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Timely Updates on Critical Standards

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In this issue

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New & Pending Changes to EMC Standards

This Issue of the ACIL EMC Standards Alert Newsletter, we continue to focuses strictly on "news you can use," i.e., new and pending changes to EMC Standards that will cost EMC Lab owners and managers money, increase test burden and/or impose new or altered testing and staff training procedures. This Issue details important changes to both the EFT/Burst Immunity Standard IEC 61000-4-4, and, the Power-frequency Magnetic Fields Immunity Standard IEC 61000-4-8, as well as discussing the newly approved Amendment 1 to Edition 5 of CISPR 11.. In addition, the confusing subject of the required NSA/VSA Site Validation Intervals for Open Area Test Sites and for RF Anechoic Chambers is also clarified.

We open this edition with news of a proposed change to Edition 5 of CISPR 11:

Proposed amendment 1 to CISPR 11, Edition 5- Interference to Industrial, scientific, and medical RF apparatus, to other (heavy) industrial equipment, to overhead power lines, to high voltage equipment and to electric traction

The voting period on the Final Draft International Standard (FDIS) containing this amendment closed on Friday, 12 February. The amendment has a major impact for both Class limits (A and B) and applicable Groups (1 and 2) as it allows measurement at a separation of 3 meters. The caveat is that this will be allowed ONLY for equipment that is “small”. “Small equipment” is defined as equipment, either positioned on a table top or standing on the floor which, including its cables, fits in a cylindrical test volume of 1.2 meters in diameter and 1.5 meters above the ground plane. Tables 4, 5, 9 and 11 have limits for 3 meter separation in addition to 10 meters. Table 10 which contains the limits arc welding equipment also adds limits for 3 meter separation for equipment meeting the above small equipment definition.

Voting results will be published soon. The CDV (Committee Draft for Vote)—which preceded the FDIS document—barely passed and so it is left to see if the FDIS including changes from the CDV will be successful. There are indications that it may pass. The next Standards alert will confirm this assertion.

Changes to the Electrical Fast Transient/Burst Immunity Test Standard — IEC 61000-4-4

Many ACIL Conformity Assessment (CAS) EMC laboratories test using this standard. The second edition of IEC 61000-4-4 came out in 2004. A key element of the IEC 61000-4-4 standard is, of course, the coupling decoupling network (CDN).

Almost immediately after the Second Edition of IEC 61000-4-4 was published, there were two corrigenda issued. Even more interestingly, one of the corrigenda, and the amendment now just completing a successful vote both involved Clause 6.2.2 "Verification of the characteristics of the coupling/ decoupling network". Additionally, the figures describing the coupling/decoupling networks were also revised, and a new one was introduced in this chain of four documents.

To be ready to test in accordance with the amended version of the standard, it is important to follow what has happened over time and to understand what is about to be published.

• IEC 61000-4-4 (2004)—Second Edition

Clause 6.2.2 contained a short sentence stating that the waveform should be verified at the common mode output of the CDN using a 50 ohm termination. It also recommended that the functionality of each single CDN path be verified.

Figure 4 "CDN for power mains supply ports/terminals"-- had a schematic of the CDN with ferrites in the phase, neutral and PE lines (5 lines total). These ferrites were in series with 100 µH inductors. The 33 nF coupling capacitors from the test generator to these 5 lines (for 3-phase mains) were shown.

• Corrigendum 1 (2004)

Corrigendum 1 only made a change to Figure 4 by correcting the protective earth line on the EUT side connection to the chassis of the CDN, but simply being the port which the PE of the EUT connects.

• Corrigendum 2 (2004)

In Corrigendum 2, Clause 6.2.2 was changed. The short sentence noted above in 1 in the second edition was dropped and the following text was added: ",,, The waveform shall be verified at the common mode output of the CDN with all outputs tied together and a single 50 ohm termination as shown in Figure 14. In addition to verification of the waveform at the common mode output of the CDN, it is recommended that each individual output be checked to ensure that all outputs are functional. ...". *(Editor's Note: a new Figure 14 was added in Corrigendum 2).* The important change is that the waveform verification requirement was "clarified" to specifically state that waveform verification is to be performed with all outputs tied together (which was not mentioned in the original second edition).

