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INTERNATIONAL STANDARD

NORME INTERNATIONALE

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE
COMITÉ INTERNATIONAL SPÉCIAL DES PERTURBATIONS RADIOÉLECTRIQUES

BASIC EMC PUBLICATION
PUBLICATION FONDAMENTALE EN CEM

AMENDMENT 1
AMENDEMENT 1

Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements

**Spécifications des méthodes et des appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques –
Partie 1-4: Appareils de mesure des perturbations radioélectriques et de l'immunité aux perturbations radioélectriques – Antennes et emplacements d'essai pour les mesures des perturbations rayonnées**

CISPR 16-1-4:2010/A1:2012

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FOREWORD

This amendment has been prepared by subcommittee A: Radio-interference measurements and statistical methods, of IEC technical committee CISPR: International special committee on radio interference.

The text of this amendment is based on the following documents:

FDIS	Report on voting
CISPR/A/995/FDIS	CISPR/A/1005/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION
(to Amendment 1)

This amendment introduces the Reference Site Method (RSM). In addition to introducing new content, Clause 5 is significantly restructured. To aid the reader in navigating this amendment, the following table provides a comparison of subclauses in the existing Edition 3.0 with those in this amendment. This introduction will be removed before the subsequent edition is published.

Comparison of Clause 5 between original Edition 3.0 and Amendment 1

Original Edition 3.0		**Amendment 1**	
5	Test sites for the measurement of radio disturbance field strength for the frequency range of 30 MHz to 1 000 MHz	5	Test sites for the measurement of radio disturbance field strength for the frequency range of 30 MHz to 1000 MHz
5.1	General	5.1	General
5.2	OATS	5.2	OATS
5.2.1	General	5.2.1	General
5.2.2	Weather protection enclosure	5.2.2	Weather protection enclosure
5.2.3	Obstruction-free area	5.2.3	Obstruction-free area
5.2.4	Ambient radio frequency environment of a test site	5.2.4	Ambient radio frequency environment of a test site
5.2.5	Ground plane	5.2.5	Ground plane
5.2.6	OATS validation procedure		
5.3	Test site suitability for other ground-plane test sites	5.3	Suitability of other test sites
5.3.1	General	5.3.1	Other ground-plane test sites
5.3.2	Normalized site attenuation for alternative test sites	5.3.2	Test sites without ground plane (FAR)
5.3.3	Site attenuation		
5.3.4	Conducting ground plane		
5.4	Test site suitability without ground plane	5.4	Test site validation
5.4.1	Measurement considerations for free space test sites, as realized by fully-absorber-lined shielded enclosures	5.4.1	General
5.4.2	Site performance	5.4.2	Overview of test site validations
5.4.3	Site validation criteria	5.4.3	Principles and values of the NSA method for OATS and SAC
		5.4.4	Reference site method for OATS and SAC
		5.4.5	Validation of an OATS by the NSA method
		5.4.6	Validation of a weather-protection-enclosed OATS or a SAC
		5.4.7	Site validation for FARs
5.5	Evaluation of set-up table and antenna tower	5.5	Evaluation of set-up table and antenna tower
5.5.1	General	5.5.1	General
5.5.2	Evaluation procedure for set-up table influences	5.5.2	Evaluation procedure for set-up table influences

2 Normative references

Remove the existing date and remove the two existing amendment references from the existing reference to CISPR/TR 16-3.

3.1.12
quasi-free space test-site
Replace the existing term by the new term “quasi free-space test site”.

3.1.15
semi-anechoic chamber
SAC
Replace the existing definition of this term by the following new definition:

shielded enclosure in which all surfaces except the metal floor are covered with material that absorbs electromagnetic energy (i.e. RF absorber) in the frequency range of interest

3.1.19
test volume
Replace, in the existing definition of this term, “the FAR” *by* “a FAR”.

Replace, in the existing Note of this term, “quasi-free space condition” *by* “quasi free-space condition”*, and* “the FAR” *by* “a FAR”.

Add, after the existing definition 3.1.21, the following new terms and definitions 3.1.22, 3.1.23, 3.1.24, 3.1.25, 3.1.26 and 3.1.27:

3.1.22
antenna factor
AF
F_a
ratio of the electric field strength of an incident plane wave to the voltage induced across a specified load (typically 50 Ω) connected to the antenna

NOTE 1 F_a is affected by the load impedance connected to the antenna radiating elements, and is frequency dependent. For a biconical antenna this impedance could be up to 200 Ω. For antennas with no balun the impedance is equal to the load impedance, typically 50 Ω.

