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**Electromagnetic compatibility and
Radio spectrum Matters (ERM);
Maritime Personal Homing Beacon
intended for use on the frequency 121,5 MHz for
search and rescue purposes only;
Part 1: Technical characteristics and methods of measurement**

Reference
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Foreword

This draft European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

The present document is part 1 of a multi-part deliverable covering the Electromagnetic compatibility and Radio spectrum Matters (ERM); Maritime Personal Homing Beacon intended for use on the frequency 121,5 MHz (radio beacons) as identified below:

Part 1: "Technical characteristics and methods of measurement";

Part 2: "Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive";

Part 3: "Harmonized EN covering the essential requirements of article 3.3 (e) of the R&TTE Directive".

The present document lays down the minimum requirements for maritime "Personal Homing Radio Beacon for 121,5 MHz search and rescue purposes", and incorporates the relevant provisions of the International Telecommunication Union (ITU) radio regulations.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

Introduction

The present document has been produced by ETSI in response to a mandate from the European Commission issued under Council Directive 98/34/EC [4] laying down a procedure for the provision of information in the field of technical standards and regulations.

1 Scope

The present document lays down the minimum requirements for maritime "Personal Homing Radio Beacon for 121,5 MHz search and rescue purposes", and incorporates the relevant provisions of the International Telecommunication Union (ITU) radio regulations.

The radio beacons described in the present document are intended only for transmission of radio signals on the frequency 121,5 MHz for locating purposes.

The present document applies to radio beacons intended for short-range maritime personal homing applications. For this application, both the radiated power and the length of time of operation are reduced to enable the equipment to be sufficiently small and light to be worn comfortably at all times.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

[1] ITU-R Recommendation M.690-1: "Technical characteristics of emergency position-indicating radio beacons (EPIRBs) operating on the carrier frequencies of 121.5 MHz and 243 MHz".

[2] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[3] ETSI TR 102 273-7 (2001): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 7: Artificial human beings".

[4] Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations.

[5] ANSI C63.5-2006: "American National Standard for Calibration of Antennas Used for Radiated Emission Measurements in Electro Magnetic Interference".

[6] IEC 60489-3 (edition 2.0) and Amendment 1: "Methods of measurement for radio equipment used in the mobile services. Part 3: Receivers for A3E or F3E emissions", appendix F.

[7] ETSI TR 102 273 (Parts 2, 3 and 4): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document the following terms and definitions apply:

homing device: 121,5 MHz radio beacon primarily intended for transmitting homing signals

3.2 Symbols

For the purposes of the present document, the following symbols apply:

ε	permittivity
σ	Conductivity
λ	wavelength
cSt	centi-Stokes
dB	decibel
div	division
S	Siemens

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ASK	Amplitude Shift Keying
ASTM	American Society for Testing and Materials
CSP	Channel Spacing
CW	Continuous Wave
DF	Direction Finding
ERP	Effective Radiated Power
ERPEP	Effective Radiated Peak Envelope Power
EUT	Equipment Under Test
OATS	Open Area Test Site
RF	Radio Frequency
SINAD	(Signal+Noise+Distortion) to (Noise + Distortion)
VSWR	Voltage Standing Wave Ratio

4 General requirements

4.1 Construction

The manufacturer shall declare that compliance to the requirements of clause 4 is achieved and shall provide relevant documentation.

In all respects, the mechanical and electrical design and the construction and finish of the equipment shall conform with good engineering practice.

The equipment shall be designed to minimize the risk of internal and external damage during use or stowage.

The exterior of the equipment shall have no sharp edges or projections that could easily damage inflatable rafts or injure personnel.

The general construction and method of operation shall provide a high degree of proof against inadvertent operation due to magnetic influences, handling, stowage and transit, whilst still providing a simple means of operation in an emergency.

The equipment shall be portable, lightweight, compact and be designed as one integral unit. The radio beacon shall derive its energy from a battery forming a part of the equipment and incorporate a permanently attached antenna which may be either fixed length or extendible.

The radio beacon may be fitted with a test facility by which the functioning of the transmitter and battery can be easily tested without the use of any external equipment.

The equipment shall be capable of being used by an unskilled person.

The radio beacon shall be watertight and buoyant.

A substantial part of the equipment shall be of highly visible yellow or orange colour to assist visual location. Beacons operating on 121,65 MHz for training purposes shall not be substantially yellow or orange but another clearly different colour.

The equipment shall not be unduly affected by sea water or oil and shall be resistant to deterioration by prolonged exposure to sunlight.

Necessary operating instructions shall be provided with the equipment.

4.2 Controls

The equipment shall be initially activated by the use of two simple, but independent mechanical actions, neither of which on its own shall activate the equipment. The second mechanical action may be replaced by an immersion sensor.

It shall only be possible to activate the equipment after a seal or other mechanical restraint has been removed from the first mechanical action. After activation it shall be simple to de-activate the equipment and the means to deactivate the equipment shall be clearly marked.

The switch that operates any test facility (clause 4.1) shall be so designed that it returns automatically to the off-position when released.

4.3 Indicators

The equipment shall be provided with a visual indication that signals are being emitted. The indicator shall be sufficiently bright to be seen in bright sunlight. The indicator shall not be green in colour.

4.4 Labelling

The equipment shall be provided with a label, or labels, permanently affixed to the exterior of the equipment, containing the following information:

- frequency or frequencies of operation of the equipment;
- serial number of the equipment;
- type designation of the equipment;
- adequate instructions to enable the equipment to be activated and de-activated;
- the type of battery as specified by the manufacturer of the radio beacon;
- a warning to the effect that the radio beacon should not be operated except in an emergency;
- the date on which the battery will need to be replaced. Simple means shall be provided for changing this date when the battery is replaced.

4.5 Power source

4.5.1 Battery requirements

The type of battery and designation specified by the manufacturer for use in the equipment shall be clearly and indelibly marked on the equipment.

The battery shall be clearly and durably marked with the expiry date.

4.5.2 Safety precautions

Provisions shall be made for protecting the equipment from damage due to the accidental reversal of polarity of the battery.

5 Technical requirements

5.1 Radio beacon transmission characteristics

When activated, the radio beacon shall transmit continuously on the frequency 121,5 MHz or 121,65 MHz for beacons solely intended for training and testing purposes.

The class of emission shall be A3X as defined in ITU-R Recommendation M.690-1 [1]. However, the signal may include information of the identity of the beacon. If included, this information should be transmitted automatically as defined in clause 8.2.

5.2 Radio beacon power source

5.2.1 Battery requirements

The battery provided as a power source shall be a primary battery and have sufficient capacity to operate the equipment for an uninterrupted period of at least 6 hours, under all temperature conditions, (clause 6.6), within the requirements of the present document.

6 General conditions of measurement

6.1 Test frequencies

For the purpose of conformity testing, the radio beacon shall be tested on 121,5 MHz. For beacons solely intended for training purposes shall be tested on 121,65 MHz. Where radiated measurements are not performed in an anechoic chamber the alternative frequency of 121,65 MHz shall be used.

6.2 Test fixture

In the case of integral antenna equipment, if the equipment does not have an internal permanent 50 Ω connector then it is permitted to supply a second sample of the equipment with a temporary antenna connector fitted to facilitate testing. Alternatively a test fixture may be used provided that it complies with the requirements below.

The test fixture is a device for coupling the integral antenna of the equipment under test to a 50 Ω radio frequency terminal at the working frequency. This allows certain measurements to be performed using the conducted measurement methods. Only relative measurements shall be performed and only those at or near the frequency for which the test fixture has been calibrated.

The test fixture normally shall be provided by the manufacturer.

The performance characteristics of the test fixture shall conform to the following basic parameters:

a) the coupling loss shall not be greater than 30 dB;

b) a coupling loss variation over the frequency range used in the measurement which does not exceed 2 dB;

c) circuitry associated with the Radio Frequency (RF) coupling shall contain no active or non linear devices;

d) the VSWR at the 50 Ω socket shall not be greater than 1,5 over the frequency range of the measurements;

e) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced;

f) the coupling loss shall remain substantially constant when the environmental conditions are varied.