• Draft Amendment 1 to the Second Edition

The Amendment 1 draft document recently passed the FDIS vote with 100 percent approval. It consolidates the two corrigenda, and makes a change to Fig 14 to remove the shorting of all CDN outputs (as that is not the way it is to be done anymore!) in the replacement text for Clause 6.2.2. Thus, the CDN verification procedure will change *again* when this amendment is published. The text of the new Amendment also adds changes to the impulse duration set up by removing the 50 ohm load requirements, and adds the peak voltage (set at 2 kV) which was missing in the second edition. Finally, the NOTE in the second edition which warns of needing minor modifications from that of the first edition of the standard has been removed.

• What is next? Draft Third Edition

While the ink on the amendment to the second edition is still not dry, a new CD draft is being circulated that will constitute the Third Edition. This draft document has yet another version of Figure 14 and how the mains connection is handled. It is also called "calibration" and not "verification" of the waveform at the output of the CDN, which will mean that this will come under the lab's general calibration program, and not the lab's periodic verification program.

In addition to the CDN in newly-added Figure 4, an RF filter at the input to the CDN from the mains is shown. Also, Clause 6.2.2 is changed yet again with more calibration details added, including a new table with multiple output voltage calibrations with variable repetition rates.

There were well over 100 national committee comments to this draft Third Edition, which led the committee to seek another draft. So the publication of the Third Edition of IEC 61000-4-4 is at least one year or more away.

• What to do for now and in the near future

For now, IEC 61000-4-4 Second Edition with Corrigenda 1 and 2 are applicable. In the near future, IEC 61000-4-4 Second Edition with Amendment 1 (i.e., Edition 2.1) will apply. (See draft amendment 1 to the 2nd edition above for details.)

Changes in the Power Frequency Magnetic Field Immunity Standard— IEC 61000-4-8

- **IEC 61000-4-8 (1993)—first edition**

The first edition of 61000-4-8 was published in 1993. Included in the standard were test procedures for both table top and floor standing equipment. There was more complexity for the floor standing equipment because the magnetic loop had to be large to fit around the EUT. However, there was also a "proximity" method where a smaller loop was moved around the volume occupied by the EUT to see specific areas which might not be immune to the test field. There was a considerable emphasis on the magnetic field coil calibration methods, problems with generating the test magnetic field, selection of test levels (various classes), and expected field strength levels from different sources at several separation distances.

The standard covered not only 50 Hz and its harmonic fields, but also other power frequencies indicated at 16 2/3, 20 or 30, and 30-400 Hz. This included 60 Hz systems. Even DC fields were mentioned. The test levels are for steady state or continuous fields and for fields for short duration, such as when a power line fault occurs.

- **Edition 1.1 (2001-03)**

In Edition 1.1, a separate Clause 10 was added on test reports. (The first edition had test reports included in Clause 9.) Also, Annex ZA (which was normative in the first edition) on "Other international publications," which quoted standards with the references to the relevant European publications, was dropped, probably because it was considered inappropriate to an international standard.

Edition 1.1 contains a reference to Amendment 1 (2000) of the first edition. Amendment 1 will not be discussed here, because, as a new edition, which in this case is Edition 1.1, it had to contain the previous base edition and the text of Amendment 1. In fact, Edition 1.1 has vertical lines in the margin to show what was changed by Amendment 1.

Clause 8.1.1 (Climatic Conditions) in Edition 1.1 removes references to specific temperature, relative humidity, and atmospheric pressure ranges that were in the first edition. Instead, it says to use values for these three items that are within the limits specified for the operation of the EUT and test equipment by their respective manufacturers.

Clause 9 of Edition 1.1 contains only requirements for the evaluation of test results. There is some rewording, but the gist of it is the same as the first edition. However, the sentence that stated that the EUT should not become dangerous or unsafe as the result of this test was removed. Test reports are now covered in a new Clause 10. This clause has 10 items explicitly called out that must be in the record in order to replicate the test. In addition to indicating what was tested, test conditions, and performance criteria specified by the manufacturer, the rationale for stating pass/fail must be stated. Also, any specific conditions of use, such as examples of cable lengths and type, shielding, etc. needed to bring the product into compliance, are required to be stated.

