

EMC Engineer Training

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Abstract:

Training and qualifying a group of EMC test engineers for specific EMC tests is a normal laboratory function. What is considered adequate training in one laboratory may be just the beginning of the process in another, and documentation methods vary widely. This paper presents one EMC test method training philosophy, and shows one method of documenting that training. It is hoped that this will encourage others to come forward with alternative approaches to training and documentation and engage in a fruitful discussion of the benefits and pitfalls of each.

Keywords

EMC, EMI, Testing, Training, Documentation.

1. Introduction

A Training Philosophy

Training for the operation of sensitive equipment and its use in the evaluation of equipment under test to a specific standard requires a strong familiarity with several aspects of the test:

- The relevant national, international or company standard.
- The detailed test procedure developed by the EMC laboratory,
- The function and operation of the physical equipment and
- The operation of any control and monitoring software.

This list requires either that the organization institute a regular series of classes to introduce new test engineers to the tests, or mandate a course of self study of the materials, or a combination of the above.

A Training Example

While individual study of the standards, the laboratory test procedures and the equipment manuals is possible, an introduction to the complete 'package' from an experienced test engineer can go a long way toward providing the engineer with an overall appreciation of how all of these elements work together and give him a real advantage in his study.

Reading:

There is good justification to initiate the engineer's study of a test with a multiple reading assignment that would include:

- The Standard,
- The Laboratory Procedure and
- The Equipment Operations Manual(s).

This initial reading is often conducted as a 'skim' of the material to get a 'sense' of the document contents as opposed to an in depth reading which will come later.

Note: Only the Operations section of the equipment manual needs to be covered for this training, unless the engineer will also be expected to maintain and calibrate the equipment as well.

Lecture:

The reading assignment is followed by a lecture from one of the company senior engineers that will provide an overview to help orient the new engineer to the test. The lecture introduces the standard, its history, and the rationale for its application in to this type of test. The second part of the lecture addresses the internal laboratory test procedure and how it is applied to meet the intention of the standard. This will include an introduction to the specific test equipment and facilities used in the laboratory to set up the physical test, the philosophy of the test setup as well as the practical aspects of the physical arrangements needed to implement the test.

NOTE: Safety requirements should be stressed both in this initial lecture, as well as subsequent demonstrations of the equipment and its use.

Equipment Demonstration:

The introduction to the test equipment is conducted as a 'hands-on' demonstration, where both the engineer and instructor exercise the various functions and settings of the equipment and its controls.

No attempt is made at this stage to introduce the control software to the engineer. It is necessary for the engineer to be able to operate the test manually if required. We have also observed a tendency for engineers to rely on software to an unhealthy degree if it is introduced too early which makes it difficult

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for them to later grasp the manual operation principles.

In-Depth Reading Plus Software Manual:

When this overall introduction to the test is concluded, the engineer is asked to do 'in-depth' reading of the Standard, Lab Procedure and Equipment operation manuals.

It is recommend that the reading of the equipment operation manuals be done with the equipment immediately at hand. This allows the engineer to 'push' the buttons and operate the equipment through it's menus and functions. This will help the learning process by including the kinesthetic memory function.

Demonstration-Manual & Software Driven Testing:

When the 'in-depth' reading is concluded, the instructor should take the engineer through a demonstration of the total test including:

- Initial review of the test plan (if one is required),
- Review of the test standard,
- Setup of the equipment under test,
- Manual operation of the test equipment to gather data, and
- Calculation of cable loss, unit conversions, and transducer factors effects on the data (primarily emissions tests), but not to be neglected on other tests,
- Data sheet usage, if appropriate, and
- Reporting formats and conventions.

Test Software:

If software is normally used to drive the test equipment for this test, it should be introduced to the engineer after the engineer has demonstrated the ability to manually conduct the test.

For the first time now, the engineer should be encouraged to read the documentation on the test software. As with the equipment manuals, the engineer should do a 'scan' through the information on his first read.

Just as he was encouraged to read the equipment manuals with the equipment at hand so that he can 'play' with the controls, in the case of software, on the second read through of the software documentation, the engineer should do an in-depth reading of the software manuals with a computer at hand running the test software, at least in 'demo' mode.

