



**Federal Communications Commission
Office of Engineering and Technology
Laboratory Division**

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TEST SITES FOR RADIATED EMISSION MEASUREMENTS

1. INTRODUCTION

Radiated emission compliance measurements for devices operating under Parts 15, 18, and licensed radio service equipment rules shall be performed, to the extent possible, using an open-area test site (OATS).^{1,2} Section 15.31(d) states that:

“Field strength measurements shall be made, to the extent possible, on an open field site. Test sites other than open field sites may be employed if they are properly calibrated so that the measurement results correspond to what would be obtained from an open field site. ...”

Alternative test sites, such as semi-anechoic chambers and TEM waveguides, may also be employed, as described in this document.³

The following conditions need to be addressed when using radiated emissions test sites for compliance measurements.

- Compile a description of the measurement facilities employed, as specified in Section 2.948(b);⁴
- Meet the applicable site validation requirements, defined in Section 2.948(d); and
- For test sites located in the United States, obtain a Compliance Testing Experimental License,⁵ as described in Section 6.

¹ In this document the term “open-area test site” (OATS) is used in place of other terms such as “standard test site” and “open field site” for frequencies of 30 MHz and above, consistent with industry convention.

² Basic requirements for compliance measurements in FCC equipment authorizations include §§ 2.911(c), 2.1033(b)(6), and 2.1033(c)(14), with measurement procedures per §§ 2.947, 15.31(a), and 15.31(b).

³ See also Subclauses 5.4.1 and 5.4.2 of ANSI C63.4-2014. Alternative test sites include RF absorber-lined metal test chambers and weather-protected OATS; alternative test sites (other than TEM waveguides; see Section 5 of this document) are required to comply with the volumetric normalized site attenuation (NSA) requirements specified in ANSI C63.4-2014.

⁴ § 2.948 uses the term “measurement facility,” rather than, e.g., “open field test site,” to reflect that for example a semi-anechoic chamber may be used as an alternative to an OATS (FCC 03-149; docket no. 01-278; 18 FCC Rcd 14762).

⁵ See: 47 CFR Part 5. An experimental license, either compliance testing or conventional, is not required when operations of radio-frequency devices are fully contained within an anechoic chamber or a Faraday cage.

2. RADIATED EMISSION TEST SITES FOR MEASUREMENTS FROM 9 kHz TO 30 MHz

The test site requirements of Section 15.31(d) apply for part 15 device radiated emission measurements at frequencies below 30 MHz. Site validation requirements for radiated emission measurements below 30 MHz have not been established.⁶ However, ANSI C63 standards⁷ provide general criteria for test sites used to make measurements in the 9 kHz to 30 MHz frequency range. For example, Subclause 5.2 of ANSI C63.10-2013 states that “radiated emission test sites below 30 MHz shall be free from metal objects, buried pipes, and any objects that can affect radiated measurements. An alternative test site that can demonstrate equivalence to a test site as described in the preceding sentence shall be accepted for the purposes of this standard.”

Therefore, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30 MHz if characterized so that the measurements correspond to those obtained at an open-field test site.⁸ Site characterization shall be obtained by other means such as performing measurements at an alternative test site and comparing to measurement results obtained at an open-field test site. Statistical analysis of the measurement data from several similar devices may be required to show correlation between the measurements from the alternative test site and the open-field test site.⁹ Test laboratories wishing to make radiated emission measurements below 30 MHz using other than an open-field site must document evidence of correlation between the alternative site and an open-field test site and make it available to the Commission upon request and for review during a laboratory accreditation assessment.¹⁰

For Part 18 equipment, Section 2.1 of FCC Measurement Procedure MP-5 also permits the use of test sites other than an open-field test site only if it can be shown that the results obtained at such a location are correlated with those made at an open-field test site.¹¹ Sufficient tests shall be made to demonstrate that the alternative test site produces results that correlate with the results of tests made at an open-field test site.