- **Edition 2.0 (2009-09)**

The Second Edition now explicitly states that it applies to 60 Hz systems, although as noted above, the first edition indicated in the scope that there were other kinds of magnetic fields which would be the "object of standardization" and included a frequency range that included 60 Hz, but not DC. In contrast, the Second Edition does not include the other frequencies or DC.

The specification for the generator for different inductive coils is changed from both the first edition and edition 1.1. There is now a Table 3 in the Second Edition that shows the increases in the range of current for the generator output for continuous operation for each coil (standard square coil and standard rectangular coil). In the previous edition, you had to apply the appropriate coil factor for each of these two coil configurations to obtain the generator output. Also, Edition 2.0 added statements to the effect that continuous operation had to be up to 8 hours in duration, and that the output of the transformer used to feed the coil had to be isolated from protective earth.

For verifying the characteristics of the test generator in clause 6.2.3, there is an additional characteristic—namely the field strength in all other (than the standard one described in the text) inductive coils. This is useful when the standard square (1m by 1m) coil and standard rectangular (1m by 2.6 m) coil are not used as indeed the magnetic field has to be known (which it is), if one makes uses of the same laws of physics as were used to determine the physical properties of the two standard coils. Table 4 indicates the equivalency of getting a field of various levels of amperes/meter for this ensemble of coils.

For table top EUT testing, there is now a requirement that the ground reference plane cannot be part of the coil or on the table below the EUT. For floor standing equipment, a standard rectangular coil is used where the test volume is 0.6 m by 0.6 m by 2 m (height). The previous edition sized the coil dependent on the size of the EUT. However, if the EUT does not fit in this standard size coil, the "proximity" method which uses a smaller coil that is moved around the EUT (with a note that says this technique may give useful but not necessarily reproducible results)—or—simply make a coil which will contain the volume (but not touch the EUT frame) of the EUT. There is also simplification of the process for finding

the coil factor for the standard square and rectangular coils. Since their construction is covered in detail, all you have to do s measure the current in these coils to know the magnetic field that they produce.

The requirement for 3 m separation between test generator and the induction coil was removed from the test generator section, and was replaced with a statement that the test generator shall not influence the magnetic field and shall not be placed "close" to the coil. In addition, the bottom of the coil can be bonded at the foot of the coil to the ground plane.

In the test procedure clause under "electromagnetic conditions," there remains as in Edition 1.1 the requirement that EM conditions shall not affect the operation of the EUT and shall not influence the test results. However, Edition 2.0 adds a new requirement that the ambient magnetic field strength in the laboratory shall be at least 20 dB lower than the selected test level. Edition 2.0, clause 8.2.3 states the following: "The electromagnetic conditions of the laboratory shall be such as to guarantee the correct operation of the EUT in order not to influence the test results; otherwise, the test **shall** be carried out in a Faraday cage." In particular, the power frequency magnetic field value of the laboratory shall be at least 20 dB lower than the selected test level".

EMC Labs that primarily perform only commercial EMC testing should take careful note of this requirement, because it may be difficult to prove that the EMC Lab ambient 50 Hz and/or 60 Hz magnetic fields are at or below 100 dBuA/m (for the case of level 1 Tests at 1 A/m applied magnetic field) using only the basic EMC instruments and transducers typically available in a general test lab facility.

The applied magnetic field is specified as that which is determined by immersing the product into a field generated using the standards inductive coils. Normative Annex A indicates that the applied field can also be determined using calibrated magnetic field sensors (examples of Hall Effect sensors and multi-turn loop sensors) with a diameter of at least an order of magnitude smaller than the test inductive coil and using a narrow band power frequency instrument.

However, this approach may allow such a field to be generated of the proper magnitude, but may not have the field spatial distribution that would have been obtained using the square or rectangular coils specified in the standard.

The section on carrying out the test now has a statement on human exposure which should be followed by test personnel. The rest of the clause repeats in essence that of Amendment 1. Clauses 9 on evaluation of the test results and 10 on test reports are unchanged. The annexes are virtually identical between editions 1.1 and 2.0. Finally, there is the addition of a short two document bibliography.

The then captures most of the changes between Edition 1.1 and Edition 2.0, but not all. The bottom line for EMC test Labs is that there are several differences between Edition 1.1 and Edition 2.0 that should be carefully reviewed and understood prior to performing tests in accordance with Edition 2.0.

