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Development of Remote Field Eddy Current Technology for In-service Inspection of Steam Generators – Experience on Steam Generator Test Facility

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Abstract: Remote field eddy current (RFEC) technique uses separate exciter and receiver coils and low-excitation frequencies for non-destructive evaluation (NDE) of metallic tubes from tube-side. In this technique, induced voltage in a receiver coil placed at 2 to 3 tube diameters away from the exciter coil is measured. For in-service inspection of ferromagnetic steam generator (SG) tubes (~23 m long, 17.2 mm dia and 2.3 mm thickness) of fast breeder reactors, a comprehensive RFEC technology has been successfully developed and field-tested.

Reliable detection and sizing of defects in SG tubes requires that the excitation frequency is optimized and the receiver coil is positioned in remote-field zone. In this regard, detailed finite element analysis has been carried out to examine the electromagnetic field-defect interactions in the RFEC technique using an axi-symmetric model and a 3-D code developed in-house. Triangular and hexahedral meshes have been employed in axi-symmetric and 3-D models, respectively and RFEC signals due to various types of defects have been predicted at different frequencies and inter-coil spacings. The test frequency, excitation current and receiver coil location and its size have been optimised using the models. Studies have been carried out to investigate the influence of sodium deposits on the outer surface of the SG tubes and also in defects, if any, during RFEC testing.

For in-service inspection of SG tubes, flexible RFEC probes have been designed to negotiate the expansion bend regions and a specially designed, computer controlled winch with a coil drum has been developed for insertion and retrieval of RFEC probe. A detailed procedure has been developed to detect and size defects deeper than 10% wall loss. Recently, this RFEC technology has been successfully employed for in-service inspection of steam generator test facility (SGTF) comprising of 19 SG tubes. The RFEC probes successfully negotiated the bend regions and as anticipated, characteristic signals have been observed from Inconel support plate and bend regions. The inspection data has been acquired, analysed and stored for comparison with future RFEC inspection data. This paper discusses details of the RFEC technology comprising of instrumentation, sensor, data acquisition, signal processing etc. and the results obtained during the in-service inspection of 1:1 SGTF.