Coach Engineer Through Test:

When the engineer has familiarized himself with the software, it is time to repeat a test with the equipment, this time with the instructor talking the

engineer through the setup and manual running of the test. Next, have the instructor coach the engineer through a typical run of the test under software control, with the engineer 'driving' and the instructor giving suggestions and advice.

It may be necessary to repeat this 'coaching' stage several times until both the engineer and the instructor feel confident that the engineer is ready to operate the equipment 'solo'.

Determining when the engineer is ready is a matter of judgment on the part of both the engineer and the instructor. If the engineer needs to repeat the 'coaching' process several times in order to feel truly confident in his handling of the test, the equipment and the software, then it is in the best interests of the engineer, the instructor and the laboratory to provide sufficient opportunity in which to grow that skill.

Observation of Engineer Conducting Test:

When the engineer is ready, the final check to be sure that all of the lessons have been successfully acquired is to have the engineer run the test, under the watchful eye of the instructor. However, this time the instructor must remain silent and observant.

If the engineer makes a mistake, and can recognize it and recover, he is learning. During this 'solo' phase, we are asking the engineer to prove to himself and to his instructor that he is ready to run the test alone. The main function of the instructor at this time is to witness the engineer's progress, and act as a safety monitor, in case the engineer is about to do something dangerous to the equipment or himself.

Training Documentation

One of the requirements that we mentioned at the beginning of this paper was the need to document the training, and maintain the records as evidence that the training had been accomplished. This is no particular problem when the training only needs to be recorded for one person. It is quite another matter when the training must document an entire staff of an EMC laboratory. A typical laboratory may be accredited to conduct as few as 10-15 tests, or as many as 100 or more. Couple this with staff's of up to 30 or 40 test engineers, and it is obvious that keeping track of a test engineer certification matrix of this magnitude ($100 * 40 = 4000$) intersections can be a monumental task.

When training for a large number of engineers' must be coordinated and recorded, some method needs to be employed that will allow easy entry of the data into the system, easy visual identification of the fact that an entry has been made, a rapid means of determining how close each staff member is to the

training goal and when the training needs to be renewed.

The spreadsheet shown below was developed to perform all of these documenting and tracking functions.

Figure 1: Detail of Spreadsheet

		Engr. 1	Engr. 2	Engr. 3
Technical Manuals				
Std #	Ref Doc			
CE01	MIL-STD-462 C			
CE02	MIL-STD-462 (C)			
CE03	MIL-STD-462 (C)		2/4/03	
CE04	MIL-STD-462 (C)			
CE07	MIL-STD-461 (C)			
CS01	MIL-STD-462 (C)			
CS02	MIL-STD-462 (C)			

The columns to the left of the main page are used to list the specific test, and the top row lists the engineers. This generic example shows only the title of Engr. 1, etc. In the actual application, the names of the particular individuals would be used.

In the example when a date is entered in the body of the spreadsheet, the cell is formatted so that the cell color changes from gray to white when a valid date entry has been made. This allows a quick visual check to see which tests the engineer has completed for this section of the spreadsheet, and which tests are still 'in-work'. A further enhancement of the system can be made that will cause the cell to change to red when training dates have 'expired' and a refresher of the material is needed.

The entire spreadsheet is build of modules that record the dates when the engineer has completed each section of the certification schedule.

Putting most of the rows into a 'hide' status as to compress it into a single print column created the partial example of a full schedule shown above. This gives a view of how the total system operates. Each date entry for a particular test element is made in the different sections of the spreadsheet:

- Review Equipment Technical Manuals,
- Review Test Standards & Procedures,
- OJT – Intro to Setup/Cal/SPC & Test,
- OJT – Coach on Test,
- OJT – 'Solo' – Instructor Observes.

As each section has a date entered for a particular engineer and test, the final section:

- Test Method Certification Status,

adds another 20% to the total shown. When all the entries have been, made for that engineer and that test, the 'Status' cell shows 100% qualified, and turns white. Again, this allows a quick visual check

of the entire staff, for who is qualified to run what test.

