Transmit carrier centre frequency stability

Purpose:

Protection of transmissions on the same satellite.

Specification:

The transmitted carrier centre frequency shall not deviate from its nominal value by more than an amount which allows the carrier (and its close-in spectral components which have a spectral power density greater than the specified spurious levels) to remain within its nominated bandwidth. This frequency tolerance refers to the initial frequency adjustment plus long-term drift. Long-term drift is being assumed to be at least one month of continuous operation.

Verification:

Conformance shall be determined from documentary evidence.

6.5 Transmit antenna gain pattern (co-polar and cross-polar)

Purpose:

Protection of terrestrial services and other satellite (up-link) systems.

Specification:

The transmit gain G (ϕ) in dB, relative to an isotropic antenna, of the main lobe and of at least 90 % of the sidelobe peaks shall not exceed the following limits:

29 - 25 log ϕ dBi for $2,5° \leq \phi \leq 7,0°$;
+ 8 dBi for $7,0° < \phi \leq 9,2°$;
32 - 25 log ϕ dBi for $9,2° < \phi \leq 48°$;
- 10 dBi for $48° < \phi \leq 180°$.

Additionally, the cross-polar gain G (ϕ) in dB, relative to an isotropic antenna, of the main lobe and of at least 90 % of the sidelobe peaks shall not exceed the following limits:

19 - 25 log ϕ dBi for $2,5° \leq \phi \leq 7,0°$;
- 2 dBi for $7,0° < \phi \leq 9,2°$.

where ϕ is the angle, in degrees, between the main beam axis and the direction considered.

For $\phi > 70°$ the values given above may be increased to 0 dBi over the range of angles for which the particular feed system may give rise to relatively high levels of spillover.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for ϕ between 2,5° and 20° need only be met within 3° of a plane bisected by the main beam axis.

This plane shall be marked and identified on the antenna. There shall be an axis of rotation along the main beam axis, with adjustment capability to an accuracy of ± 0,5°. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

The method of statistical processing of side-lobe peaks and the definition of a peak is dealt with in ITU-R Recommendation 732 [6], Annex II.

Verification:

Conformance shall be determined by measurement of the co-polar and cross-polar transmit gain patterns in four planes: the E- and H-planes and the two planes with an inclination of 45° relative to these.

The measurement shall be made in accordance to IEC 510-2-1 [3], Clause 8, or any other recognised method that can be proved to give the same results, at 3 frequencies (low, middle and high) in each of the transmit bands declared by the manufacturer.

6.6 Transmit antenna polarization discrimination

Purpose:

Protection of signals on the orthogonal polarization.

Specification:

The ratio of the on-axis co-polar to the cross-polar gain of the linear polarised antenna shall not be less than:

35 dB within the - 0,3 dB contour of the main beam; and

25 dB for any off-axis angle lower than 2,5°.

Verification:

Conformance shall be determined either by measuring according to IEC 510-2-1 [3], Clause 7, or by any other recognised method that can be proved to give the same results.

The initial polarization alignment shall be such that the crosspolarized component on the main axis is minimum. No other polarization alignment shall be done during the measurement.

The test results shall consist of bi-dimensional plots of co-polar and cross-polar antenna gain versus angle from boresight to ± 2,5° at 3 frequencies (low, middle and high) in each of the transmit bands declared by the manufacturer.

The angle of the plane of the above plots shall be stated with respect to a fixed reference on the antenna rim.

The documentation shall contain information, under which the limits for polarization discrimination shall be met, within the following parameters:

- geographical locations relative to satellite (e.g. for stations with an optimised sidelobe pattern in a given plane);

- antenna orientation position.

6.7 Electromagnetic immunity

Purpose:

Protection of the SNG TES against interfering electromagnetic fields up to 2 GHz caused by other equipment. Beyond 2 GHz a recommendation is given in subclause 8.3.

Specification:

The SNG TES shall have an adequate level of intrinsic immunity to enable it to operate as intended, when it is exposed to the electromagnetic field whose electrical field component strength is as shown in table 4.