NOTE 2 Usually, the AF is defined for the plane wave incident from the direction corresponding with the maximum gain of the antenna and at a specified point of the antenna.

NOTE 3 The AF has the physical dimension of inverse metres (m^{-1}) and measured data are normally expressed in dB(m^{-1}). In radiated emission measurements, if F_a is known, the strength of an incident field, E, can be estimated from a reading, V, of a measuring receiver connected to the antenna as follows:

$$E = V + F_a$$

where E is in dB(μV/m), V is in dB(μV) and F_a is in dB(m^{-1}).

3.1.23
antenna factor, free-space
$F_{a\,fs}$
AF of an antenna located in a free-space environment

NOTE $F_{a\,fs}$ is a measurand for uncertainty calculation for antenna calibration. For NSA measurements $F_{a\,fs}$ is an input quantity for uncertainty calculation.

3.1.24
antenna pair reference site attenuation
A_{APR}
set of site attenuation measurement results for both vertical and horizontal polarizations using a pair of antennas separated by a defined distance at an ideal open-area test site, with one antenna at a specified fixed height above the ground plane, and the other antenna scanned over a specified height range in which the minimum insertion loss is recorded

NOTE 1 A_{APR} is a measurand for uncertainty calculation.

NOTE 2 A_{APR} measurements are used for comparison to corresponding site attenuation measurements of a COMTS to evaluate the performance of the COMTS.

3.1.25
antenna reference point
midpoint of an antenna from which the distance to the EUT or second antenna is measured

NOTE The antenna reference point is either defined by the manufacturer using a marker on LPDA antennas or by the calibration laboratory.

3.1.26
ideal open-area test site
open-area test site having a perfectly flat, perfectly conducting ground plane of infinite area, and with no reflecting objects except the ground plane

NOTE An ideal OATS is a theoretical construct that is used in the definition of the measurand A_{APR} and in the calculation of the theoretical normalized site attenuation A_N for ground plane sites.

3.1.27
reference test site
REFTS
open-area test site with metallic ground plane and tightly specified site attenuation performance in horizontal and vertical electric field polarizations

3.2 Abbreviations

Add, before the existing abbreviation EUT of this subclause, the following new sentence:

The following are abbreviations used in this standard that are not already given in 3.1.

Add the following new abbreviation to the existing list:

RSM Reference site method

Delete, in the existing list, the entire abbreviation SAC.

4.5.3 Antenna characteristics

Replace, in item c) 2) of the list, in the paragraph after the variable list of Equation (4), the existing text "corrections or as" *by* "a correction with associated".

Delete the existing NOTE 3 in the existing item c) 3) of the list.

Replace, in the list of quantities below Equation (4), existing quantity "h_1" by "h_2" and replace existing quantity "h_2" by "h_1".

Replace the existing Figure 1 by the following new figure:

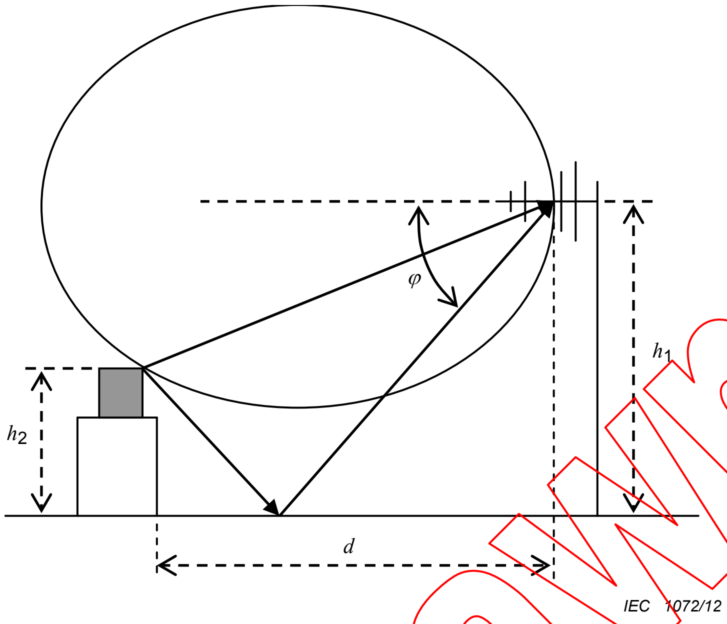

Figure 1 – Schematic of radiation from EUT reaching an LPDA antenna directly and via ground reflections on a 3 m site, showing the half beamwidth, φ , at the reflected ray

