ALTERNATIVE METHODOLOGY FOR THE RADIATED EMISSION MEASUREMENT OF LARGE MACHINES

Johan Catrysse, Filip Vanhee, Jos Knockaert, Ivan Hendrickx

KHBO, Flanders Mechatronics Engineering Center, Zeedijk 101, B 8400 Oostende (Belgium)

Abstract
On the legal aspect, the new European Directive on ElectroMagnetic Compatibility 2004/108/EC concerns also large machines. On a technical point of view, the special situation to characterise the EMC behaviour of large machines imply that current procedures are complex and very expensive, and in some cases even not possible. Adapted measuring methodologies and procedures are needed.

1. Introduction

Regarding EMC, the machinery-industry drags along a set of problems that makes testing and characterising very complex and expensive. Therefore, adapted procedures are needed.
One of the important aspects is that they are basically system-integrators of electrical and electronic modules. Moreover, most of the machines have characteristics (size and dimensions, weight, supply voltage, power consumption, other auxiliary provisions as cooling water, pressured air …) that make the self-certification based on the complete machine testing on an EMC test-site very complex, expensive or impossible. Most of the times, it is not feasible to transport the machine and evaluation must be carried out “in-situ” at the manufacturer or user premises.

2. European EMC Directive and standards

First of all, the EMC legal aspect should be considered. The new European Directive on ElectroMagnetic Compatibility 2004/108/EC [1] concerns also large machines. Concerning standards, one might consider the product family standards for machine tools EN 50370-1 [3] and EN 50370-2 [4], respectively for emission and immunity. Of course, large machines are not only machine tools but these standards might be applied as a reference.
The test approach described in these standards is quite informative. Type testing of a finished product should be the normal method for conformity assessment. In the case of a complete machine, a complete testing is only technically and economically feasible for a limited number of machines. It should be well defined what a type-testable machine is considering weight, dimensions, operation, testing costs and testing delay conditions.
The decision for the test procedure is mainly based on the question if the machine contains or not electromagnetic relevant components and/or modules. In the second case, no tests are required. In the first case, three procedures are applicable:

- procedure A is a type-test on the complete machine,
- procedure B is a type-test on the entire electrical set of the machine, and a visual inspection regarding the correct installation of the components and cabling,
- procedure C is to divide the machine in EMC relevant modules and test them separately under lab conditions, followed by a visual inspection, and a test as final check at the manufacturer premises.

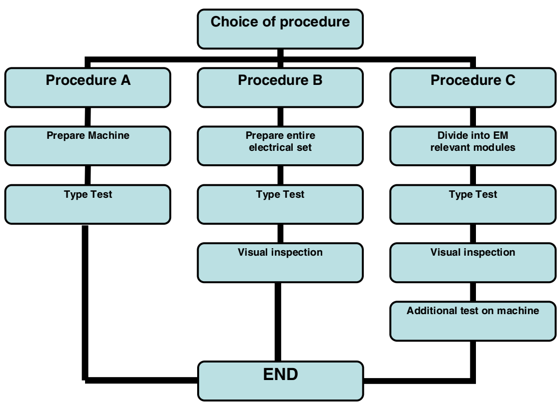

Table 1. Procedure for compliance as given in EN 50370

It is clear that procedure C sounds interesting to the machinery community, also because this allows a flexible way of handling, especially for these machines including a lot of customer based options. It allows an in-depth characterization and validation of all separate modules, and only an additional test is needed on the complete machine. These final testing may be performed using alternative methods, as developed in the research project TEMCA2. This project was conceived and proposed by a joint Working Group formed by CECIMO (European Committee for Co-operation of the Machine Tool Industries) and CENELEC. This group prepared also the EN 50370-1/2 standards, dealing with EMC and Machine Tools.

3. Radiated emission

The main problems for in-situ measurements for radiated emission are:

- the lack of space to perform adequate measurements using antenna's
- the background noise in an industrial environment

Therefore, an alternative methodology has been developed, by putting a simple wire over the machine. This wire acts as an antenna, and is able to capture radiated emissions. The problem is to identify and define a correlation factor (or antenna factor) for this "test-wire" method. The general concept of measuring setups using antenna's and using a "test-wire" is sketched in figure 1.

3.1. Generic Test Object (GTO)

In order to understand the underlying phenomena, theoretical models have been developed, as well as a representative test-specimen (GTO or Generic Test Object). This GTO has been send around the partners for a round-robin test, in order to compare classical antenna measurements and the results forthcoming from the test-wire method.

