Requirements and Techniques for Passing a NVLAP On-Site Assessment

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The process and requirements are explained from an assessor's point of view.

BACKGROUND

The National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NVLAP) grew out of a desire to have a reputable independent organization accredit laboratories that measured fire retardancy, asbestos contamination, and other industrial areas related to public safety. NVLAP accreditation of laboratories which test for electromagnetic compatibility (EMC) grew out of a U.S. Navy program designed to offer accreditation to laboratories conducting MIL-STD-462 tests under Navy contracts. The program was expanded to include laboratory accreditation to perform commercial EMC measurements for Federal Communications Commission (FCC), Part 15 compliance in the U.S. when some organizations saw the value of independent accreditation. Subsequently, the FCC decided to allow laboratories accredited by NVLAP or other recognized reputable independent technical organizations to certify products as complying with Part 15 EMC requirements.

Today many laboratories seek accreditation to perform Part 15 EMC measurements. One important facet of this process is the on-site assessment by a NVLAP representative or other expert. This article explains the process and the requirements from an assessor's point of view so that laboratories can better understand and prepare for the assessment.

WHAT NEEDS TO BE EVALUATED?

EMC measurement is — like it or not — a quality control function. The objective of EMC testing is to demonstrate formally that electronics equipment meant to perform some useful task also conforms to arbitrary quality standards. This conformity is necessary so that equipment can be successfully collocated with other electronics equipment.

Precise measurement of emissions is essential to EMC testing. For proper measurement, a laboratory must ensure and/or provide:

- Calibrated measurement equipment
- Technical competence of the measurement personnel so that equipment is operated properly
- Test reports so that the results of the test and the circumstances under which it is performed can be reproduced and the test sample's performance can be evaluated
- A proper attitude among laboratory personnel. The people involved must care about doing a good job and be dedicated to doing it properly.
- A quality control program so that lines of responsibility and authority are clear and procedures which can be measured and evaluated are followed.
- A quality control manual and other documentation so that the quality program can be recorded and formalized, learned and assessed by others, periodically reviewed for shortcomings, and updated to include improvements.

LAB STRENGTHS AND WEAKNESSES

The test reports of the EMC laboratories are almost always excellent. This is the product delivered to the customer, and as such, is carefully crafted, upgraded by trial and error, and reproduced from recorded documentation. The technical personnel in most laboratories possess and use excellent technical skills. Most laboratories have properly calibrated key measuring equipment which is kept in good repair and used properly.

If the testing laboratory or its parent company has ISO 9000 series registration or a MIL-SPEC quality control program, the quality control manual and quality program will likely be exemplary.

The most common failure of EMC testing laboratories relates to the area of quality control. Specifically, the attitude of the personnel about quality control, the quality control program, and the quality control manual determine the integrity of test results collected in the lab. The order of these items should be noted because without the proper attitude, the other two quality control functions are virtually impossible.

CORRECTING THE PROBLEM

The steps necessary to correct the problem are relatively simple. A good start is reviewing what is done in the laboratory. The testing is probably done carefully by dedicated people who want to do a good job. They no doubt

consistently turn out good test reports or the lab would soon be out of business. They are following an unwritten set of rules — a quality control program.

This unwritten program should be documented and can then serve as a basic quality control manual. An older quality control manual or one that is used by another company and has been audited can be used as a guide to format the new manual.

The quality control manual must include:

- Test and verification procedures for all testing covered by NVLAP.
- A section dealing with customer complaints, procedures for handling them, and persons responsible for various remedial action.
- A section dealing with handling the test sample, including a paragraph on procedures for obtaining information on normal operation of the test sample.
- A paragraph on the use of the NVLAP logo.
- A section on measurement uncertainty calculation procedures for each test and verification performed by the laboratory (calculations for each verification and each test procedure, i.e., radiated emissions, ±7 dB.)

Finally, to prepare for the NVLAP on-site assessment, managers should get copies of the assessor's checklists and use them to stage an on-site dry run assessment. Then the quality procedures and manual can be updated based on the results of the dry run.

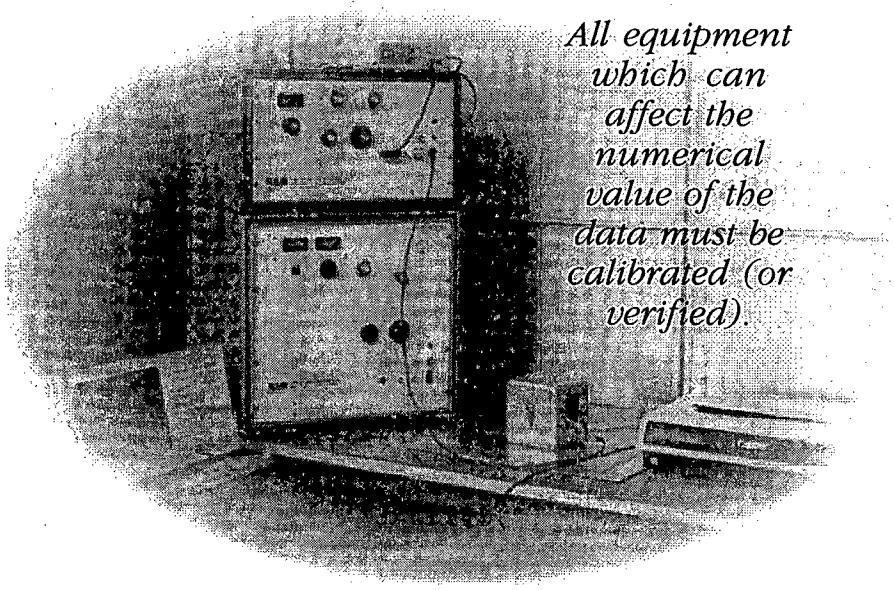
ONE MORE STEP

Once an acceptable quality control program is established, implemented and documented in a formal quality control manual, the outcome of properly performed tests can be ensured.