Any connections provided on the equipment in order to facilitate relative measurements shall not affect the performance of the equipment, neither in the test fixture nor when making measurements involving the use of radiated fields.

6.3 Measurement uncertainty and interpretation of the measured results

6.3.1 Measurement uncertainty

Table 1: Absolute measurement uncertainties: maximum values

Parameter	Maximum uncertainty
RF frequency	$\pm 1 \times 10^{-7}$
Radiated emission of transmitter	±6 dB
Conducted RF power variations using a test fixture	±0,75 dB
Modulation depth	±5 %
Modulation duty cycle	±5 %
Spectral carrier power ratio	±0,75 dB
Audio frequency	±5 %
Sweep repetition rate	±5 %

6.3.2 Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 1.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 [2] and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

Table 1 is based on such expansion factors.

6.4 Test conditions power sources and ambient temperatures

6.4.1 Normal and extreme test conditions

Conformity testing shall be carried out under normal test conditions (clause 6.5) and also where stated under extreme test conditions (clauses 6.6.1 and 6.6.2 applied simultaneously).

6.4.2 Test power source

Where stated, the battery of the equipment shall be replaced by a test power source capable of producing normal (clause 6.5.2) and extreme test voltages as specified in clauses 6.6.2.1 and 6.6.2.2.

6.5 Normal test conditions

6.5.1 Normal temperature and humidity

Normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity, within the following ranges:

- Temperature: +15 °C to +35 °C.
- Relative humidity: 20 % to 75 %.

6.5.2 Normal test voltage

The normal test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that a fresh battery gives at normal temperature and humidity at a load equal to that of the equipment when activated.

6.6 Extreme test conditions

6.6.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedure specified in clause 6.6.1.1 at the lower and upper temperatures of -20 °C and +55 °C respectively except when installed within other equipment subject to more stringent temperature requirements, in which case the more stringent requirements shall apply.

6.6.1.1 Procedure for tests at extreme temperatures

The equipment shall be switched off during the temperature stabilization period.

Before tests are carried out, the equipment shall have obtained thermal balance in the test chamber and have been activated for a period of 5 minutes.

The location of the equipment under test in the climatic chamber shall not substantially influence the power output or the power consumption of the equipment under test.

6.6.2 Extreme test voltages

6.6.2.1 Upper extreme test voltage

The upper extreme test voltage shall be determined in each case and shall be the voltage corresponding to the voltage that a fresh battery gives at the upper extreme temperature with a load equal to that of the equipment when activated.

6.6.2.2 Lower extreme test voltage

The lower extreme test voltage shall be determined in each case. The equipment fitted with a primary battery shall be placed in a climatic chamber and cooled to -20 °C allowing a stabilization period of 2 hours. The equipment shall then be activated for a period of 6 hours. After this period the battery voltage shall be measured. This voltage shall be taken as the lower extreme test voltage and shall be measured before disconnecting the battery.

7 Environmental tests

7.1 Introduction

The requirements of clause 7 demonstrate that the equipment is capable of continuous operation under the conditions of various sea states, vibration, humidity and change of temperature likely to be experienced on a ship in which it is carried.

7.2 Procedure

Environmental tests shall be carried out before tests in respect of the other requirements in the present document are performed on the same equipment.

7.3 Performance check

The term performance check as used in the present document shall be taken to mean a check of:

- Frequency error: the carrier frequency 121,5 MHz shall be measured with the equipment placed in the test fixture (clause 6.2). The frequency error shall not exceed ±10 ppm.
- Maximum effective radiated peak envelope power: the output power shall be measured with the equipment placed in the test fixture (clause 6.2). The measured power corrected with the reference factor (clause 8.4.3) shall be at least 25 mW.

The performance check shall be carried out only under normal test conditions unless otherwise stated.

7.4 Drop test

7.4.1 Definition

The immunity against the effects of dropping is the ability of the equipment to maintain the specified mechanical and electrical performance after being subjected to a series of drops on a hard wooden test surface.

7.4.2 Test conditions

During the test, the equipment shall be fitted with a suitable set of batteries and antenna but it shall be switched off. The test shall be carried out under normal temperature and humidity conditions as detailed in clause 6.5.1.

The hard wooden test surface shall consist of a piece of solid hard wood with a minimum thickness of 15 cm and a mass of at least 30 kilograms.

The height of the lowest part of the equipment under test, relative to the test surface at the moment of release, shall be 1 m.

Equipment shall be subjected to this test in the configuration as it is normally used in operational circumstances.

7.4.3 Method of measurement

The test shall consist of six drops, once on each face.

7.4.4 Requirements

After the drops have been completed the equipment shall be inspected visually for signs of damage. Inspection for mechanical damage, both internal and external, shall be carried out. Any damage shall not impair the operation of the equipment. In particular, parts like knobs, switches and the antenna shall operate in the normal manner. The act of dropping shall not cause the equipment to operate.

7.5 Temperature tests

7.5.1 Definition

The immunity against the effects of temperature is the ability of the equipment to maintain the specified mechanical and electrical performance after the following tests have been carried out.

The maximum rate of raising or reducing the temperature of the chamber in which the equipment is being tested shall be 1 °C/minute.

7.5.2 Dry heat test

7.5.2.1 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The EUT and, if appropriate, any climatic control devices with which it is provided shall then be switched on. The temperature shall then be raised to and maintained at +55 °C (±3 °C). At the end of the period of 10 hours to 16 hours at +55 °C (±3 °C), the EUT shall be subjected to the performance check. The temperature of the chamber shall be maintained at +55 °C (±3 °C) during the whole of the performance check period. At the end of the test, the EUT shall be returned to normal environmental conditions or to those at the start of the next test.

7.5.2.2 Requirement

The requirement for the performance check shall be met.

7.5.3 Damp heat test

7.5.3.1 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be raised to +40 °C (±2 °C), and the relative humidity raised to 93 % (±3 %) over a period of 3 hours ± 0,5 hours. These conditions shall be maintained for a period of 10 hours to 16 hours.

The EUT shall be switched on 30 minutes later, or after such period as agreed with the manufacturer, and shall be kept operational for at least 2 hours during which period the EUT shall be subjected to the performance check. The temperature and relative humidity of the chamber shall be maintained as specified during the whole test period.

At the end of the test period and with the EUT still in the chamber, the chamber shall be brought to room temperature in not less than 1 hour. At the end of the test the EUT shall be returned to normal environmental conditions or to those required at the start of the next test.

7.5.3.2 Requirement

The requirement for the performance check shall be met.

7.5.4 Low temperature test

7.5.4.1 Method of measurement

The EUT shall be placed in a chamber at normal room temperature and relative humidity. The temperature shall then be reduced to, and be maintained at, -15 °C (±3 °C) for a period of 10 hours to 16 hours. Any climatic control devices provided in the EUT may be switched on at the conclusion of this period. The EUT shall be switched on 30 minutes later, or after such period as agreed by the manufacturer, and shall be kept operational for at least 2 hours during which period the EUT shall be subjected to a performance check. The temperature of the chamber shall be maintained at -15 °C (±3 °C) during the whole of the test period. At the end of the test the EUT shall be returned to normal environmental conditions or to those required at the start of the next test.

Throughout the test the equipment shall be working normally.

7.5.4.2 Requirement

The requirement for the performance check shall be met.

7.6 Vibration test

7.6.1 Definition

The immunity against the effects of vibration is the ability of the equipment to maintain the specified mechanical and electrical performance when the following test is carried out.

7.6.2 Method of measurement

The equipment, complete with any shock absorbers which are part of it, shall be clamped to the vibration table by its normal means of support and in its normal attitude.

The equipment may be suspended to compensate for weight not capable of being withstood by the vibration table.

Provisions may be made to reduce or nullify any adverse effect on the equipment performance which may be caused by the presence of any electro-magnetic fields from the vibration table.

Taking at least 15 min to cover each octave of frequency, the equipment shall be subjected to sinusoidal vertical vibration at all frequencies between:

- 2 Hz or 5 Hz and 13,2 Hz with an excursion of ±1 mm ± 10 %;
- 13,2 Hz and 100 Hz with a constant maximum acceleration of 7 m/s/s.