Table 4: Interfering electrical field strengths

Frequency range	Electrical field strength (V/m)
150 kHz to 50 MHz	1
50 MHz to 2 GHz	3

Verification:

Conformance shall be determined by measurement according to IEC 801-3 [7], Clauses 6 to 9.

Equipment under test shall be in its operational configuration.

The SNG TES shall be considered to satisfy the specification if the following conditions are met when the disturbing field is applied:

1) the quality of transmission observed is equal to, or better than, the lowest acceptable quality of transmission declared by the manufacturer;

2) the control and monitoring sub-system, if it exists, is not affected;

3) when the SNG TES is in the carrier-off state there shall be no change in the transmitted and received signal levels;

4) when the SNG TES is in the carrier-on state there shall be no change in the transmitted signal level.

7 Mechanical

7.1 Assembly and disassembly

7.1.1 Interference protection

Purpose:

To limit interference to other users of the radio spectrum.

Specification:

Where one or more part(s) are removed from the complete assembly, or where the orientation of the relative parts of the antenna changes during stowage procedures, repeated assembly and disassembly of the antenna sub-system shall not result in either the radiation patterns or the cross-polarization discrimination performance being reduced below the specified levels.

Verification:

Conformance shall be determined from documentary evidence provided by the manufacturer.

7.1.2 Personnel protection

Purpose:

Protection of operating personnel, the public and goods.

Specification:

Where one or more part(s) are removed from the complete assembly, during stowage or where the orientation of the relative parts of the antenna changes during stowage procedures, repeated assembly and disassembly of the antenna sub-system shall not result in any component becoming insecure in any way.

Verification:

Conformance shall be determined by documentary evidence supplied by the manufacturer.

7.2 Pointing stability

Purpose:

To limit interference to both the same and adjacent satellites during severe wind conditions.

Specification:

The installation shall not show any sign of distortion and shall not need repointing whilst being used in a wind speed which is under that specified by the manufacturer at which the antenna shall be stowed.

Verification:

Conformance shall be determined from documentary evidence provided by the manufacturer.

7.3 Antenna pointing accuracy capability

Purpose:

To make possible precise antenna pointing in order to limit interference to adjacent satellites.

Specification:

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

Verification:

Conformance shall be determined from documentary evidence provided by the manufacturer. When the documentation covers non-symmetrical antennas then the worst case shall be indicated.

7.4 Polarization angle alignment capability

Purpose:

To make possible precise antenna linear polarization alignment in order to avoid interference to other users of the same satellite.

Specification:

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

Verification:

Conformance shall be determined by documentary evidence provided by the manufacturer.

7.5 Polarization alignment stability

Purpose:

To limit interference to other users of the same satellite or another satellite which is co-located.

Specification:

The installation shall not show any sign of distortion and 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.

Verification:

Conformance shall be determined from documentary evidence provided by the manufacturer.

7.6 Test and monitoring point

Purpose:

To facilitate verification procedures and testing of operational parameters.

Specification:

The transmit equipment shall be fitted with a calibrated test point for output power and frequency measurements.

Verification:

Conformance shall be determined from documentary evidence provided by the manufacturer and visual inspection.

8 Additional characteristics

8.1 Receive antenna gain pattern (co-polar and cross-polar)

General:

This specification applies if required by the manufacturer.

Purpose:

Protection of the wanted signals from interference from terrestrial services and from adjacent satellites.

Specification:

The receive gain G (ϕ) in dB, relative to an isotropic antenna, of the main lobe and of at least 90 % of the sidelobe peaks shall not exceed the following limits:

$29 - 25 \log \phi$ dBi for $2{,}5° \leq \phi \leq 7{,}0°$;
$+ 8$ dBi for $7{,}0° < \phi \leq 9{,}2°$;
$32 - 25 \log \phi$ dBi for $9{,}2° < \phi \leq 48°$;
$- 10$ dBi for $48° < \phi \leq 180°$.