Site Validation Confirmation Intervals

During audits of testing laboratories, the laboratory assessors are required to witness test site validation measurements made at selected frequencies. This is to show that there is competency in performing site validation, as well as to ensure that the test site has remained in compliance with the validation criteria published in, for example, ANSI C63.4 and CISPR 16 -1-4. The assessors are also looking to see that the laboratory has followed the required site validation confirmation intervals as published in ANSI C63.4. *[Editor's Note: site validation confirmation intervals are not stated in CISPR 16-1-4.]* Hence, there are two laboratory practices being checked for compliance with ISO/IEC 17025: 2005 during a laboratory assessment.

But what is in C63.4 on site validation intervals?

C63.4-2003 (which is still referenced by the FCC in Part 15 of their Rules): 30 to 1000 MHz

The re-validation interval requirement for test sites validated using normalized site attenuation (NSA) is given in Clause 5.4.6.2. Since NSA is discussed, this applies only to the frequency range 30 to 1000 MHz. In 2003 (and before) the most used "referenced" test site was an open area test site or OATS. Hence, the clause talks about situations primarily where the OATS is covered or enclosed with some type of covering to keep out the weather. As the focus was on an OATS, NSA is to be performed only over the main measurement axis between the EUT location (typically at the center or the turntable) and the receiving antenna as there was much less concern for undesired reflections in an "open area".

The NSA measurement process is explicitly applicable for "alternative test sites" defined in Clause 5.4.2, such as fully weather-protected OATS, and semi-anechoic chambers. For alternative test sites, the NSA is performed over the horizontal footprint of the EUT not just the main measurement axis. This is called the Volumetric NSA requirement (VSA). Clause 5.4.6.5 shows how to define the EUT volume and where to set up the transmitting antennas. It turns out that the selected positions of the transmit antenna are at cardinal compass points on the turntable (assuming that the turntable diameter was selected to accommodate the largest horizontal dimension of the EUT that will be tested).

For these facilities, there is a minimum requirement that new test sites still meet NSA requirements. After that time, site validation checks can be in longer (up to three years) or shorter intervals based on reviewing NSA data. What this usually means is that NSA data should be documented to show a lab assessor. Typically, if no changes have occurred in the test facility that would alter the RF characteristics of the test site/facility, there would be a reason to extend the confirmation interval. Shorter intervals would be required if there were changes made to the test site/facility affecting its RF characteristics. The requirement is still, however, to review NSA data to make these decisions as stated in the second sentence in Clause 5.4.6.2. But in any case, the test facility must have its validation checked with an interval no longer than three years.

How then can the test lab make a decision on a shorter or longer validation interval than 1 year? In three words: data, data, and data - taken with spot checks of NSA at several frequencies to see that the site continues to meet NSA over time and is not progressively degrading, i.e. coming closer and closer to the maximum difference magnitude of 4 dB from the theoretical NSA. Where is there help in taking such data to show/prove that the validation interval that the lab selects? ISO 10012: 2003 provides help in determining what to do. In the vernacular of the ISO standard, the NSA is the customer metrological requirements (CMR) and the measuring equipment metrological characteristics (MEMC) is, of course, the equipment used to measure NSA. The standard then states that if the spot checked NSA is still within +/- 4 dB, there is not action needed, or we could state that the validation interval can be extended up to the 3 year maximum interval. If the NSA is close to the +/- 4 dB limit--or larger than this value—site validation must be checked more often than 1 year, and when the +/- 4 dB is exceeded, quite obviously the site has to be evaluated and repaired prior to allowing the test site/facility to be used.

C63.4-2003 (which is still referenced by the FCC in Part 15 of their Rules): Above 1 GHz

In clause 5.5 of ANSI C63.4-2003 it clearly states the there is no site validation criterion above 1 GHz. It then goes on to state that a site meeting NSA below 1 GHz can be used above, even with a ground plane that was present for testing under 1 GHz. Since there was no criterion for site validation above 1 GHz, there could not be a statement of validation interval above 1 GHz.