A resonance search shall be carried out during the vibration test. If any resonance of the EUT has Q greater than 5 measured relative to the base of the vibration table, the EUT shall be subjected to a vibration endurance test at each resonant frequency at the vibration level specified in the test with a duration of 2 h. If no resonance with Q greater than 5 occurs the endurance test shall be carried out at one single observed frequency. If no resonance occurs the endurance test shall be carried out at a frequency of 30 Hz.

The test shall be repeated with vibration in each of the mutual perpendicular direction in the horizontal plane.

A performance check shall be carried out at least once during each endurance test period and once before the end of each endurance test period.

7.6.3 Requirement

The radio beacon shall not automatically activate during the vibration test.

The requirement for the performance check shall be met. No damage or mechanical deterioration shall be visible to the naked eye. The EUT if tested with a vibration absorber (e.g. a life jacket) shall not become detached.

7.7 Corrosion test

This test need not be carried out if the manufacturer produces sufficient evidence that the components, materials etc. maintain their specified mechanical and electrical performance against the effects of corrosion.

7.7.1 Definition

The immunity against the effects of corrosion is the ability of the equipment to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.7.2 Method of measurement

The equipment shall be placed in a chamber fitted with apparatus capable of spraying in the form of fine mist, such as would be produced by a spray gun, salt solution to the formula in table 2.

Table 2: Salt solution formula

sodium chloride	26,5	g	±10 %
magnesium chloride	2,5	g	±10 %
magnesium sulphate	3,3	g	±10 %
calcium chloride	1,1	g	±10 %
potassium chloride	0,73	g	±10 %
sodium bicarbonate	0,20	g	±10 %
sodium bromide	0,28	g	±10 %
plus distilled water to make the solution up to 1 l.			

Alternatively a 5 % sodium chloride (NaCl) solution may be used. The salt used for the test shall be high quality sodium chloride (NaCl) containing, when dry, not more than 0,1 % sodium iodide and not more than 0,3 % of total impurities.

Salt solution concentration shall be 5 % (±1 %) by weight. The solution shall be prepared by dissolving 5 parts ±1 by weight of salt in 95 parts by weight of distilled or de-mineralized water.

The pH value of the solution shall be between 6,5 and 7,2 at temperature of 20 °C (±2 °C). The pH value shall be maintained within this range during conditioning. For this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

The spraying apparatus shall be such that the products of corrosion cannot mix with the salt solution contained within the spray reservoir.

The equipment shall be sprayed simultaneously on all its external surfaces with the salt solution for a period of 1 hour. This spraying shall be carried out 4 times with a storage period of 7 days; at 40 °C (±2 °C) after each spraying. The relative humidity during storage shall be maintained between 90 % and 95 %.

At the end of the total period the equipment shall be examined visually.

7.7.3 Requirements

There shall be no undue deterioration or corrosion of the metal parts, finishes, material, or component parts visible to the naked eye.

In the case of hermetically sealed equipment there shall be no evidence of moisture penetration.

7.8 Thermal shock test

7.8.1 Definition

The immunity against the effects of thermal shock is the ability of the equipment to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.8.2 Method of measurement

The equipment shall be placed in an atmosphere of +65 °C (±3 °C) for 1 hour. It shall then be immersed in water at +4 °C (±3 °C) to a depth of 10 cm, measured from the highest point of the equipment to the surface of the water, for a period of 1 hour.

7.8.3 Requirements

The requirement for the performance check shall be met. No damage shall be visible to the naked eye and the equipment shall not show any sign of significant external damage or harmful penetration of water.

7.9 Buoyancy test

7.9.1 Definition

Buoyancy, expressed as a percentage, is its buoyant force divided by its gravity force.

7.9.2 Method of measurement

The radio beacon shall be submerged in calm fresh water.

One of the following methods of measurement shall be used:

- the buoyant force shall be measured when the radio beacon is totally submerged in fresh water. The buoyant force shall be then divided by the measured gravity force. The result shall be recorded; or
- the buoyancy may be calculated by dividing the volume of the unit above the waterline by the total volume of the radio beacon. The result shall be recorded.

7.9.3 Requirements

The value of buoyancy shall be at least 5 %.

7.10 Solar radiation test

This test need not be carried out if the manufacturer produces sufficient evidence that the components, materials etc. maintain their specified mechanical and electrical performance against the effects of continuous solar radiation.

7.10.1 Definition

The immunity against the effects of continuous solar radiation is the ability of the equipment to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.10.2 Method of measurement

The equipment shall be placed on a suitable support and exposed continuously to a simulated solar radiation source (table 3) for 80 hours.

The intensity at the test point, which shall also include any radiation reflected from the test enclosure, shall be 1 120 W/m^2 ± 10 % with a spectral distribution given in table 3.

Table 3: Spectral distribution

Spectral Region	Ultra-violet B	Ultra-violet A	Visible			Infra-red
Bandwidth {μm}	0,28 to 0,32	0,32 to 0,40	0,40 to 0,52	0,52 to 0,64	0,64 to 0,78	0,78 to 3,00
Radiance {W/m^2}	5	63	200	186	174	492
Tolerance {%}	±35	±25	±10	±10	±10	±10
NOTE: Radiation shorter than 0,30 μm reaching the earth's surface is insignificant.						

7.10.3 Requirements

No damage shall be visible to the naked eye and the equipment shall not show any sign of significant external damage or harmful penetration of water.

7.11 Oil resistance test

This test need not be carried out if the manufacturer produces sufficient evidence that the components, materials etc. maintain their specified mechanical and electrical performance against the effects of corrosion.

7.11.1 Definition

The immunity against the effects of immersion in mineral oil is the ability of the equipment to maintain the specified mechanical and electrical performance after the following test has been carried out.

7.11.2 Method of measurement

The equipment shall be immersed horizontally for a period of 24 hours under a 100 mm head of mineral oil as specified below at normal room temperature.

- aniline point: 120 °C;
- flash point: minimum 240 °C;
- viscosity: 10 - 25 cSt at 99 °C.

The following oils may be used:

- ASTM Oil No. 1;
- ASTM Oil No. 5;
- ISO Oil No. 1.

7.11.3 Requirements

No sign of damage such as shrinking, cracking, swelling, dissolution or change of mechanical qualities of the radio beacon, including labelling, shall be visible to the naked eye.

7.12 Protection of the transmitter

7.12.1 Definition

When operating, the radio beacon transmitter shall not be damaged due to antenna mismatching.

7.12.2 Method of measurement

With the transmitter operating, the equipment shall be completely immersed in water for a period of 5 minutes. For equipment fitted with an extendible antenna, the test shall be carried out with the antenna fully extended, and repeated with the antenna fully retracted under normal test conditions.

7.12.3 Requirement

No damage shall be visible to the naked eye and the equipment shall not show any sign of significant external damage or harmful penetration of water, and the requirements of the performance check shall be met.

8 Tests on the transmitter

8.1 Frequency error

8.1.1 Definition

The frequency error is the difference between the measured carrier frequency and its nominal value (clause 5.1).

8.1.2 Method of measurement

The carrier frequency shall be measured with the equipment placed in the test fixture (clause 6.2). The measurement shall be made using the test power source (see clause 6.4.2) under both normal and extreme test conditions.

8.1.3 Limit

The frequency error under normal conditions shall not exceed ±10 ppm, and under extreme test conditions shall not exceed ±15 ppm.

8.2 Modulation characteristics

The carrier shall be amplitude modulated with audio modulation interspersed with brief non-audio modulation. Non-audio modulation is used to support Direction Finding (DF) receivers and to transmit identity and position information data.

8.2.1 Modulation sequence

8.2.1.1 Definition

The modulation sequence comprises cycles of audio and non-audio modulation in sequence as shown in figure 1.