Additionally, the cross-polar gain G (ϕ) in dB, relative to an isotropic antenna, of the main lobe and of at least 90% of the sidelobe peaks shall not exceed the following limits:

$19 - 25 \log \phi$ dBi for $2{,}5° \leq \phi \leq 7{,}0°$;
$- 2$ dBi for $7{,}0° < \phi \leq 9{,}2°$.

where ϕ is the angle, in degrees, between the main beam axis and the direction considered.

For $\phi > 70°$ the values given above may be increased to 0 dBi over the range of angles for which the particular feed system may give rise to relatively high levels of spillover.

For antennas designed for minimum off-axis gain in the direction of the geostationary orbit, the specification for ϕ between 2,5° and 20° need only be met within 3° of a plane bisected by the main beam axis.

This plane shall be marked and identified on the antenna. There shall be an axis of rotation along the main beam axis, with adjustment capability to an accuracy of ± 0,5°. The antenna shall be capable of having the above plane aligned with the geostationary orbit plane.

The method of statistical processing of side-lobe peaks and the definition of a peak is dealt with in ITU-R Recommendation 732 [6], Annex II.

Verification:

Conformance shall be determined by measurement of the co-polar and cross-polar receive gain patterns in four planes: the E- and H-planes and the two planes with an inclination of 45° relative to these.

The measurement shall be made in accordance to IEC 510-2-1 [3], Clause 8, or any other recognised method that can be proved to give the same results, at 3 frequencies (low, middle and high) in each of the receive bands declared by the manufacturer.

8.2 Receive antenna polarization discrimination

General:

This specification applies if required by the manufacturer.

Purpose:

Protection from signals on the orthogonal polarization.

Specification:

The ratio of the on-axis co-polar to the cross-polar gain of the linear polarised antenna shall not be less than:

35 dB within the -0,3 dB contour of the main beam; and

25 dB for any off-axis angle lower than 2,5°.

Verification:

Conformance shall be determined either by measuring according to IEC 510-2-1 [3], Clause 7, or by any other recognised method that can be proved to give the same results.

The initial polarization alignment shall be such that the cross polarization component on the main axis is minimum. No other polarization alignment shall be done during the measurement.

The test results shall consist of bi-dimensional plots of co-polar and cross-polar antenna gain versus angle from boresight to ± 2,5° at 3 frequencies (low, middle and high) in each of the receive bands declared by the manufacturer.

The angle of the plane of the above plots shall be stated with respect to a fixed reference on the antenna rim.

The documentation shall contain information, under which the limits for polarization discrimination shall be met, within the following parameters:

- geographical locations relative to satellite (e.g. for stations with an optimised sidelobe pattern in a given plane);

- antenna orientation position.

8.3 Electromagnetic immunity

General:

This specification applies if required by the manufacturer.

Purpose:

Protection of the SNG TES against interfering electromagnetic fields between 2 and 3 GHz caused by other equipment.

Specification:

The SNG TES shall have an adequate level of intrinsic immunity to enable it to operate as intended, when it is exposed to the electromagnetic field whose electrical field component strength is as shown in table 5.

Table 5: Interfering electrical field strengths

Frequency range (GHz)	Electrical field strength (V/m)
2 to 3	3

Verification:

Conformance shall be determined by measurement according to IEC 801-3 [7], Clauses 6 to 9 as described in subclause 6.7.

8.4 Communication between SNG TES and satellite operator

General:

This specification applies if required by the manufacturer.

Purpose:

To ensure an efficient means of controlling transmissions from the SNG TES.

Specification:

Two-way communication channels shall be available between the on-site operator of the SNG TES and the satellite operator prior to and during transmission of the SNG carrier.

It is recommended that these communications channels may be provided by one of the following methods:

1) a circuit via a Public or Private Network;

2) a circuit via the SNG TES;

3) a circuit provided by any combination of the above.

Verification:

In the case of method 1) above verification is not applicable.

In the case of method 2) above conformance shall be determined by documentary evidence and by visual inspection.

In the case of method 3) above conformance shall be determined by documentary evidence and by visual inspection.

8.5 Automatic Transmitter Identification System (ATIS)

General:

This specification applies if required by the manufacturer.