What is still left to do however, is to confirm that the procedures implemented and documented in the laboratory are in accordance with those in use at other laboratories. While this agreement does not enhance the product, it does insure its portability and acceptability by people with other views of what constitutes perfection.

SITE AND FACILITIES

EMC testing laboratories are by and large unsightly and disreputable looking establishments. Before the site is inspected, the grounds should be cleaned up, the ground screen repaired, and the area around the test equipment organized. NVLAP aside, laboratory managers should consider the impression on their customers. Would they patronize a business — any business — in which the housekeeping was on a par with the housekeeping in some labs?



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THE TEST EQUIPMENT

All equipment which can affect the numerical value of the data must be calibrated (or verified). This includes:

- Receivers or spectrum analyzers
- Antennas
- LISNs
- Cables
- Switches, attenuators, and patch panels, if used
- Turntable angle marks or sensors and readouts
- Antenna height marks or sensors and readouts

Calibration must be performed at a NVLAP-accredited or qualified calibration laboratory or in-house, in which case NVLAP refers to it as verification.

All records of calibration, certificates of traceability, maintenance and records of initial inspections must be kept for each piece of equipment used in formal EMC compliance testing.

For proper in-house calibration or verification, a procedure must be written and followed. The serial number and calibration status of equipment used to perform the verification must be recorded for traceability. A certificate — a signed and dated test data sheet — must be issued, a calibration sticker must be affixed to the antenna, cable, etc., and the item must be entered onto the calibration list with the equipment which has been calibrated elsewhere.

THE OPEN FIELD SITE

Site attenuation data — the result of a site verification — must be available and have been taken within the year.

PERSONNEL

Records of schooling, experience, and continuing education must be maintained for each person making measurements. The requirements for these records and acceptable levels of performance in each category must be detailed in the quality control manual. It is suggested but not necessary to have at least one such record available for review by the assessor.

SOFTWARE

Any and all software that can affect the data recorded or reported must be documented. This means it must be controlled in a fashion equivalent to document control. The simplest method is to save the source code on a floppy disk. Remove the disk from the computer. Label it with a program name, date, and the signature of the responsible custodian. This becomes the official documented version of the software.

If the source code is not available, date and sign the distribution disks and file them under "documentation control." Other more modern systems using password protection or read-only copies in a network environment are acceptable so long as the fire walls, password protection procedures, etc., are properly documented in the quality control manual.

THE TEST REPORTS

Data recorded in the test report must include amplitude, frequency, antenna polarization, antenna height and table position. All this data, along with cable positions for maximum emissions — recorded with a photograph — are necessary to reproduce the test elsewhere.

A list of test equipment with model and serial numbers and calibration dates must be in the test reports as well. A paragraph describing deviations from specified procedures must be included. If there are none, *none* should be stated under the heading but the heading should not be omitted. Test procedures must be detailed in the test report.

A NVLAP signatory must sign off on all reports.

Several specific statements must be included:

"This report does not imply product endorsement by NVLAP or the U.S. Government."

"This report must be reproduced in full. It can only be reproduced in part after obtaining written permission from the testing laboratory."

"The results of this report describe the performance of only the particular device tested."

These statements can be edited to suit the specific circumstance.

MEASUREMENT UNCERTAINTY CALCULATION PROCEDURES AND PASS/FAIL CRITERIA

The laboratory must establish and document formal pass/fail criteria. In addition, a method must be established for calculating measurement uncertainty. This is a NVLAP requirement, and is a requirement for IEC/CISPR 22 accreditation. Unfortunately, the calculation of the second moment of a composite distribution comprised of a series of second moments of various dissimilar distribution functions and raw data points is extremely difficult. Without knowing the distribution functions from which the original moments were derived, and without having the original data set, it is usually impossible. In other words, knowing that the manufacturer of a spectrum analyzer says it is accurate to ±2 dB is not sufficient data to properly perform a measurement uncertainty calculation.

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Because of the complexity and nature of this problem, the ultimate practical solution is that the calculation procedures be mandated by a panel of technical experts empowered to decide the issue. In the meantime, many laboratories are using the expedient, although grossly approximate, method of treating the separate constituent errors expressed in dB as data points from a normal distribution, and calculating the probable error also expressed in dB:

$$\text{Measurement Uncertainty} = \sqrt{\frac{\Sigma U_i^2}{N}}$$

Where:

U_i = manufacturer's published measurement uncertainty or the uncertainty calculated or reported for verified or calibrated instruments or components of the system.

N = number of system components.

Typical calculated values are 3 to 5 dB for conducted interference measurements and 5 to 8 dB for radiated interference measurements.

SUMMARY: NVLAP GOALS

NVLAP wants to raise the level of EMC laboratory performance and recognize laboratories whose performance is above minimum acceptable standards. The first goal implies that NVLAP will work with a laboratory to help them achieve accreditation. The on-site assessor's visit, therefore, is not a confrontational meeting but a work session where an impartial outside expert helps laboratory personnel identify and correct areas in which a laboratory's performance or quality control program needs to be upgraded.

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