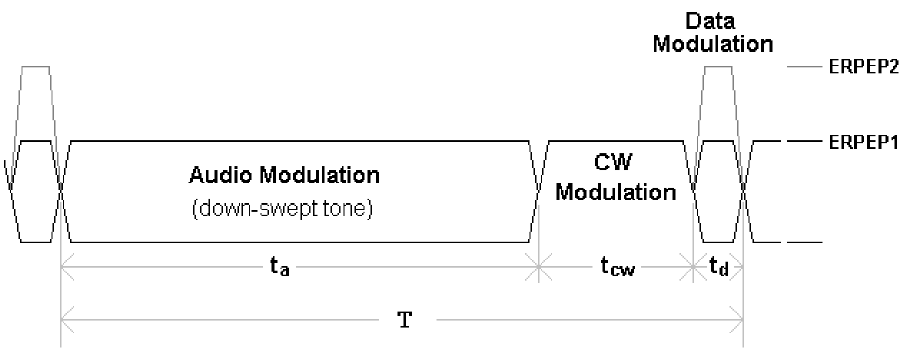

Figure 1

Continuous Wave (CW) modulation is non-audio modulation used to aid DF receivers in getting a bearing to target. CW is transmitted continuously at an average ERP approximately equal to the ERPEP of the audio modulation that it follows (ERPEP1 in figure 1).

Data modulation is non-audio modulation. It may be used to transmit information such as the identity and position of a radio beacon. Either ASK (A1D) or sub-carrier modulation shall be employed. The ERPEP of transmitted data (ERPEP2 in figure 1) may be significantly higher than used for the other modulation types in order to aid reception in a field where multiple beacons are transmitting simultaneously. The format for the transmission of data is not specified here. Note that the use of non-constant (randomised) values of T will assist in decoding of multiple beacons.

Audio modulation is mandatory whereas CW and data modulation are optional, however if all types are employed they shall always be in the sequence set out in figure 1.

8.2.2 Depth of audio modulation

8.2.2.1 Definition

The depth of modulation is calculated from the formula: $\frac{A-B}{A+B} \times 100\ \%$

Where A and B are respectively the maximum and minimum value of the modulation envelope in figure 2.

8.2.3 Audio modulation duty-cycle

8.2.3.1 Definition

The modulation duty cycle is the ratio: $\frac{t_1}{t_2} \times 100\ \%$ where t_1 is the duration of the positive half cycle of the audio modulation measured at the half amplitude points of the modulation envelope, and t_2 is the period of the fundamental of the audio modulation, in figure 2.

8.2.4 Method of measurement

The modulation sequence timings (t_a, t_{CW} and t_d), depth of modulation and the modulation duty cycle shall be measured with the radio beacon placed in the test fixture (see clause 6.2). The emission is suitably applied to the input of a storage oscilloscope. A display of the type shown in figures 1 and 2 can be obtained on the storage oscilloscope. The modulation sequence timings are calculated as depicted in figure 1 with the storage scope timebase set to an appropriately long period (e.g. 5 S /div). Where the measurement of t_d is not practical due to the relative position of the data burst the manufacturer shall supply suitable equipment to decode the data burst such that the value of t_d may be determined. The modulation duty cycle and the depth of modulation are calculated as depicted in figure 2 with the storage scope timebase set to an appropriate period (e.g. 250 uS /div).

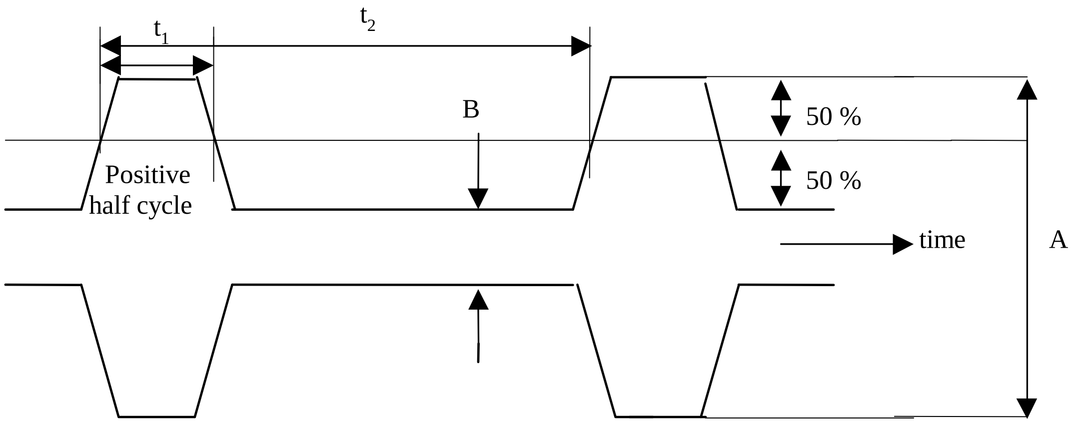

Figure 2

Audio modulation proportion: $\frac{t_a}{T} \times 100\ \%$

Audio modulation depth: $\frac{A-B}{A+B} \times 100\ \%$

Audio modulation duty cycle: $\frac{t_1}{t_2} \times 100\ \%$

Where data modulation is employed at least two consecutive modulation sequence periods (T) shall be measured and compared. The difference ΔT shall be calculated.

NOTE: Low modulation duty cycle may occur by over-modulation.

8.2.5 Limits

The audio modulation proportion shall be at least 80 % of the overall cycle time.

The depth of audio modulation shall be at least 85 %.

The audio modulation duty cycle shall be between 33 % and 55 %.

The period of CW modulation t_{CW} (if employed) shall be between 3 seconds and 5 seconds.

The data modulation period t_d (if employed) shall be no more than 0,5 seconds.

If data modulation is employed ΔT shall be greater than t_d.

8.2.6 Audio sweep characteristics

The audio part of modulation shall be a down-swept tone.

8.2.6.1 Audio sweep range

The audio sweep range is defined by the upper and lower frequencies with which the carrier is amplitude modulated.

8.2.6.2 Audio sweep repetition rate

The sweep repetition rate is defined as the rate at which the audio sweep is repeated.

8.2.6.3 Method of measurement

The sweep range and repetition rate shall be measured with the radio beacon placed in the test fixture (clause 6.2). The emission shall be applied to the input of a suitable receiver or analyser. If a spectrum analyser is used, it shall be tuned to the emission centre frequency and with the following settings:

- Resolution bandwidth: 30 kHz;
- Frequency span: 0 Hz;
- Vertical scale: Linear.

The reference line shall be set as close to full scale deflection as practicable. The video output of the spectrum analyser shall be applied to the input of a digital storage oscilloscope. The oscilloscope shall have deep memory capability (in the order of 50 K samples) such that a complete sweep cycle can be captured without losing waveform detail.

8.2.6.4 Limits

The sweep shall be downwards (high frequency to low frequency).

The highest frequency shall not exceed 1 600 Hz.

The lowest frequency shall be greater than 300 Hz.

The total swept range shall be at least 700 Hz.

The sweep repetition rate shall be between 2 Hz and 4 Hz.

8.3 Spectral carrier power ratio

8.3.1 Definition

The spectral carrier power ratio is the ratio of the total power of the emission to the power centred on the carrier in a specified bandwidth, both measurements taken under normal audio modulated conditions.

8.3.2 Method of measurement

The measurement shall be performed under normal test conditions with the radio beacon placed in the test fixture (clause 6.2).

The manufacturer shall supply a sample with only audio modulation.

To determine the total power, the emission is suitably applied to the input of a spectrum analyser with the following preferred settings:

- Resolution bandwidth: 10 kHz;
- Video filter: off;
- Scan time: 100 ms/division (div);
- Centre frequency: Carrier frequency as measured in clause 8.1.

The total power is determined by noting the power measured from the amplitude reading on the spectrum analyser expressed in logarithmic form and adding it to the modulation duty cycle previously measured and converted to a figure in dB, i.e. $10 \log_{10}$ (spectrum analyser power) $+10 \log_{10} (t_1/t_2)$ using relevant units. (For the definition of t_1 and t_2 see figure 2).

To determine the power in the specified bandwidth, the preferred spectrum analyser settings are as follows:

- Resolution bandwidth: 100 Hz or less;
- Video filter: off;
- Scan time: 10 s/div;
- Centre frequency: Carrier frequency as measured in clause 8.1.

The power in the specified bandwidth is determined from the amplitude reading on the spectrum analyser.

The difference between the total power and the power in the specified bandwidth in dB is the spectral carrier power ratio.