4.5.4.2 Balun DM/CM conversion check

*Replace, in the existing Note 2, "*room*" by "*FAR*", and "*±4 dB criterion*" by "*± 4 dB site validation criterion*".*

*Replace, in the existing Note 3, "*fully-anechoic room*" by "*FAR*", and "*NSA (normalized site attenuation)*" by "*site validation*".*

4.5.5 Cross-polar response of antenna

*Replace, in the third paragraph of this subclause, "*quasi-free space conditions*" by "*quasi free-space conditions*", and "*high-quality anechoic chamber*" by "*high-quality fully anechoic room*".*

5.1 General

Replace the existing text of this subclause by the following new text:

An environment is required that assures valid, repeatable measurement results of disturbance field strength from an EUT. For an EUT that can only be tested at its place of use, other provisions shall be utilized (i.e. see details on in-situ measurements in CISPR 16-2-3).

5.2.1 General

Replace the existing text of this subclause by the following new text:

An OATS is an area characterized by cleared level terrain and the presence of a ground plane. To meet the validation requirements of this standard, a metallic ground plane is recommended. Such a test site shall be free of buildings, electric lines, fences, trees, etc. and free from underground cables, pipelines, etc., except as required to supply and operate the EUT. Refer to Annex D for specific construction recommendations of an OATS for disturbance field-strength measurements in the range of 30 MHz to 1 000 MHz. The site validation procedures for an OATS are given in 5.4.4 and 5.4.5. Annex F explains the basis for the acceptability criterion.

5.2.3 Obstruction-free area

Replace the third paragraph of this subclause by the following new paragraph:

For this ellipse, the length of the path taken by the undesired indirect ray reflected from any object on the perimeter is twice the length of the path taken by the direct ray between the foci. If a large EUT is installed on the turntable, the obstruction-free area shall be expanded so that the obstruction clearance distances exist from the perimeter of the EUT.

Replace, in the last sentence of the fourth paragraph of this subclause, the existing words "separation distance" by "measurement distance".

Replace the existing Figure 2 by the following new figure:

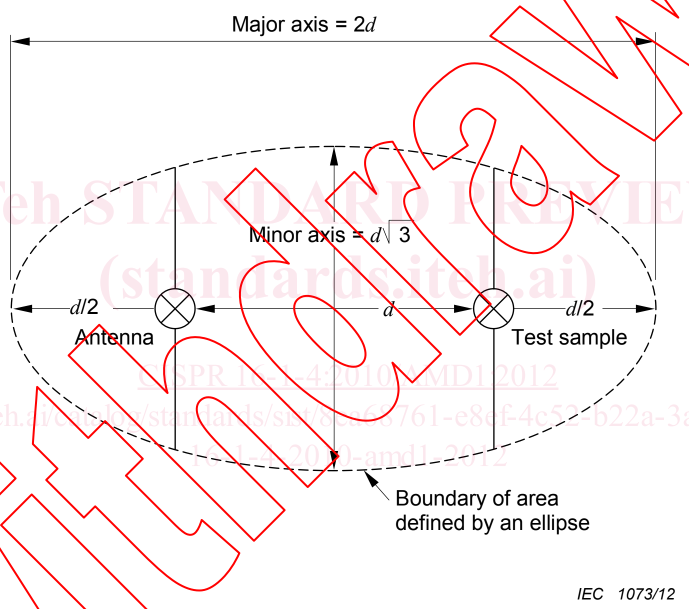

Figure 2 – Obstruction-free area of a test site with a turntable (see 5.2.3)

Replace the existing Figure 3 by the following new figure:

