Prototype Probe Development for Liquid Injection Shutdown System Tube Gap Detection By Remote Field Pulsed Eddy Current Technique

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Abstract

Pressurised Heavy Water Reactors (PHWR) play a prominent role in contributing power for the Nuclear Energy Programme in India. In 540MWe type PHWR reactors, there are horizontally placed Liquid Injection Shutdown System (LISS) tubes for injecting poison into the moderator to clamp down the nuclear power under trip conditions. The Horizontally placed LISS pipes are placed perpendicular to the horizontal Coolant Channels in the inter lattice positions as shown in Figure 1. The gap between the coolant channel and the LISS tube is critical considering the possibility of fretting damage in the event of closing of this gap. The Coolant channels consists of two co-axial tubes called Pressure tube (inner) and Calandria Tube (outer). The gap between LISS tube and calandria tube cannot be measured directly as the whole core of the reactor is enclosed in a vessel called Calandria vessel. Only easy access to the core is through the bore of the pressure tube for employing any inspection technique for measuring the gap. As the probing medium has to penetrate the pressure tube and calandria tube barriers, Electromagnetic technique only appears to be feasible for the inspection. Remote Field Pulsed Eddy Current technique is proposed for this measurement. The remote field originates from the exciter coil kept in the bore of the pressure tube and propagates through the outside metallic barriers and makes a re-entry into the pressure tube approximately at a axial distance of 2 diameters of pressure tube. The search coil is used at this location to pickup the prominent Remote Field. The pick up signals are further Digitally Signal Processed to gather information of the gap between LISS tube and calandrai tube. COMSOL Multiphysics software was used to map the poynting vector to guage the re-entry location of the remote field. The Poynting Vector mapping is shown in Figure 2. Further it is also simulated to know the order of the voltage to be picked by the remote pick up coil. The Figure 3 shows pick up voltage simulated for one turn.

Reference

1. Binfeng Yang, Xuechao Li, 'Pulsed remote field technique used for nondestructive inspection of ferromagnetic tube' NDT&E International, 2009.

Figures used in the abstract

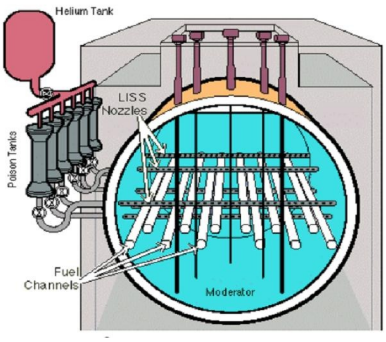

Figure 1: Schematic of the core of the reactor.

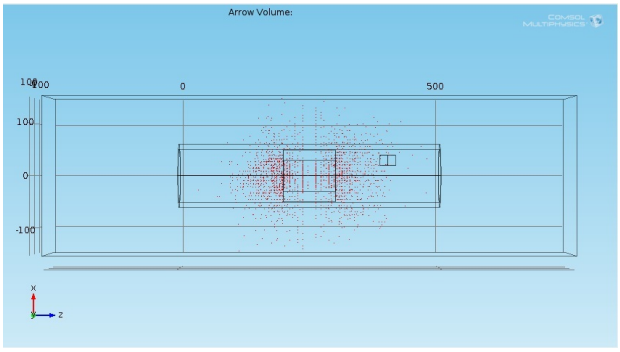

Figure 2: Poynting Vector mapping.

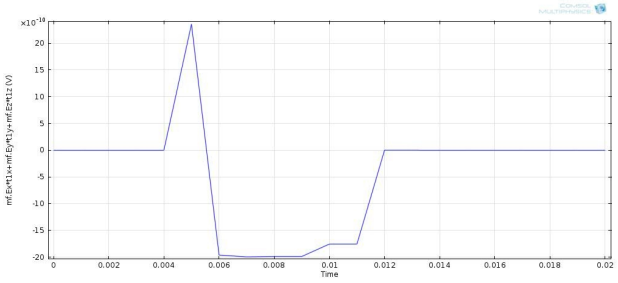

Figure 3