8.3.3 Limit

The spectral carrier power ratio shall be less than 5,2 dB.

8.4 Maximum Effective Radiated Peak Envelope Power (ERPEP)

8.4.1 Definition

The maximum ERPEP is defined as the ERPEP in the direction of maximum field strength under specific conditions of measurement.

The peak envelope power is the average power supplied to the antenna transmission line by a transmitter during one radio cycle at the crest of the modulation envelope taken under normal operating conditions of audio modulation (ERPEP1 in figure 1).

The measurements shall be made under normal test conditions and under extreme test conditions.

8.4.2 Method of measurement under normal test conditions

On a test site selected from annex A, the equipment shall be placed on the support and according to the requirements of clause A.4 for equipment intended to be worn on a person. The equipment shall then be activated. Note that 121,5 MHz shall not be used when testing in an open area.

The receiver shall be tuned to the transmitter carrier frequency. The test antenna shall be orientated for vertical polarization. The test antenna shall be raised or lowered through the specified range of heights until a maximum signal level is detected on the measuring receiver.

The transmitter shall be rotated through 360° around a vertical axis in order to find the direction of the maximum signal.

The maximum signal level detected by the measuring receiver shall be noted.

The transmitter shall be replaced by a substitution antenna as defined in annex A.

The substitution antenna shall be connected to a calibrated signal generator.

The frequency of the calibrated signal generator shall be adjusted to the transmit carrier frequency.

The input attenuator setting of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver, if necessary.

The test antenna shall be raised or lowered through the specified range of heights to ensure that the maximum signal is received.

The input signal to the substitution antenna shall be adjusted to the level that produces a level detected by the measuring receiver that is equal to the level noted to that detected from the equipment under test corrected for the change in input attenuator setting of the measuring receiver.

The maximum ERPEP is equal to the power supplied by the signal generator, increased by the gain of the substitution antenna and corrected for the change in the attenuator.

8.4.3 Method of measurement under extreme test conditions

The equipment shall be placed in the test fixture connected to the artificial load with a means of measuring the power delivered to the load. The equipment shall be operated from the test power source (clause 6.4.2).

The measurement shall be made under normal test conditions initially with the equipment on the support in the standard position (annex A or clause A.4 for equipment intended to be worn on a person) to enable a reference measurement to be made. This enables a reference factor to be determined. The measurement shall be repeated with the test fixture placed in the chamber under extreme test conditions (clause 6.6).

8.4.4 Limit

The ERPEP shall be at least 25 mW, and not more than 500 mW.

8.5 Effective Radiated Power during CW modulation (ERP(CW))

8.5.1 Definition

The ERP(CW) is defined as the ERP in the direction of maximum field strength under specific conditions of measurement during the CW transmission.

The measurements shall be made under normal test conditions.

8.5.2 Method of measurement under normal test conditions

The equipment shall be placed in the test fixture connected to the artificial load with a means of measuring the power delivered to the load. The equipment shall be operated from the test power source (clause 6.4.2).

The measurement of ERPEP shall be made under normal conditions with only audio modulation to give a reference level. A measurement of the average power at the artificial load under the same conditions with only CW modulation will then be made.

8.5.3 Limit

The ERP(CW) shall equal ERPEP within ±1,5 dB.

8.6 Transmitter spectrum mask

8.6.1 Definition

The transmitter spectrum mask defines the limits within the range fc ±75 kHz for the peak power of all modulated signals including all side bands associated with the carrier.

8.6.2 Method of measurement

The equipment shall be placed in the test fixture connected to the artificial load with a means of measuring the power delivered to the load. The equipment shall be operated from the test power source (clause 6.4.2).

The measurement shall be made under normal test conditions initially with the equipment on the support in the standard position (annex A or clause A.4 for equipment intended to be worn on a person) to enable a reference measurement to be made.

To determine the reference peak power and measure the emissions in the adjacent channels, the emission is suitably applied to the input of a spectrum analyser with the following preferred settings:

- Resolution bandwidth: 3 kHz;
- Video filter: off;
- Scan bandwidth: 150 KHz;
- Centre frequency: Carrier frequency as measured in clause 8.1;
- Detector type: Peak hold.

At least 10 minutes of emissions shall be measured and a reference carrier power calculated as being the maximum power within the frequency limits set in clause 8.1.3. The emission profile shall then be normalised so that the reference carrier power is set to 0 dBc. The result is compared to the mask given in figure 3.

The modulation sequence and the data content (if employed) during the test shall be representative of normal operation.

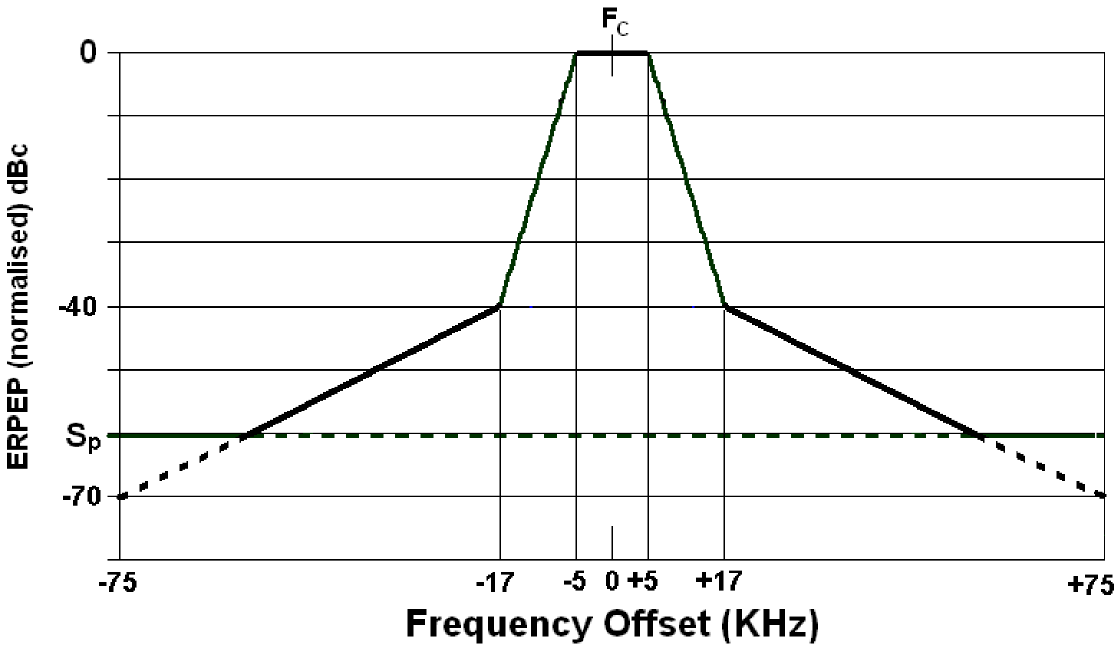

Figure 3

The mask comprises a set of straight lines determined as follows:

A straight line from (-75 KHz, -70 dBc) to (-17 KHz, -40 dBc), a straight line from (-17 KHz, -40 dBc) to (-5 KHz, 0 dBc), a straight line from (-5 KHz, 0 dBc) to (+5 KHz, 0 dBc), a straight line from (+5 KHz, 0 dBc) to (+17 KHz, -40 dBc), a straight line from (+17 KHz, -40 dBc) to (+75 KHz, -70 dBc). Where the mask falls below the line S_p then the line S_p shall be used as the mask.

S_p is the normalised spurious emission limit (clause 8.8.3): S_p = -37 - ERPEP (as measured in clause 8.4.2) dBc.

8.6.3 Limit

The normalised emission profile shall not exceed the mask of figure 3.

8.7 Radiation produced by operation of the test facility

8.7.1 Definition

Radiation produced by operation of the test facility is the radiation at the nominal frequencies when the equipment is being tested.

8.7.2 Method of measurement

The radio beacon shall be with the switch in the test position.

The method of measurement described in clause 8.4 shall be used, however, the test shall be performed at normal test conditions only.

The transmitter shall be rotated in all directions until the maximum radiation is detected.