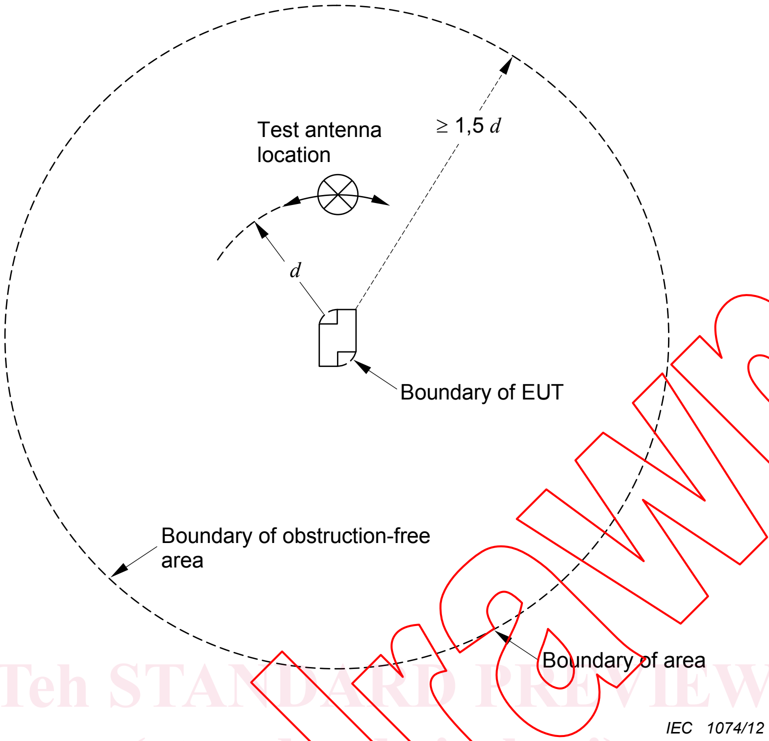

Figure 3 – Obstruction-free area with stationary EUT (see 5.2.3)

5.2.4 Ambient radio frequency environment of a test site

Replace the first paragraph of this subclause before the list by the following new paragraph:

The ambient radio frequency levels at an OATS shall be sufficiently low compared to the levels of measurements to be performed. The quality of the site in this regard may be evaluated under four categories, listed below in order of merit:

Replace the existing note of this subclause by the following new note:

NOTE A measured ambient level of 20 dB or more below the emission limit is considered optimum.

5.2.5 Ground plane

Replace the existing text in this subclause by the following new text:

The OATS ground plane can be at earth level or elevated on a suitably sized platform or horizontal rooftop site. A metal ground plane is preferred, but for certain equipment and applications, product publications may recommend other site types. Adequacy of the metal ground plane will be dependent on whether the test site meets the site validation requirements of 5.4. If metallic material is not used, caution is required to select a site that does not change its reflective characteristics with time, weather conditions, or effects due to buried metallic material such as pipes, conduits, and non-homogeneous soil. Such sites generally give different SA characteristics compared to those with metallic surfaces.

5.2.6 OATS validation procedure

Delete this existing subclause, as well as the existing subclauses 5.2.6.1 to 5.2.6.4.

5.3 Test site suitability for other ground-plane test sites

Replace the existing title of this subclause by the following new title:

5.3 Suitability of other test sites

5.3.1 General

Replace the existing title of this subclause by the following new title:

5.3.1 Other ground-plane test sites

Replace the existing text of this subclause by the following new text and new note:

There are many different test sites and facilities that have been constructed and used to make radiated emission measurements. Most are protected from the weather and the adverse effects of the radio frequency ambient. In a SAC, all walls and the ceiling are equipped with appropriate absorbing material. The floor consists of a metallic ground plane to emulate an OATS. A SAC isolates the receiving antenna from the RF ambient environment, and permits EUT testing independent of weather conditions.

Whenever construction material encloses a ground-plane test site, it is possible that the results of a validation measurement at a single location, as specified in 5.4.5, are not adequate to show acceptability of such an alternative site.

To evaluate suitability of an alternative ground-plane test site, the procedure of 5.4.6 shall be used, which is based on making multiple validation measurements throughout a volume occupied by the EUT. These validation measurement results shall all be within a tolerance of ± 4 dB for a site to be judged suitable as an equivalent to an OATS.

NOTE SACs typically meet the site quality categories listed in 5.2.4.

5.3.2 Normalized site attenuation for alternative test sites

Replace the existing title of this subclause by the following new title:

5.3.2 Test sites without ground plane (FAR)

Replace the existing text of this subclause by the following new text and new note:

A fully-absorber-lined shielded enclosure, also known as a fully-anechoic room (FAR), can be used for radiated emission measurements. When a FAR site is used, appropriate radiated emission limits shall be defined in relevant standards (generic, product or product family standards). Compliance of an EUT with the requirements for the protection of radio-services (limits) shall be evaluated at FAR sites using similar methods as for tests done at an OATS.

A FAR is intended to simulate a free-space environment such that only the direct ray from the transmitting antenna or EUT reaches the receiving antenna. All indirect and reflected waves shall be minimized by appropriate placement of absorbing material on all walls, ceiling and floor of a FAR. Like a SAC, a FAR isolates the receiving antenna from the RF ambient environment, and permits EUT testing independent of weather conditions.