3. TEST SITE VALIDATION REQUIREMENTS FOR 30 MHz TO 40 GHz

The site validation requirements for radiated emission compliance measurements of unintentional radiators, intentional radiators, and licensed radio service equipment performed at a test site for 30 MHz

⁶ NOTE: At the time of publication of this document, site criteria and validation methods are under development in ASC C63® SC-4, and in IEC SC CISPR/A (Proposed draft amendment to CISPR 16-1-4 for test site validation from 9 kHz to 30 MHz). When that work product is sufficiently mature, it will be reviewed to determine its acceptability then updates to this or other KDB publications may be proposed accordingly.

⁷ See Subclause 5.3 of ANSI C63.4-2014, 5.2 of ANSI C63.10-2013 and 4.6.3.1 of ANSI C63.26-2015.

⁸ An open-field test site is an open, flat, level area that must be clear of any objects or structures within the obstruction-free area that may cause reflections that significantly affect radiated emission measurements. See Subclause 5.3 of ANSI C63.4-2014, “for magnetic field strength measurements (see 8.2.1), a site similar to that shown in Figure 5, should be used, except that a reference ground plane is not required.”

⁹ See 47 CFR § 15.31(d); also quoted in Section 1 of this document.

¹⁰ KDB Publication 349827 provides other information on FCC requirements for testing laboratory qualifications.

¹¹ Per 47 CFR § 18.311, the measurement techniques used by FCC to determine compliance with the technical requirements of Part 18 are set out in FCC Measurement Procedure MP-5 (1986), “FCC Methods of Measurements of Radio Noise Emissions from Industrial, Scientific, and Medical Equipment.”

to 40 GHz are specified in Section 2.948(d).¹² When the measurement method used requires the testing of radiated emissions from equipment at a validated test site, the site validation measurement results must comply with the requirements of Subclauses 5.4.4 and 5.5 of ANSI C63.4-2014.^{13, 14} Validation of the test site shall be confirmed no less than once every three years.¹⁵

The FCC rules provide for a transition period for test sites to demonstrate compliance with the site validation requirements above 1 GHz of the CISPR standard (i.e., required by Subclause 5.5 of ANSI C63.4-2014).¹⁶ During the three-year transition period, which began July 13, 2015, either of the two site validation options provided in Subclause 5.5.1 of ANSI C63.4-2014 may be used. However, at the end of the transition period, i.e., July 13, 2018, a test site used for radiated emission measurements above 1 GHz is required to comply with CISPR 16-1-4:2010-04.¹⁷ Test laboratories are encouraged to start the transition to CISPR 16-1-4:2010-04 immediately, so they have time to make any changes needed to their test sites to demonstrate compliance with the preceding requirements.

Note that some radiated emission measurement methods, such as the substitution method¹⁸ and in situ measurements,¹⁹ may not require the use of a validated test site. However, the test site used is required to comply with the conditions provided in the applicable measurement standard. For example, ANSI C63.26-2015 provides criteria for test sites to be used in performing substitution measurements.²⁰

4. RADIATED EMISSION TEST SITES FOR MEASUREMENTS ABOVE 40 GHz

Site validation standards for test sites used to make radiated emission measurements above 40 GHz have not been established. ANSI C63.10-2013, for example, does state that for measurements above 40 GHz, reflection contributions shall be reduced to the extent possible in consideration of practical limitations.²¹

¹² 47 CFR § 2.948(d) includes: “When the measurement method used requires the testing of radiated emissions on a validated test site, ...”; in the preceding sentence, “measurement method” refers to those applicable for any unlicensed devices and licensed devices.

¹³ 47 CFR § 2.948(d) includes: “Measurement facilities used to make radiated emission measurements from 30 MHz to 1 GHz shall comply with the site validation requirements in ANSI C63.4-2014 (clause 5.4.4) ...”

¹⁴ NOTE: Although not mandatory, it is acceptable to use ANSI C63.4a-2017 Amendment 1: Test Site Validation.