8.7.3 Limit

The test facility provided to indicate the correct functioning of the radio beacon shall not produce an ERPEP greater than 5 uW.

8.8 Spurious emissions

8.8.1 Definition

Emission(s) on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emissions.

8.8.2 Method of measurement

Spurious emissions shall be measured using a test site described in annex A.

The measurement shall be performed with the radio beacon in its standard position (annex A) and according to the requirements of clause A.4 for equipment intended to be worn on a person.

The method of measurement described in clause 8.4 shall be used to search for spurious emissions in the frequency band 30 MHz to 2 GHz.

The measuring receiver shall have a bandwidth of 100 kHz to 120 kHz.

The measurement shall only be performed under normal test conditions, the radio beacon being rotated until the maximum emission is detected. The measurement is made for all modulation types in the modulation sequence (clause 8.2.1). The measurement is then made for test transmission (clause 8.7.1). The measurement is also made when the radio beacon has been activated but is not transmitting.

8.8.3 Limit

The power of any spurious emission component when transmitting shall not exceed 0,2 µW.

The power of any spurious emission component when not transmitting shall not exceed 2 nW between 30 MHz and 1 GHz and 20 nW between 1 GHz and 2 GHz.

Annex A (normative): Radiated measurements

A.1 Test sites and general arrangements for measurements involving the use of radiated fields

This normative annex introduces three most commonly available test sites, an anechoic chamber, an anechoic chamber with a ground plane and an Open Area Test Site (OATS), which may be used for radiated tests. These test sites are generally referred to as free field test sites. Both absolute and relative measurements can be performed in these sites. Where absolute measurements are to be carried out, the chamber should be verified. A detailed verification procedure is described in TR 102 273, relevant parts 2, 3 and 4 [7].

NOTE: To ensure reproducibility and traceability of radiated measurements only these test sites should be used in test measurements.

A.1.1 Anechoic chamber

An anechoic chamber is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The chamber usually contains an antenna support at one end and a turntable at the other. A typical anechoic chamber is shown in figure A.1.

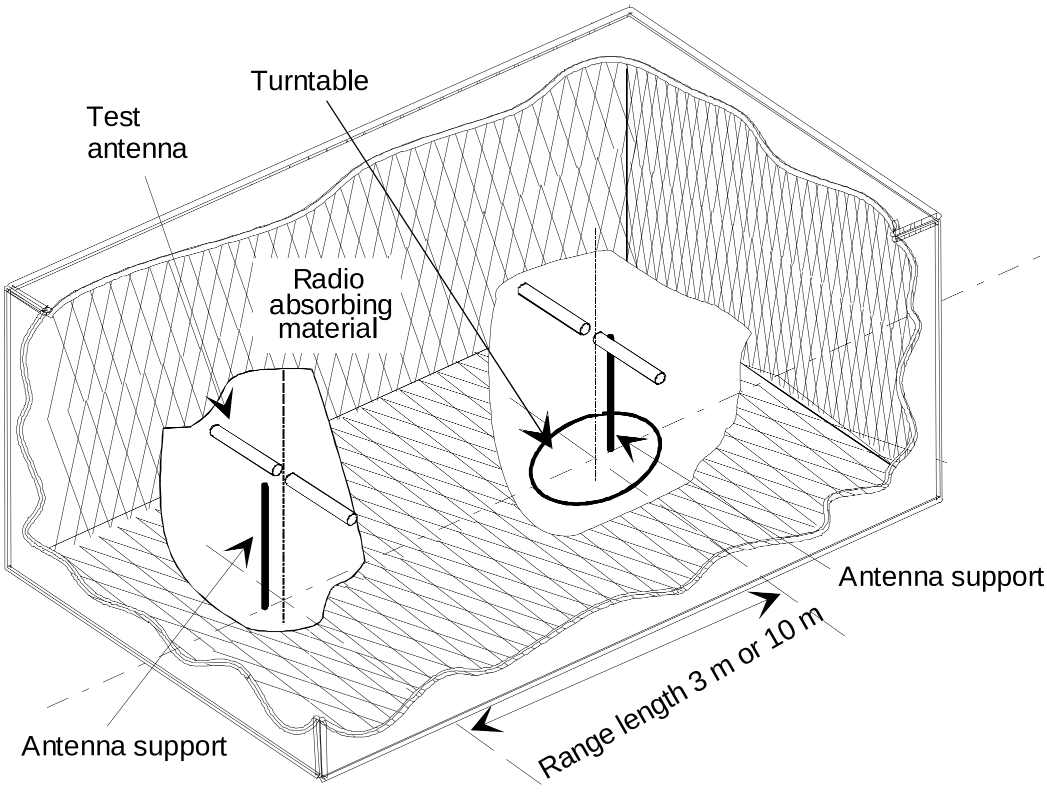

Figure A.1: A typical anechoic chamber

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. In practice it is relatively easy for shielding to provide high levels (80 dB to 140 dB) of ambient interference rejection, normally making ambient interference negligible.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a suitable height (e.g. 1 m) above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

The anechoic chamber generally has several advantages over other test facilities. There is minimal ambient interference, minimal floor, ceiling and wall reflections and it is independent of the weather. It does however have some disadvantages which include limited measuring distance and limited lower frequency usage due to the size of the pyramidal absorbers. To improve low frequency performance, a combination structure of ferrite tiles and urethane foam absorbers is commonly used.

All types of emission, sensitivity and immunity testing can be carried out within an anechoic chamber without limitation.

A.1.2 Anechoic chamber with a ground plane

An anechoic chamber with a ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material, normally of the pyramidal urethane foam type. The floor, which is metallic, is not covered and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other. A typical anechoic chamber with a ground plane is shown in figure A.2.

This type of test chamber attempts to simulate an ideal OATS whose primary characteristic is a perfectly conducting ground plane of infinite extent.

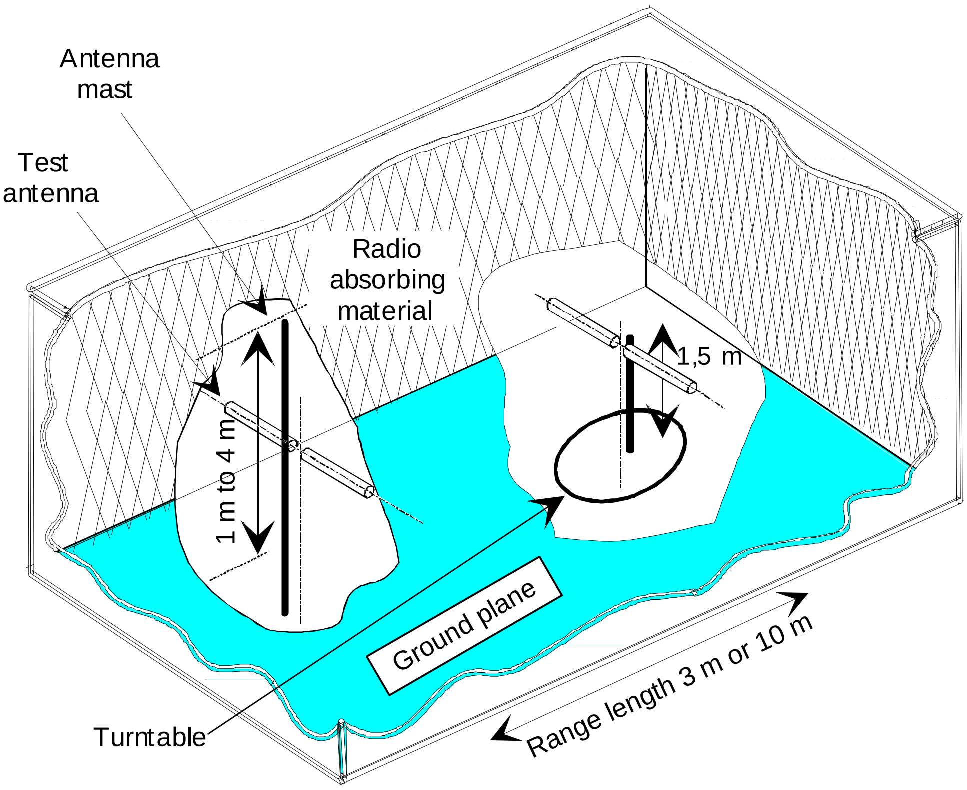

Figure A.2: A typical anechoic chamber with a ground plane

In this facility the ground plane creates the wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals from both the direct and reflected transmission paths. This creates a unique received signal level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the test antenna can be optimized for maximum coupled signal between antennas or between an EUT and the test antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane. The chamber shall be large enough to allow the measuring distance of at least 3 m or $2(d_1+d_2)^2/\lambda$ (m), whichever is greater (see clause A.2.5). The distance used in actual measurements shall be recorded with the test results.

