

Modelling the Influence of the Tube Support Plate on the Eddy Current Testing of the Steam Generator: Sensitivity Study & Validation

Edouard Demaldent¹, Audrey Vigneron¹, Jean-Marc Decitre², Thierry Sollier²

¹Department of Non Destructive Testing, CEA LIST, France, ¹Non Destructive Testing, IRSN, France

Eddy current testing (ECT) of Steam Generator (SG) tubes is part of the maintenance program of Nuclear Power Plants. Tube Support Plates (TSP) are usually only considered as extraneous signals for tube inspection. However, for long-term operation of SGs, there is a safety concern related to the build-up of deposits in the TSPs flow holes. The clogging-up of the TSPs flow holes affect the safe thermal-hydraulic operation of SGs. The deposits come from the feedwater train and are mostly iron oxides (magnetite) with a weak electrical conductivity and magnetite permeability. The ability of ECT probes to detect and characterize TSPs deposits is therefore of great interest. The most common and industrial ECT technique, the bobbin coil, averages the surrounding electromagnetic field over 360°, whereas the geometry of tri-foiled and quadri-foiled TSPs, and thus of clogging, is rather complex and non-axisymmetric, hence motivating the evaluation of the performance of conventional ECT rotating probes used for SGs tubes inspection. Although simulation is a powerful tool to support such a study, it requires dedicated models to be made available to NDT experts, and CEA develops ECT physical models in CIVA for this purpose. In addition to standard fast CIVA modules based on 3D semi-analytical or 2D numerical calculations restricted to canonical or axisymmetric parts, respectively, CEA develops a module dedicated to the simulation of SG tube inspection based on a 3D numerical simulation. This module allows tube deformation such as ovalization, bending or tube expansion. It also allows the addition of external objects such as anti-vibration bars, different geometries of tube support plates and now their clogging by deposits. This model is used to study various influent parameters and to perform benchmarks in the framework of a scientific collaboration between the CEA and the IRSN. Here, the specificity of the TSPs and their clogging justifies qualifying the simulation model before evaluating the influence of material and geometry properties of the deposit as well as the performance of the inspection techniques. We present the main features of the simulation module in CIVA, its experimental validation, and the main trends in the distortion of the simulated signal as a function of variation in the clogging description.