¹⁵ See: 47 CFR § 2.948(d).

¹⁶ See: 47 CFR § 2.950(f) (80 FR 33443, June 12, 2015; Docket No. 13-44, FCC 14-208).

¹⁷ The three-year transition period also applies to radiated emission measurements made in accordance with ANSI C63.10-2013, which requires the test site used to conform to the site validation criteria called out in CISPR 16-1-4:2010-04.

¹⁸ Concerning the substitution method, see KDB Publication 442401.

¹⁹ Concerning in situ measurements, see 47 CFR § 15.31(d), and for example Subclause 5.6 of ANSI C63.4-2014. In the case of equipment for which measurements can be performed only at the installation site, measurements shall be performed at a minimum of three installations that can be demonstrated to be representative of typical installation sites.

²⁰ See Subclause 4.6 of ANSI C63.26-2015.

²¹ See: Subclause 5.2 of ANSI C63.10-2013.

5. TEM WAVEGUIDE TEST FACILITIES

Transverse Electromagnetic (TEM) waveguides including gigahertz transverse electromagnetic (GTEM) may be used to make radiated emission measurements. On December 2, 1993, the FCC released Public Notice 40830 announcing that radiated emission test data measured in GTEM cells may be accepted under limited conditions for Part 15 equipment authorization purposes. FCC Public Notice 54796 further expanded the acceptance conditions of GTEM cells.²²

See Annexes F and G of ANSI C63.4-2014 for other guidance about test methods and data reporting for TEM waveguide test facilities (including GTEM cells).

6. COMPLIANCE TESTING EXPERIMENTAL LICENSE

In the *Report and Order (R&O)* adopted January 31, 2013, in ET Docket Numbers 06-155 and 10-236, the Commission amended its Part 5 rules governing the Experimental Radio Service (ERS). In addition to the conventional experimental license, the *R&O* authorized the issuance of three new kinds of experimental licenses: program, medical testing, and compliance testing experimental licenses.

A testing laboratory recognized by the FCC may obtain a Compliance Testing Experimental Radio License that permits radiated emissions compliance testing on an outdoor validated test site for equipment subject to either the Certification, Declaration of Conformity (DoC) or Verification approval procedures.^{23, 24}

A testing laboratory not recognized by the FCC may obtain a Compliance Testing Experimental Radio License for performing test site validation measurements.

A Compliance Testing Experimental Radio License does not authorize RF immunity testing or susceptibility testing, which must be performed in a shielded enclosure, or otherwise with a conventional experimental license under Part 5.^{25, 26}

To apply for any FCC experimental license, see: Dashboard for Experimental Radio Station Authorization (Form 442) (<https://apps.fcc.gov/oetcf/els/forms/442Dashboard.cfm>).²⁷

For additional information on the experimental licensing requirements, see: Small Entity Compliance Guide – Experimental Radio Service (https://apps.fcc.gov/edocs_public/attachmatch/DA-14-398A1.pdf).

²² See: FCC Public Notices 40830 and 54796, available as attachments in this KDB Publication 414788.

²³ See: 47 CFR Part 5, Subpart G—Compliance Testing Experimental Radio Licenses.

²⁴ See also KDB Publication 349827, D01 Testing Laboratory Qualifications.

²⁵ See: 47 CFR § 5.503.

²⁶ See also FCC Public Notice, Conditions for Use of Outdoor Test Ranges for RF Immunity Testing, July 17, 1996, (https://apps.fcc.gov/edocs_public/attachmatch/DOC-93003A1.pdf), (http://transition.fcc.gov/Bureaus/Miscellaneous/Public_Notices/1996/pnmc6033.txt).

²⁷ Additional information is available in: FCC Public Notice DA 17-362, Office of Engineering and Technology Announces Acceptance of Applications for Program Experimental Licenses, Apr. 14, 2017, (https://apps.fcc.gov/edocs_public/attachmatch/DA-17-362A1.pdf), and Federal Communications Commission (FCC) Experimental Licensing System – Compliance Testing License User Manual, (https://apps.fcc.gov/oetcf/els/misc/ELS%20Web%20Application%20User%20Guide_Conventional%20October%202016.pdf).