Emission testing involves firstly "peaking" the field strength from the EUT by raising and lowering the receiving antenna on the mast (to obtain the maximum constructive interference of the direct and reflected signals from the EUT) and then rotating the turntable for a "peak" in the azimuth plane. At this height of the test antenna on the mast, the amplitude of the received signal is noted. Secondly the EUT is replaced by a substitution antenna (positioned at the EUT's phase or volume centre) which is connected to a signal generator. The signal is again "peaked" and the signal generator output adjusted until the level, noted in stage one, is again measured on the receiving device.

Receiver sensitivity tests over a ground plane also involve "peaking" the field strength by raising and lowering the test antenna on the mast to obtain the maximum constructive interference of the direct and reflected signals, this time using a measuring antenna which has been positioned where the phase or volume centre of the EUT will be during testing. A transform factor is derived. The test antenna remains at the same height for stage two, during which the measuring antenna is replaced by the EUT. The amplitude of the transmitted signal is reduced to determine the field strength level at which a specified response is obtained from the EUT.

A.1.3 OATS

An OATS comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, whilst good conductivity can be achieved, the ground plane size has to be limited. A typical OATS is shown in figure A.3.

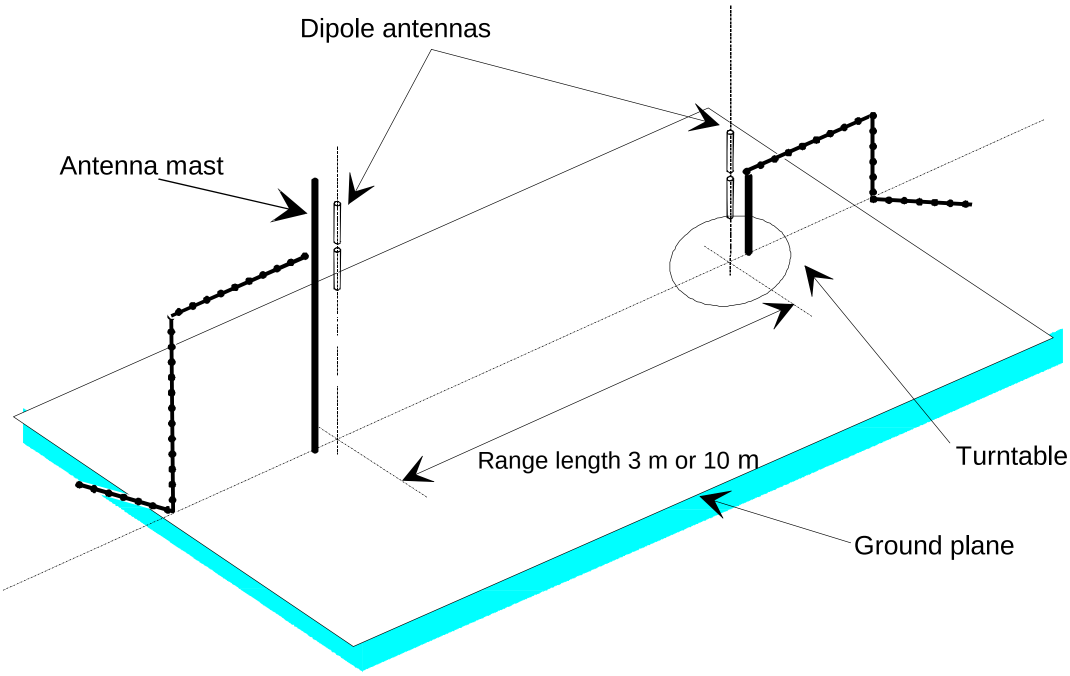

Figure A.3: A typical OATS

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

Site qualification concerning antenna positions, turntable, measurement distance and other arrangements are same as for anechoic chamber with a ground plane. In radiated measurements an OATS is also used by the same way as anechoic chamber with a ground plane.

Typical measuring arrangement common for ground plane test sites is presented in figure A.4.

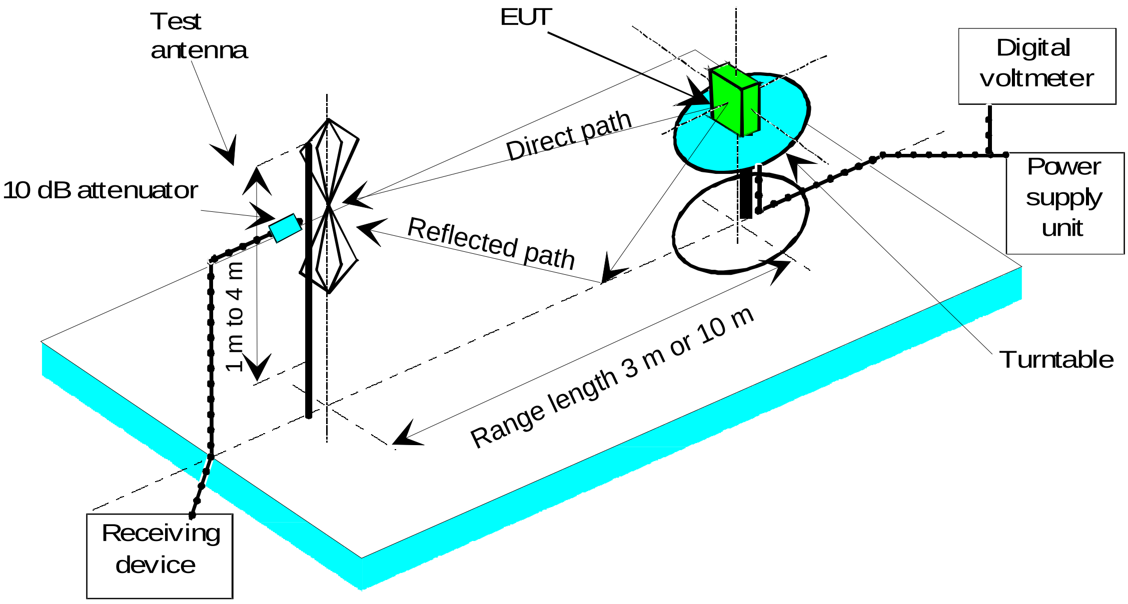

Figure A.4: Measuring arrangement on ground plane test site (OATS set-up for spurious emission testing)

A.1.4 Test antenna

A test antenna is always used in radiated test methods. In emission tests (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) the test antenna is used to detect the field from the EUT in one stage of the measurement and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics (i.e. sensitivity and various immunity parameters) the antenna is used as the transmitting device.

The test antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization which, on ground plane sites (i.e. anechoic chambers with ground planes and OATS), should additionally allow the height of its centre above the ground to be varied over the specified range (usually 1 m to 4 m).

In the frequency band 30 MHz to 1 000 MHz, dipole antennas (constructed in accordance with ANSI C63.5 [5]) are generally recommended. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For spurious emission testing, however, a combination of bicones and log periodic dipole array antennas (commonly termed "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band. Above 1 000 MHz, waveguide horns are recommended although, again, log periodics could be used.

NOTE: The gain of a horn antenna is generally expressed relative to an isotropic radiator.

A.1.5 Substitution antenna

The substitution antenna is used to replace the EUT for tests in which a transmitting parameter (i.e. frequency error, effective radiated power, spurious emissions and adjacent channel power) is being measured. For measurements in the frequency band 30 MHz to 1 000 MHz, the substitution antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [5]). For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. For measurements above 1 000 MHz, a waveguide horn is recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT it has replaced.