In order to have a better understanding of the simulation process, first the GTO will be shortly discussed. The GTO has been designed as a generic machine. This means a type of metal enclosure, with noisy components inside (typically frequency converters) and a lot of cabling coming out for capturing data of external sensors. The noisy content was generated by an appropriate comb-generator, and the external cabling was provided by some wires near the ground and at a larger distance from the ground. The GTO is shown in figure 2.

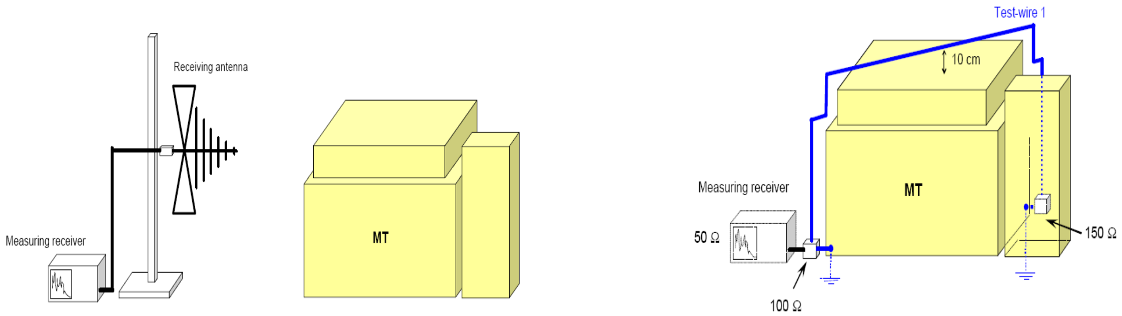

Figure 1. Antenna measuring setup (left) and test-wire setup (right)

Figure 2. Picture of the GTO on a test-site

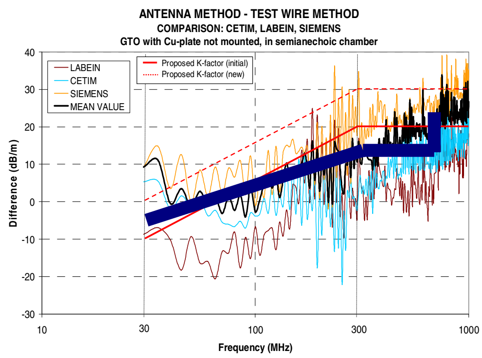

Figure 3. Example of measurements using antenna method and test-wire method, for GTO in EMC labs

3.2. Measurements performed on GTO

Different measurement sessions have been performed by the 4 EMC laboratories, participating in the TEMCA2 project. Tests were performed as well as on the GTO, under controlled lab conditions, as "in-situ" on large machinery. An example of measuring results is shown in figure 3. More details are shown in section 4, especially about the termination of the test-wire in a Common Mode 150 Ohm impedance

4. Example of testing a large machine

In this section, an example is given how to apply the methods discussed above and to perform the tests under practical conditions. The machine to be tested is and Electrical Discharge Machine (EDM) tool from the company ONA ™. The machine uses a wire for spark erosion and was the reference machine in the TEMCA2 project.

Concerning radiated emission, the next pictures and figures show the setup using 6 positions of the test-wire and the practical layout of the test-wire, as well as the measured results for radiated emission, using an antenna method at 3m distance, and the test-wire method. Again, no k-factor or adapted antenna-factor has been applied to the test-wire measuring results.

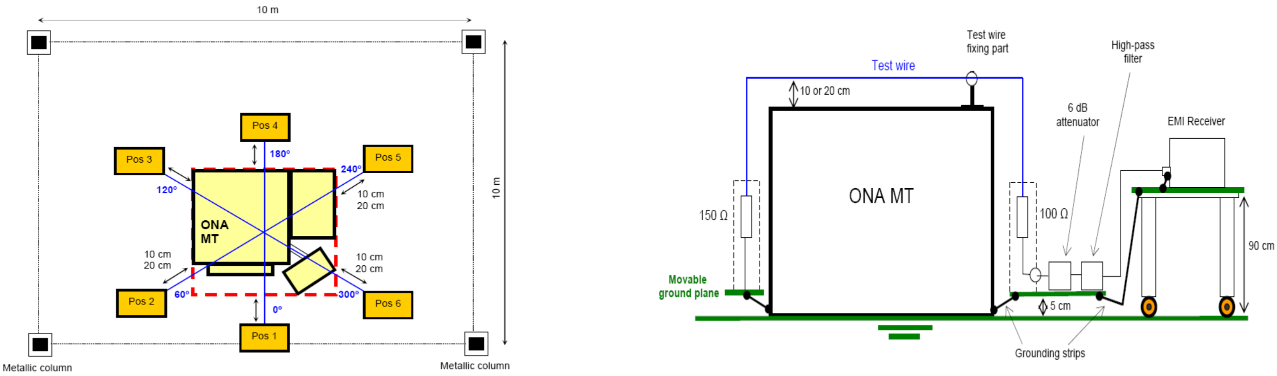

Figure 4. Sketch of the measuring setup for radiated emission using the test-wire method

