ITER – EARTHING

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The security rules which apply to electrical installations are driven by two basic principles. First, elements under voltage must be inaccessible and second, in case of failure, any elements which are accessible must not rise to a dangerous potential. Compliance with these two criteria has lead to the implementation of the earthing principles, techniques and rules.
Tokamaks are large-scale electrical installations. Moreover, they are known to generate large and low frequency magnetic fields as well as large and high frequency electrical fields. Because of these intrinsic properties, the electrical engineers should not apply the usual earthing rules without paying specific care and attention. Preventing the electric and magnetic fields from endangering the device integrity and from polluting signal measurements requires extensive engineering studies.
These problems are well known inside the fusion community. The fusion laboratories have approached them in many different ways and have arrived to a number of different philosophies, some of them, perhaps, with better results than others.
ITER is facing exactly the same issues. Moreover, it will generate higher magnetic fluxes and higher electrical fields (1 MV NB injectors) than the tokamaks built in the eighties.
The earthing schemes of JET (Abingdon, England), ASDEX Upgrade (Garching, Germany), TORE SUPRA (Cadarache, France) and TCV (Lausanne, Switzerland) have been analyzed.
Based on the best practices identified in these installations, a conceptual design of the ITER earthing system is presented. The concept first affects the configuration of the ITER site high voltage (400kV), medium voltage (69, 20, 6.9kV) and low voltage (400V) networks and their earthing policy. The earthing rules which apply to the loads supplied by these networks are also presented. The earthing circuit to be designed and installed then has to comply with both the network earthing philosophy and with the load earthing rules.
Because of the proximity to the tokamak core, the equipment earthing rules and the design of the earthing circuits within the tokamak complex (diagnostic building, tritium building and tokamak building) have to handle additional constraints.
Finally, the earthing scheme of the ITER vacuum vessel and cryostat, and of all the equipment located very close to the cryostat, is driven by severe constraints which also impact on the design of the earthing circuit below and around the tokamak.
The earthing circuit takes advantage of and integrates many structural components of the buildings, such as concrete reinforcement rebars and steel structures. These elements, together with the interface between the circuit and the soil, will end up buried and beyond reach after construction of the building. The detailed design of the earthing circuit, together with the tests and the measurements to be carried out during its construction, have been specified in detail to allow for the implementation of an earthing grid whose quality and durability will be guaranteed.

This work, supported in part by the Swiss National Science Foundation and by the European Communities under the contract of Association between EURATOM and CRPP-EPFL, was carried out within the framework of the European Fusion Development Agreement. The views and opinions expressed herein do not necessarily reflect those of the European Commission.