Purpose:

To enable identification of interfering television carriers.

Specification:

An ATIS shall be installed such that it is activated whenever a TV carrier is activated.

NOTE: A common standard for an ATIS is under study.

Verification:

Conformance shall be determined from documentary evidence provided by the manufacturer.

Annex A (informative): Spurious radiation: test procedures

A.1 Introduction

This Annex addresses the measurement procedure of spurious radiation from 30 MHz to 40 GHz generated by an SNG TES under operation. The radiation's considered are those which are not only generated at the focal point of the antenna sub-system and are thus radiated in random directions around the earth station. Since these radiation's are most likely to interfere with any type of equipment, the measurement should be done at ground level and at several locations surrounding the SNG TES.

For purposes of the test, the SNG TES is referred to as the EUT and is defined in subclause 3.2.

The test procedure is based on existing international standards and more specifically CISPR Publication 22 [5] and EN 55011 [8].

A.2 Measuring equipment

A.2.1 Spectrum analyser

The spectrum analyser should comply with the following characteristics:

- sweep time variation capability is recommended;

- a filter should be provided at the input of the spectrum analyser to give at least 30 dB of attenuation at the operating frequency in order to protect the input circuits of the analyser from damage when measuring weak spurious emissions in the presence of a strong fundamental;

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

- quasi-peak detector is recommended for all measurements below 960 MHz.

A.2.2 Signal generator

This should be calibrated for operation across the frequency range of interest.

A.2.3 Substitution antenna

When measuring in the frequency range up to 960 MHz the substitution antenna should be calibrated with respect to an isotropic antenna. When measuring in the frequency range above 960 MHz a series of horn antennas of known gain/frequency characteristics should be used.

A.2.4 Measuring antenna and associated amplification system

The antenna should be mounted in such a way that both horizontal and vertical polarisation's can be measured. The antenna should have pronounced directivity. The amplitude/frequency response of this system should remain within ± 1 dB of the combined calibration curve across the measurement frequency range considered for the antenna.

A.2.5 Screening

The screening performance of all measurement equipment and interconnecting cables should be in conformity with CISPR Publication 16 [9], Section One, Clause 6.

A.3 Test site and test set-up

A.3.1 Test site

The test site should be on a reasonable level surface or ground and it should be free from reflecting objects so that the measurement results are not unduly affected. The test site should be in conformance with CISPR Publication 22 [5] subclause 10.3.

A.3.2 Test set-up

The measuring antenna should be installed at a distance of 10 m from the boundary of the EUT. and outside ± 7° of the main beam direction and at the level of the lower edge of the aperture of the EUT antenna. The boundary of the EUT is defined in CISPR Publication 22 [5] subclause 10.3.1. The main beam of the EUT antenna should have an angle of elevation of at least 7°.

The measuring equipment and interconnecting cables should be properly screened so that the background noise with the EUT switched off should be at least 10 dB below the expected spurious levels when the EUT is switched on.

A.4 Measuring method

The test consists of two phases, the identification of spurii and the measurement of their respective levels:

1) below 960 MHz the measurement method of CISPR Publication 22 [5] applies;

2) for frequencies above 960 MHz the European Standard EN 55011 [8] applies.

The identification of spurii should be done so that the EUT is inspected at all frequencies within the test band in both polarisation's.

The test can be performed either on an open area test site or in an anechoic chamber, whilst either a screened room or TEM cell can be used for the first phase of the test.

The measurement of the identified spurii should be performed in accordance with the test equipment set-up as in subclause A.3.2 with the following parameters:

- measuring bandwidth: 120 kHz for quasi-peak detection apparatus;

- measuring angular step in the horizontal plane: 10° around the EUT;

- EUT main beam elevation: 7° or greater.

For each frequency, previously identified, the maximum field strength, as obtained by peaking up both horizontal position and polarization, should be recorded.

The power level of the spurii should be determined from the field strength measured in accordance with the appropriate reference document for that particular frequency. Above 960 MHz the path loss between the EUT and the measuring antenna should be taken into account in determining the actual eirp emanating from the EUT.