Figure 5. Applying the test-wire in practice (left) and its termination in 100/50 Ohm

5. Conclusions

In this paper, an overview has been given on the work performed and the results obtained during the TEMCA2 research project, on "Alternative EMC testing methods for large machines".

For radiated emission, a simple test-wire method has been identified.

Anyway, it is referred to the standard EN 50370-1 [3] for EMC testing of large machinery, and especially to the "path C" to show evidence of compliance, by characterising relevant subparts and modules, and by checking the final implementation in the machine by combined visual inspection and simple testing.

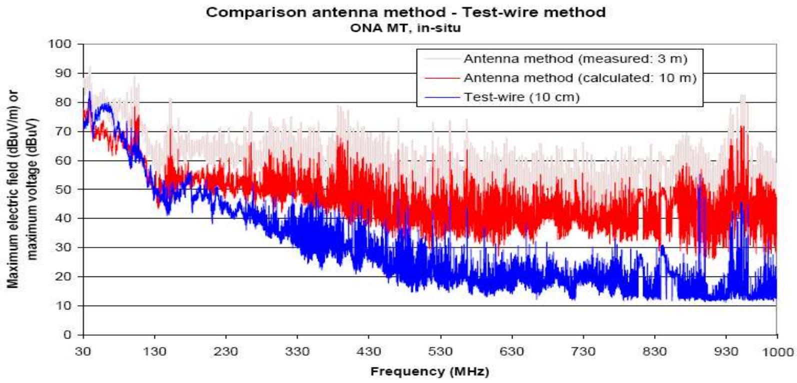

Figure 6. Comparison of measured radiated emission by antenna method (left) and test-wire (right)

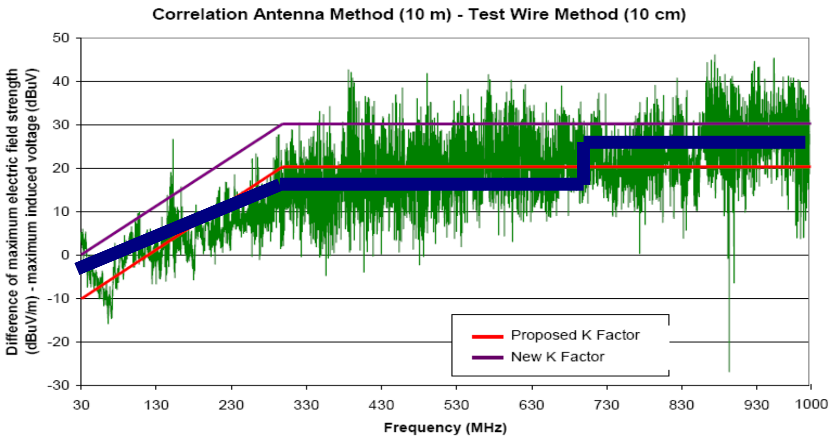

Figure 7. Example of comparison between antenna method and test-wire method, and proposed k-factors

Acknowledgement
This work was done by a research grant: TEMCA2, G6RD-CT-2002-00865 (5th European Framework Program).

References

[1] Directive 2004/108/EC of the European Parliament and of the Council of the 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.

[2] TEMCA2, "Alternative EMC testing methods for large machines", No. G6RD-CT-2002-00865 for the 5th European Framework Program, GROWTH, Objective 6.2.1. (Methodologies to support standardisation)

[3] CENELEC, EN 50370-1, EMC – Product family standard for machine tools. Part 1: Emissions, 2005

[4] CENELEC, EN 50370-2, EMC – Product family standard for machine tools. Part 2: Immunity, 2003

[5] Knockaert J. et al., Comparison of alternative conducted emission measurement methods using FSV and IELF algorithms, Proceedings EMC Europe 2006, Barcelona, pp. 718-722

[6] Final report TEMCA2 (can be obtained from johan.catrysse@khbo.be)