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Magnetic compatibility of standard components for electrical installations Tests on programmable logical controllers and other electronic devices

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Abstract

The electrical distribution boards and control cubicles, installed inside the ITER tokamak building, can be subjected to a constant or slowly variable magnetic field up to 70 mT, 10 mT/s induced by ITER coils. This is a very unusual environmental condition and there are almost no data available on static magnetic field compatibility for the standard industrial, electrical and electronic components, usually installed inside standard low voltage distribution boards and standard control boards.

A series of tests has therefore been envisaged, in collaboration with EFDA close support unit [I. Benfatto, P. Bettini, M. Cavinato, A. De Lorenzi, J. Hourtoule, E. Serra, Magnetic compatibility of standard components for electrical installations: computation of the background field and consequences on the design of the electrical distribution boards and control boards for the ITER tokamak building, SOFT Conference Presentation, Venice, September 2004] and the Consorzio RFX [L. Grando, A. De Lorenzi, G. Bettanini, D. Desideri, Magnetic compatibility of standard components for electrical installations: tests on low voltage circuit breakers and contactors, SOFT Conference Presentation, Venice, September 2004], to assess the operational limits of these components.

CEA has especially taken in charge the test of electronic, control and signal conditioning units.

On this subject, a test bed composed of a solenoid and a 30 V, 800 A power supply, has been developed at CEA Cadarache. Its characteristics are the following:

Magnetic field capability: 140 mT
Variation of field: up to 10 mT/s
Useful dimensions for equipment under test: 500 mm × 500 mm × 500 mm

The list of the components to be tested has been identified trying to find common and recent components of different manufacturers.

Test procedures have been written following the most relevant IEC standards and manufacturing recommendations and procedures.

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Magnetic compatibility tests on the basic components of standard low voltage control boards have been performed.

All components tested are more or less sensitive to magnetic fields and the effect varies from the simple perturbation of the output signals to the partial destruction of some electronic card. The most sensitive are the ferromagnetic components like small power supply transformers, relays, inductors, etc.

For power supplies, the most important consequence is the increase of the consumption (primary current).

For most of the conditioning units (signal treatment), the operational limits were found in the range of 30 mT (destruction of power supply filter by over current and overload of the supply).

For PLC central units tested, the limit is in the order of 40 mT (components permanently out of service).

Relays are limited to 15 mT (outputs oscillations, no commutation).

The paper will present, in detail, the methods and the results of these tests giving recommendations for future analysis.

Keywords: Control boards; Power supplies; PLC; Relays; Magnetic field compatibility

1. The survey

The European normative about the electromagnetic compatibility (EMC) is described in the standard EN 61,000.

The standard is divided into different sections. In our case, the EN 61,000-4 is the most appropriate. In this section, the majority of recommendations concerns the 50 Hz network. The EN 61,000-4-8 precise the immunity of the magnetic field at 50 Hz frequency. In this case, acceptable limits are very low (about 0.1 mT).

In conclusion, applicable standards are not available for compatibility assessment of components to static magnetic field to our case [1].

2. The test bed and procedures

EN 61,000-4-8 standard can be used as model to define the test bed [2].

The standard describes also the different conditions to execute a test:

- climatic conditions,
- field measurement [3],
- field direction,
- electromagnetic environment, and
- test levels.

Test procedures have been written following the most relevant IEC standards manufacturing recommendations and procedures.

Functional tests have been performed in order to obtain the operating limits in each direction of the field, in accordance with the IEC61000 alternative magnetic field compatibility.

For each component, the limit of operation in the presence of magnetic field is required. For that, the field is increased by steps of 10 mT. When the component does not function any more, the field is reduced of a level (10 mT) in order to find a correct operation. This stage, a half level is added in order to find the limit of operation (Fig. 1).

It is this value that is then recorded like absolute limit of operation (Fig. 2).

After each test, components are tested without magnetic field, to verify the main manufacturer characteristics (Fig. 3).

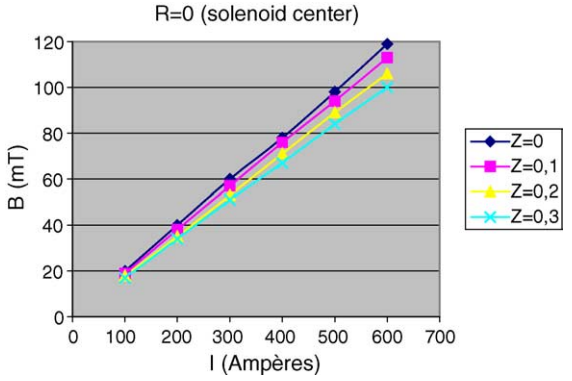

Fig. 1. Field modulus inside the protection copper coil as a function of power supply current.