Figure 2: Overall Spreadsheet Example

			TEAM MEMBERS		
			Engr. 1	Engr. 2	Engr. 3
Review Equipment Technical Manuals					
Test Name	Std #	Ref Doc			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Cntl & Sig (30Hz-20kHz)	CE02	MIL-STD-462 (C)			
CE Pwr Leads (20kHz-50MHz)	CE03	MIL-STD-462 (C)		2/4/03	
Review Test Standards & Procedures					
Test Standards	Std	Standard #			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Cntl & Sig (30Hz-20kHz)	CE02	MIL-STD-462 (C)			
CE Pwr Leads (20kHz-50MHz)	CE03	MIL-STD-462 (C)			
OJT - Intro to Setup/ Cal/ SPC/ & Test					
Test Standards	Std	Standard #			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Cntl & Sig (30Hz-20kHz)	CE02	MIL-STD-462 (C)			
CE Pwr Leads (20kHz-50MHz)	CE03	MIL-STD-462 (C)			
OJT - Coach on Test					
Test Standards	Std	Standard #			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Pwr Leads (20kHz-50MHz)	CE03	MIL-STD-462 (C)			
OJT - 'Solo' - Instructor Observes					
Test Standards	Std	Standard #			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C			
CE Pwr Leads (20kHz-50MHz)	CE03	MIL-STD-462 (C)			
			TEAM MEMBERS		
			Engr. 1	Engr. 2	Engr. 3
Test Method Certification Status					
Test Name	Std	Std. Number			
CE Pwr Leads (30Hz-20kHz)	CE01	MIL-STD-462 C	100%	100%	100%
CE Cntl & Sig (30Hz-20kHz)	CE02	MIL-STD-462 (C)	100%	100%	100%
CE Pwr Leads (20kHz-50MHz)	CE03	MIL-STD-462 (C)	100%	100%	100%

Use of this method allows relatively easy tracking of what training is needed, how progress is going for individual training, and quick selection of those who are fully qualified on a particular test for test scheduling purposes.

The spreadsheet is easy to modify to include more tests as the laboratory increases its 'scope' of accreditation, and more test engineers as the staff of the laboratory grows.

Training Refreshers

Once training has been completed, normal use of the test standard, laboratory procedure, test equipment and test software will provide enough exposure to keep the information and skills readily at the fingertips of the test engineer. Documenting this continuing experience is accomplished by doing a periodic update of the training material based upon the continuing test experience of the engineer.

It is a good idea to use the same criteria used by the FAA for private pilot certification in a particular type of aircraft. Namely, three "take off's and landing" in a 90-day period will qualify the engineer to 'Solo' that test. If the 'pilot' is out of date on a particular test, then he must 'fly' the first time he does the test again under the eye of another qualified senior engineer.

It is prudent to track this by setting a secondary format on the 'Solo' section of the spreadsheet which

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causes the cell to turn yellow if the date for a Solo is more than 90 days past. At that indication, it is either time to update the records for that engineer and test, or that the next test of that type that that engineer performs must be conducted under the watchful eye of another qualified engineer.

If the engineer finds that his job assignments focus on some tests to the exclusion of others, his skills can become 'rusty' over time, and a repeat of some of the training elements may be needed. If there is a significant change in the test standard, or if the test equipment is upgraded with a new instrument, or if there is a significant change in the test software, then the appropriate portion of the matrix is cleared, and the training in that area is performed again.

Documentation Levels:

The selection of just which elements are recorded in the spreadsheet is somewhat arbitrary. It is possible to setup a system that will document every step of the process, but this may be 'overkill', and only the 'critical' levels of progress must be recorded.

One aspect of a healthy debate on training of this type might include just how much documentation is enough, and when we are getting carried away with records just for records sake.

Summary:

This paper has looked at one approach to training EMC engineers to conduct specific tests involving a multi-stage process to ensure covering all aspects of the required material. This paper also looked at one method of documenting the training process and the question of how frequently to update training was briefly discussed.

A full discussion of training for EMC testing should examine other methods of training and documenting the training. I would like to encourage others to carry on this discussion and compare other methods.