A.5 Operating mode signal generation

In order to measure the system radiated emissions and electromagnetic immunity under operational conditions, proper arrangements should be provided, by the manufacturer, to put the SNG TES in its normal operating mode. A receive signal should be provided to emulate the operational conditions of reception. For radiated emission measurements in carrier-on mode, the SNG TES should be transmitting at the maximum eirp.

Annex B (informative): Radio frequency radiation protection: Test procedures

B.1 Introduction

This Annex addresses the measurement procedure for RF radiation levels from 300 MHz to 40 GHz generated by an SNG TES under operation. The RF radiation considered is all RF radiation generated by an SNG TES under operation. It is obvious that the main source of the hazardous RF radiation is the transmit sub-system as defined in subclause 3.2, but the other parts of the SNG TES may have a significant impact on the measuring results and cannot be overlooked. For the purposes of this procedure the complete SNG TES, as defined in subclause 3.2 should be the EUT.

The measurement procedure of the RF radiation level covers near and far-field situations which are typified by the following:

- leakage fields;

- radiation fields;

- reactive fields.

Leakage fields are generally defined as those areas around equipment and interconnection points where radiation is unintentional. Radiation fields are generally defined as those areas around equipment which is designed to radiate energy in a certain direction. These radiation fields can therefore be either intentional or unintentional. Reactive fields are present in the immediate vicinity of the sources of both leakage and radiation fields. These fields tend to be stronger near to equipment which is not designed to radiate power.

If the radiating source is an antenna with maximum overall dimension D, which is large compared to the wavelength, the far-field region is commonly taken to exist at distance greater than $2D^2/\lambda$ from the antenna, λ being the wavelength.

Since the radiation is most likely to cause exposure to personnel, the measurement should be done at ground level at all locations accessible to personnel.

The power should be measured and averaged over a surface less than 4 cm^2.

The test procedure is based on existing national recommendations.

B.2 Measuring equipment

B.2.1 General requirements

Near-field and far-field measurements require special instrumentation. This instrumentation can be divided into three basic parts:

- sensor;

- leads;

- metering equipment.

The measurement localities are in both the near-field and far-field regions and the requirements for instrumentation applies to both regions. The near-field criteria are more stringent and to make meaningful near-field measurements the following conditions should be satisfied:

- the probe should respond to a particular parameter and not have spurious responses;

- the dimension of the probe sensor should be less than a wavelength at the highest measuring frequency;

- the probe should not produce significant scattering;

- the probe response should be independent of orientation (that is, it should be non-directional and non-polarised);

- the leads from the sensor to the meter should not disturb the field at the sensor significantly or couple energy from the field.

B.2.2 Electrical performance characteristics

B.2.2.1 Power supply

The instrument should employ a self-contained power supply, isolated from external fields by appropriate shielding and filter de-coupling. If batteries are used provision should be made for determining their condition by a "press-to-test" button. The instrument should be capable of at least eight hours operation within its rated accuracy before replacement or recharging of batteries.

B.2.2.2 Polarisation

The probe should be responsive to all polarisation components of the electromagnetic field. This performance may be accomplished either by inherent design (preferred method) or by physical rotation of the antenna on its mount.

B.2.2.3 Units and range

For hazards to personnel the preferred unit of measurement is:

- average power density in watts/square metre (W/m^2).

Other acceptable units, with the last two being the more popular, are:

- mean-squared electric field strength in volts squared/metre squared (V^2/m^2);

- mean-squared magnetic field strength in amperes squared/metre squared (A^2/m^2);

- energy density in joules/cubic metre (J/m^3);

- milliWatts/square centimetre (mW/cm^2);

- picojoules/cubic centimetre (pJ/cm^3).

A dynamic range of ± 10 dB with respect to the limits specified in subclause 5.3 should be adequate. The instrument should be sensitive to continuous-wave and pulsed-continuous-wave fields and be independent of duty factor. However it is permissible to have a detector or indicator time-constant switch for the continuous-wave and pulsed-continuous-wave modes.