A.1.6 Measuring antenna

The measuring antenna is used in tests on an EUT in which a receiving parameter (i.e. sensitivity and various immunity tests) is being measured. Its purpose is to enable a measurement of the electric filed strength in the vicinity of the EUT. For measurements in the frequency band 30 MHz to 1 000 MHz, the measuring antenna should be a dipole antenna (constructed in accordance with ANSI C63.5 [5]. For frequencies of 80 MHz and above, the dipoles should have their arm lengths set for resonance at the frequency of test. Below 80 MHz, shortened arm lengths are recommended. The centre of this antenna should coincide with either the phase centre or volume centre (as specified in the test method) of the EUT.

A.2 Guidance on the use of radiation test sites

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated test are undertaken. These schemes are common to all types of test sites described in this annex.

A.2.1 Verification of the test site

No test should be carried out on a test site which does not possess a valid certificate of verification. The verification procedures for the different types of test sites described in this annex (i.e. anechoic chamber, anechoic chamber with a ground plane and OATS) are given in TR 102 273, parts 2, 3 and 4 [7], respectively.

A.2.2 Preparation of the EUT

The manufacturer should supply information about the EUT covering the operating frequency, polarization, supply voltage(s) and the reference face. Additional information, specific to the type of EUT should include, where relevant, carrier power, CSP, whether different operating modes are available (e.g. high and low power modes) and if operation is continuous or is subject to a maximum test duty cycle (e.g. 1 m on, 4 m off).

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This bracket should be made from low conductivity, low relative dielectric constant (i.e. less than 1,5) material(s) such as expanded polystyrene, balsawood, etc.

A.2.3 Power supplies to the EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. In all cases, power leads should be connected to the EUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the EUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the EUT and down to the either the screen, ground plane or facility wall (as appropriate) by the shortest possible paths. Precautions should be taken to minimize pick-up on these leads (e.g. the leads could be twisted together, loaded with ferrite beads at 0,15 m spacing or otherwise loaded).

Details shall be included in the test report.

A.2.4 Volume control setting for analogue speech tests

Unless otherwise stated, in all receiver measurements for analogue speech the receiver volume control where possible, should be adjusted to give at least 50 % of the rated audio output power. In the case of stepped volume controls, to volume control should be set to the first step that provides an output power of at least 50 % of the rated audio output power. This control should not be readjusted between normal and extreme test conditions in tests.

A.2.5 Range length

The range length for all these types of test facility should be adequate to allow for testing in the far-field of the EUT i.e. it should be equal to or exceed:

$$\frac{2(d_1+d_2)^2}{\lambda}$$

where:

- d_1 is the largest dimension of the EUT/dipole after substitution (m);
- d_2 is the largest dimension of the test antenna (m);
- λ is the test frequency wavelength (m).

It should be noted that in the substitution part of this measurement, where both test and substitution antennas are half wavelength dipoles, this minimum range length for far-field testing would be:

$$2\lambda$$

It should be noted in the test report when either of these conditions is not met so that the additional measurement uncertainty can be incorporated into the results.

NOTE 1: **For the fully anechoic chamber**, no part of the volume of the EUT should, at any angle of rotation of the turntable, fall outside the "quiet zone" of the chamber at the nominal frequency of the test.

NOTE 2: The "quiet zone" is a volume within the anechoic chamber (without a ground plane) in which a specified performance has either been proven by test, or is guaranteed by the designer/manufacture. The specified performance is usually the reflectivity of the absorbing panels or a directly related parameter (e.g. signal uniformity in amplitude and phase). It should be noted however that the defining levels of the quiet zone tend to vary.

NOTE 3: **For the anechoic chamber with a ground plane**, a full height scanning capability, i.e. 1 m to 4 m, should be available for which no part of the test antenna should come within 1 m of the absorbing panels. For both types of **anechoic chamber**, the reflectivity of the absorbing panels should not be worse than -5 dB.

NOTE 4: **For both the anechoic chamber with a ground plane and the OATS**, no part of any antenna should come within 0,25 m of the ground plane at any time throughout the tests. Where any of these conditions cannot be met, measurements should not be carried out.

A.2.6 Site preparation

The cables for both ends of the test site should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of **anechoic chamber**, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as appropriate) to the test equipment. Precautions should be taken to minimize pick up on these leads (e.g. dressing with ferrite beads, or other loading). The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (**i.e. anechoic chambers with ground planes and OATS**) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

For all items of test equipment, the maximum errors they exhibit should be known along with the distribution of the error e.g.:

- cable loss: ±0,5 dB with a rectangular distribution;
- measuring receiver: 1,0 dB (standard deviation) signal level accuracy with a Gaussian error distribution.

At the start of measurements, system checks should be made on the items of test equipment used on the test site.

A.3 Coupling of signals

A.3.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical and acoustic coupling).

A.3.2 Data signals

Isolation can be provided by the use of optical, ultra sonic or infra red means. Field disturbance can be minimized by using a suitable fibre optic connection. Ultra sonic or infra red radiated connections require suitable measures for the minimization of ambient noise.

A.3.3 Speech and analogue signals

Where an audio output connector is not available an acoustic coupler should be used.

When using the acoustic coupler, care should be exercised that possible ambient noise does not influence the test result.

A.3.3.1 Acoustic coupler description

The acoustic coupler comprises a plastic funnel, an acoustic pipe and a microphone with a suitable amplifier. The materials used to fabricate the funnel and pipe should be of low conductivity and of low relative dielectric constant (i.e. less than 1,5).

- the acoustic pipe should be long enough to reach from the EUT to the microphone which should be located in a position that will not disturb the RF field. The acoustic pipe should have an inner diameter of about 6 mm and a wall thickness of about 1,5 mm and should be sufficiently flexible so as not to hinder the rotation of the turntable;
- the plastic funnel should have a diameter appropriate to the size of the loudspeaker in the EUT, with soft foam rubber glued to its edge, it should be fitted to one end of the acoustic pipe and the microphone should be fitted to the other end. It is very important to fix the centre of the funnel in a reproducible position relative to the EUT, since the position of the centre has a strong influence on the frequency response that will be measured. This can be achieved by placing the EUT in a close fitting acoustic mounting jig, supplied by the manufacturer, of which the funnel is an integral part;
- the microphone should have a response characteristic flat within 1 dB over a frequency range of 50 Hz to 20 kHz, a linear dynamic range of at least 50 dB. The sensitivity of the microphone and the receiver audio output level should be suitable to measure a signal to noise ratio of at least 40 dB at the nominal audio output level of the EUT. Its size should be sufficiently small to couple to the acoustic pipe;
- the frequency correcting network should correct the frequency response of the acoustic coupler so that the acoustic SINAD measurement is valid (see IEC 60489-3 appendix F [6]).

A.3.3.2 Calibration

The aim of the calibration of the acoustic coupler is to determine the acoustic SINAD ratio which is equivalent to the SINAD ratio at the receiver output.

A.4 Standard position

The standard position in all test sites, except the stripline arrangement, for equipment which is not intended to be worn on a person, including hand-held equipment, shall be on a non conducting support, height 1,5 m, capable of rotating about a vertical axis through the equipment. The standard position of the equipment shall be the following:

a) for equipment with an internal antenna, it shall be placed in the position closest to normal use as declared by the manufacturer;

b) for equipment with a rigid external antenna, the antenna shall be vertical;

c) for equipment with a non-rigid external antenna, the antenna shall be extended vertically upwards by a non-conducting support.

Equipment which is intended to be worn on a person shall be tested using a salty man as support as described in TR 102 273-7 [3] Artificial human beings.

The simulated man comprises a rotatable acrylic tube filled with salt (NaCl) water with acrylic caps at both ends, placed on the ground.

The preferred dimensions of the container are:

- height: 1,7 m;
- outside diameter: 305 mm;
- sidewall thickness: 4,8 mm.

The container shall be filled with a salt (NaCl) solution of 1,49 g per litre of distilled water (σ = 0,26 S/m, ε = 77).

The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment.

NOTE: To reduce the weight of the simulated man it may be possible to use an alternative tube as described in TR 102 273-7 [3].

History

Document history			
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