7. OPERATION OF TEST EQUIPMENT AT A TEST SITE OR TEST LABORATORY

7.1. Reference-signal sources used exclusively at radiated emission test sites

Various types of reference-signal sources are intended for use exclusively at test sites (e.g., comb generator, Comparison Noise Emitter (CNE)); for example for routine verification of test site characteristics, or for proficiency testing or laboratory-to-laboratory comparison testing. An experimental license permits the operation at a test site of equipment that intentionally transmits for those activities necessary and in support of equipment authorization testing, such as antenna calibration, test site validation, proficiency testing, and compliance testing. Equipment authorization is not required for test equipment such as signal generators and reference-emission sources used to perform these testing activities in association with an experimental license.

7.2. Signal generators and similar instrumentation for laboratory use or other radiated-signal testing

- a) A signal generator used exclusively connected to another device by wire or cable, where RF signals are conducted to the other device, may be considered as test equipment that is exempt from the Certification equipment authorization requirement; see Sections 15.3(dd) and 15.103(c).^{28, 29} A signal generator used in this manner is not classified as a transmitter.
- b) A signal generator used exclusively in a shielded-room environment to radiate test signals for evaluation of other devices or for measuring the properties of materials also can be considered exempt from the Certification equipment authorization requirement. Devices used exclusively in a shielded-room environment to radiate test signals are not classified as transmitters.
- c) A signal generator that is marketed and used to radiate test signals to other devices, requires Certification as a transmitter, e.g., in accordance with Section 15.201(b); note also Sections 15.205, 15.5, 15.209, etc.
- d) Per Section 15.103(i), a signal generator (or any test equipment) that also contains an intentional radiator or licensed transmitter device or component (e.g., ZigBee, Bluetooth) is not exempt from Part 15 technical standards. The intentional radiator or licensed transmitter portion of the test equipment must comply with any applicable rules.

²⁸ 47 CFR § 15.3 Definitions. “(dd) Test equipment is defined as equipment that is intended primarily for purposes of performing measurements or scientific investigations. Such equipment includes, but is not limited to, field strength meters, spectrum analyzers, and modulation monitors.”

²⁹ Per the first paragraph and paragraph (c) of Section 15.103, digital devices used exclusively as (or as components or subassemblies of) industrial test equipment, commercial test equipment, or medical test equipment are subject only to the general conditions of operation in Sections 15.5 and 15.29 and are exempt from the specific technical standards and other requirements contained in Part 15. Although not mandatory, it is strongly recommended that manufacturers of exempted devices endeavor to have the device meet the specific technical standards in Part 15.

CHANGE NOTICE

04/18/2017: 414788 D01 Radiated Test Site v01 amends, updates, and replaces the preceding html-text version. In addition, the basic provisions from the following separate publications are incorporated herein and the separate publications are withdrawn:

- 149045; html text; Keyword: Comparison Noise Emitter (CNE), reference noise source, Open Air Testing Sites (OATS), anechoic chambers
- 704992; html text; Keyword: Test Site Validation Requirements above 1 GHZ
- 715555; html text; Keyword: Immunity testing on Open Area Test Site
- 823311; html text; Keyword: GTEM Cell, Gigahertz Transverse Electromagnetic cell
- 934285; html text; Keyword: Comparison Noise Emitters (CNE), test equipment, Broadband Noise Source
- 937606; html text; Keyword: Test Site Requirements for Part 15 and 18 Devices Operating Below 30 MHz

07/12/2018: 414788 D01 Radiated Test Site v01r01 replaces 414788 D01 Radiated Test Site v01.

Footnote: 14 revised to allow for the use of ANSI C63.4a-2017 Amendment 1: Test Site Validation.