NOTE FARs typically meet the site quality categories listed in 5.2.4.

5.3.3 Site attenuation

Delete this existing subclause and its title.

5.3.4 Conducting ground plane

Delete this existing subclause and its title.

5.4 Test site suitability without ground plane

Replace the existing title of this subclause by the following new title:

5.4 Test site validation

5.4.1 Measurement considerations for free space test sites, as realized by fully-absorber-lined shielded enclosures

Replace the existing title of this subclause by the following new title:

5.4.1 General

Replace the existing text of this subclause by the following new text and the following new Table 7:

Three methods for site validation are defined in this standard:

- NSA method with tuned dipoles;
- NSA method with broadband antennas;
- Reference site method (RSM) with broadband antennas.

Validations for test sites with a ground plane (i.e. OATS and SAC) are introduced in 5.4.2 and 5.4.3, followed by detailed procedures for the RSM in 5.4.4 and for the NSA method in 5.4.5. Validation of a SAC and a weather-protection enclosed OATS requires additional measurements as described in 5.4.6.

Table 7 summarizes the site validation methods applicable for these specific test site types. As shown in this table, two or three site validation methods are described for each of these test site types. These methods are deemed to be equivalent for the purposes of this standard; meaning compliance with the validation criterion can be evaluated using only one method. Furthermore, no one of these documented methods is defined as the reference method.

Table 7 – Site validation methods applicable for OATS, OATS-based, SAC and FAR site types

Test site type	Applicability of site validation methods		
	Tuned dipoles NSA	Broadband antennas NSA	Broadband antennas RSM
OATS	Yes	Yes	Yes
OATS with weather protection	No	Yes	Yes
SAC	No	Yes	Yes
FAR	No	Yes	Yes

5.4.2 Site performance

Replace the existing title of this subclause by the following new title:

5.4.2 Overview of test site validations

Replace the existing text of this subclause, including Subclauses 5.4.2.1 to 5.4.2.3.4, by the following new text:

The validation of a test site is performed using two co-polarized antennas. The validation shall be performed separately for both horizontal and vertical polarizations.

SA is obtained from the difference of:

- the source voltage level, V_i, applied to a transmitting antenna;
- the maximum received voltage level, V_R, measured on the terminals of a receiving antenna during a specified antenna height scan.

The voltage measurements are performed in a 50 Ω system.

The measured SA of an OATS (as in 5.2) and other ground-plane test sites (as in 5.3.1) is compared to the SA characteristics obtained at an ideal OATS – this is the definition of the measurand for test site validations. The result of this comparison is the SA deviation, ΔA_S, in dB; see Equations (26) and (27). The site is considered suitable when the SA deviation results are within a tolerance of ± 4 dB.

If the ± 4 dB tolerance is exceeded, the test site configuration shall be investigated as described in 5.4.5.3.

NOTE The basis for the 4 dB site acceptability criterion is given in Annex F.

Additionally, SA deviations shall not be used to correct field-strength measurement data for an EUT. The procedures of 5.4 shall be used only for test site validations.

5.4.3 Site validation criteria

Replace the existing title of this subclause by the following new title:

5.4.3 Principles and values of the NSA method for OATS and SAC

Replace the existing text of this subclause by the following new text, the following new Tables 8, 9, 10 and 11, and the following new Figures 29 and 30:

NSA values calculated at specific frequencies are provided in Tables 8 and 9 for tuned dipole antennas, and Table 10 for broadband antennas. The quantities d, h_1, h_2, f_M and A_N, which are used in these tables, are identified at the end of Table 8.

NOTE 1 NSA values for frequencies other than shown in the Tables 8, 9, and 10 can be obtained using linear interpolation between the tabulated values.

NOTE 2 The spacing d between the log-periodic dipole array antenna pairs is measured from the projection on the ground plane of the mid-point of the longitudinal axis of each antenna.

NOTE 3 The spacing d between biconical antennas, is measured from the element centre-line axes at the feedpoint.

For measurements in each polarization, the NSA method requires two different measurements of the received voltage, V_R; Figures 29 and 30 illustrate the set-ups for these measurements.

