Development of a method for acoustic monitoring of the pressure and composition of the gas in the fuel rods of a PWR assembly in a nuclear spent fuel pool

Samuel MARTINS[1], Christopher REECE[2], Liana RAMIANDRISOA[3], Sophie CROZAT[4], Guillaume PIERRE[4], Jean-yves FERRANDIS[1]

[1]IES, Univ Montpellier, CNRS, France, [1]DCN/PEL/DER, EDF, France, [1]R&D/PRISME, EDF, France, [1]Transducer, SONAXIS, France

The internal pressure and molar composition of the fission gases (xenon/krypton and helium) present within the free volumes of the fuel rod after irradiation is of major interest to nuclear energy suppliers. This parameter is a fuel behavior indicator and reflects the overall fuel performance in operation during shipping and long-term storage. Rod internal pressure is one criterion amongst others, like cladding corrosion, against which the acceptable fuel burn-up limit is set. IES, EDF and SONAXIS SA are developing a non-destructive acoustic process to perform measurements, directly on fuel assemblies in the spent fuel pools of nuclear power plants. This will make it possible to carry out extensive measurement campaigns to support and improve thermodynamic evolution models, and to obtain more consistent measurement statistics. The principle of the measurement is to determine the speed and attenuation of the acoustic waves propagating in the gas at the level of the tube plenum. A piezoelectric transducer, driven by a pulse generator, generates the acoustic waves in the fuel rod which acts as a resonant cavity. The signal by the transducer, of a reflected sound wave through the gas, is then analysed. The composition is determined by measuring the time of flight of the acoustic signal and the pressure can be estimated by a calibrated process analyzing the amplitude of the signal. The aim of this paper is to present the latest work which has enabled to develop operational sensors which are sufficiently miniaturized to be used in the bundle of a fuel assembly. A specific signal processing software has been developed and it was demonstrated that acoustic non-destructive measurement of pressure and composition of fission gas in a configuration close to that of an assembly in a spent fuel pool can be achieved.