Next we look at what was changed for site validation (and the validation interval) in the 2009 edition of C63.4 that is allowed to be used for certification measurements as indicated by the FCC in their Public Notice: DA 09-2478, released on November 25, 2009.

C63.4-2009 (which the FCC allows use of as of 25 November 2009)

30 – 1000 MHz:

In ANSI C63.4-2009 Clause 5.4.4.2 for frequencies between 30 and 1000 MHz, the text is very similar to that of ANSI C63.4-2003 as it still states that the validation interval can be more or less than a year after the first year validation check (for a new test site). There is also more guidance on degradations to all weather covered open area test sites and their possible deleterious effects on NSA.

The requirements for performing NSA over the main measurement axis for an OATS and over the EUT volume for alternative test sites remain unchanged.

What has been added is more information of the validation interval for such sites. In particular, a 12 month validation interval is stated as adequate unless there is a reason to believe that site degradation has occurred (examples of degradation for all weather covers (which can be a wide range of covers including fabric-type and wooden or plastic structures) of OATS are identified, hence a 6 month interval is recommended for such installations). Again, the ISO 10012: 2003 standard is suggested to be used for guidance in selecting the appropriate validation interval.

That said, the analysis of data from spot checks taken over time is still the best method to show/prove why you have selected your validation interval.

Above 1 GHz:

Clause 5.5 says that validation requirements are not established. To temporarily handle the present need for some validation criteria, there are two options given. The first option is simply to cover a 2.4 m x 2.4 m portion of the ground plane between the receive antenna and the EUT using RF absorber material (as measurements above 1 GHz are to be done in “free space” or a near equivalent) with a minimum of 20 dB RF absorption at normal incidence. The second option is to use the IEC/CISPR method contained in CISPR 16-1-4: 2007. The first method has no site validation measurement, and hence no implied or actual site validation interval. The latter has a site validation requirement, which is the so called "SVSWR Method" that was discussed in the last “ACIL EMC Standards Alert Newsletter” (No. 3, Vol. 1).

This method includes measurements with the transmitting antenna located at various separations from the receiving antenna around a minimum of 4 areas on top of the turntable and at two transmitting heights. This method is inherently a volumetric site validation.

While it was the intent of the ASC C63® to have an explicitly stated validation interval in ANSI C63.4-2009, there is no such statement. Because of this shortcoming, a request for an interpretation of what should be the validation interval for this frequency range has been made to the ASC C63® . The request suggests the following wording be inserted as a new paragraph after the present text in clause 5.5:

"Validation of the acceptability criterion shall be confirmed in the first year for a new site or one that has undergone physical and electrical upgrades or changes. Subsequent validation intervals may be longer (up to three years) or shorter, based on review of the site validation data (when invoking CISPR 16-1-4) relative to the extent and severity of use of the site and any physical modifications made to the site. It is therefore recommended that periodic site-attenuation measurements be made in order to detect anomalies that will affect the site usability. A 12-month interval is generally adequate for checks of the site continuing to meet site validation requirements when using CISPR 16-1-4. See also Annex A of ISO 10012-1:2003 for other guidance in establishing a suitable validation interval based on the results of periodic checks."

This suggested text details what should be done above 1 GHz, and is parallel to what is currently required below 1 GHz. This suggested text will be discussed in the committee and if this text or an amended version is approved by ASC C63®, it will be issued as a formal interpretation that amends the base C63.4 document.

The bottom line for EMC test Labs are: that there has to be continuing proof that test sites meet the applicable validation criterion, and that there has to be in place a method to assess that the validation criterion is met on a continuous basis. As stated above, spot checking at frequencies that yield values closest to the validation criterion limits will provide data that will support the validation interval that the laboratory uses when being assessed by an accrediting body.

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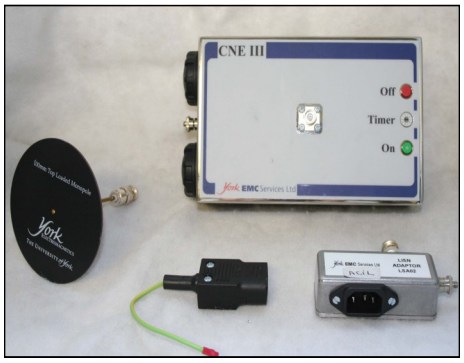

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