Table 8 – Theoretical normalized site attenuation, A_N – recommended geometries for tuned half-wave dipoles, with horizontal polarization

Polarization d h_1 h_2	Horizontal 3 m [a] 2 m 1 m to 4 m	Horizontal 10 m 2 m 1 m to 4 m	Horizontal 30 m 2 m 1 m to 4 m	Horizontal 30 m 2 m 2 m to 6 m
f_M MHz	A_N dB(m²)			
30	11,0	24,1	41,7	38,4
35	8,8	21,6	39,1	35,8
40	7,0	19,4	36,8	33,5
45	5,5	17,5	34,7	31,5
50	4,2	15,9	32,9	29,7
60	2,2	13,1	29,8	26,7
70	0,6	10,9	27,2	24,1
80	–0,7	9,2	24,9	21,9
90	–1,8	7,8	23,0	20,1
100	–2,8	6,7	21,2	18,4
120	–4,4	5,0	18,2	15,7
140	–5,8	3,5	15,8	13,6
160	–6,7	2,3	13,8	11,9
180	–7,2	1,2	12,0	10,6
200	–8,4	0,3	10,6	9,7
250	–10,6	–1,7	7,8	7,7
300	–12,3	–3,3	6,1	6,1
400	–14,9	–5,8	3,5	3,5
500	–16,7	–7,6	1,6	1,6
600	–18,3	–9,3	0	0
700	–19,7	–10,6	–1,4	–1,3
800	–20,8	–11,8	–2,5	–2,4
900	–21,8	–12,9	–3,5	–3,5
1 000	–22,7	–13,8	–4,5	–4,4

d is the horizontal separation between the projection of the transmit and receive antennas on the ground plane;

h_1 is the height of the centre of the transmit antenna above the ground plane;

h_2 is the range of heights of the centre of the receive antenna above the ground plane, in m. The maximum received signal in this height scan range is used for NSA results;

f_M is the frequency;

A_N is the NSA

[a] The mutual impedance correction factors (see Table 11) for horizontally polarized tuned half-wave dipoles spaced 3 m apart should be used in Equation (26).

Table 9 – Theoretical normalized site attenuation, A_N – recommended geometries for tuned half-wave dipoles, vertical polarization

f_M MHz	d = 3 m [a] h_1 = 2,75 m		d = 10 m h_1 = 2,75 m		d = 30 m h_1 = 2,75 m	
	h_2 m	A_N dB(m²)	h_2 m	A_N dB(m²)	h_2 m	A_N dB(m²)
30	2,75 to 4	12,4	2,75 to 4	18,8	2,75 to 6	26,3
35	2,39 to 4	11,3	2,39 to 4	17,4	2,39 to 6	24,9
40	2,13 to 4	10,4	2,13 to 4	16,2	2,13 to 6	23,8
45	1,92 to 4	9,5	1,92 to 4	15,1	2 to 6	22,8
50	1,75 to 4	8,4	1,75 to 4	14,2	2 to 6	21,9
60	1,50 to 4	6,3	1,50 to 4	12,6	2 to 6	20,4
70	1,32 to 4	4,4	1,32 to 4	11,3	2 to 6	19,1
80	1,19 to 4	2,8	1,19 to 4	10,2	2 to 6	18,0
90	1,08 to 4	1,5	1,08 to 4	9,2	2 to 6	17,1
100	1 to 4	0,6	1 to 4	8,4	2 to 6	16,3
120	1 to 4	–0,7	1 to 4	7,5	2 to 6	15,0
140	1 to 4	–1,5	1 to 4	5,5	2 to 6	14,1
160	1 to 4	–3,1	1 to 4	3,9	2 to 6	13,3
180	1 to 4	–4,5	1 to 4	2,7	2 to 6	12,8
200	1 to 4	–5,4	1 to 4	1,6	2 to 6	12,5
250	1 to 4	–7,0	1 to 4	–0,6	2 to 6	8,6
300	1 to 4	–8,9	1 to 4	–2,3	2 to 6	6,5
400	1 to 4	–11,4	1 to 4	–4,9	2 to 6	3,8
500	1 to 4	–13,4	1 to 4	–6,9	2 to 6	1,8
600	1 to 4	–14,9	1 to 4	–8,4	2 to 6	0,2
700	1 to 4	–16,3	1 to 4	–9,7	2 to 6	–1,0
800	1 to 4	–17,4	1 to 4	–10,9	2 to 6	–2,4
900	1 to 4	–18,5	1 to 4	–12,0	2 to 6	–3,3
1 000	1 to 4	–19,4	1 to 4	–13,0	2 to 6	–4,2

[a] The mutual impedance correction factors (see Table 11) for vertically polarized tuned half-wave dipoles spaced 3 m apart should be used in Equation (26).