B.2.2.4 Recorder output

The instrument should be equipped with a recorder output or other means which will enable measurement of any hazardous power density without endangering the operator. Alternate provisions to a recorder output may be extension cables between the probe and the meter or maximum-hold mode of operation where maximum surveyed indications would be maintained until reset manually by the operator.

B.2.2.5 Shielding

The instrument housing and extension cables should provide shielding, as required, to ensure that the measurement uncertainty remains within stated limits when the instrumentation or cables are exposed to the same field strength as the probe.

B.2.2.6 Modulation

The instrument should indicate rms parameters, independent of any modulation.

B.2.2.7 Static

The instrument should not be responsive to static charges.

B.2.2.8 Response time

The response time (i.e. time required to obtain a correct reading) of the instrument should be made known to the user.

B.2.3 Physical characteristics

B.2.3.1 Portability

The instrument should be portable to permit convenient operation.

B.2.3.2 Weight

The weight should be kept as low as is practical in keeping with good engineering practice.

B.2.3.3 Volume

The volume should be as small as is practical, approximating to a 15 cm cube or less (excluding the probe or antenna) for handheld units.

B.2.3.4 Temperature, humidity and pressure

The quoted accuracy of the instrument should include the effect of temperature, humidity and pressure variations within their specified ranges.

B.2.3.5 Durability

The indicating meter and other system components should be rugged enough to withstand vibration and shock resulting from transport. A carrying case is advisable.

B.2.3.6 Response to other radiation

The inherent accuracy of the instrument should not be altered by exposure to ionizing radiation, artificial light, sunlight or corona.

B.2.3.7 Readability

The indicating meter dial markings should be clearly indicated and be large enough to be easily read at arm's length.

B.2.3.8 Controls

The unit should have a minimum number of controls which should be clearly labelled as to their functions. There should be no requirements for moving two controls at the same time. For mechanical meter movements the electrical zero point should be coincident or upscale from the mechanical zero of the indicating meter.

B.2.3.9 Operation

Complicated operating procedures should be avoided. The average technician should be able to make accurate measurements with only the information supplied in the instruction manual.

B.3 Test site and test set-up

B.3.1 Test site

Special care should be taken at the test site to avoid the effects of scattering caused by the test operator, interconnecting cables, support structure and readout device.

B.3.2 Test set-up

The EUT is operated under worst operating conditions (maximum transmit power, down to minimum elevation angle by steps) as declared by the manufacturer.

If the results of measurements depend on the configuration of the cable between the probe and readout device then the cable should preferably be:

- oriented perpendicular to the incident electrical field; or

- covered with an RF absorber;

or, failing the above:

- fibre optic; or

- high-resistance cable; or

- double-shielded cable;

should be used.

All metallic objects, including the instrument readout device should be covered with absorbing material of appropriate quality.

Dielectric fixtures should be as small as possible. They should possess either a very low dielectric constant or be less than one-quarter wavelength in effective thickness, where:

$$T_E = T \times \sqrt{\varepsilon_r}$$

with T_E = the effective thickness, T = the physical thickness and ε_r = the relative permittivity.

An isotropic and broad band probe should be used at all times with the hazardous fields generated by the EUT being treated as unknown.

B.4 Measuring method

The measurements should be done by continuous scanning of the region of interest or by a series of single point measurements. If single point measurements are performed, instead of continuous scans, at least eight evenly distributed points per wavelength should be taken to ensure that the approximate maxima and minima have been measured.

While mounting or holding the measuring probe, care should be taken to avoid reflections or alterations of the field by support structures or by the operator's body.

Since standing-wave effects and multiple-field interactions should be accounted for, it is necessary to scan a volume of space in the region of interest.

Due to the large spatial variations which occur in the near field of a radiating source, a series of continuous scans or single point measurements should be performed in order to find the points exceeding the levels specified in subclause 5.3.

B.5 Using the results

Mark off the regions wherein radio frequency radiation levels exceed the levels specified in subclause 5.3. From these marked regions produce the required warning notice for display.

History

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