

TOPIC: In-service and special inspections with respect to ageing

Eddy Current NDT: A Developed Technology for In-Use and Spent Fuel Cladding Examination of TRIGA and MTR Reactors

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The development of reference calibration standards, special probes and evaluation methodologies, usable for the examination of research and test reactors fuel cladding, by means of the eddy current (EC) non-destructive test (NDT) has been conducted at CDTN and IPEN nuclear research centres in Brazil, and are intended to be applied to TRIGA-MK I reactors, such as IPR-R1 installed at CDTN and MTR reactors, such as IEA-R1 installed at IPEN.

Since eddy current is a comparative evaluation NDT method [1], the development of calibration reference standards is mandatory. For IPR-R1 reactor (Aluminium 1100F, 0.76 mm in thickness fuel cladding), a set of 22 reference standards was developed: 4 with different thicknesses, 1 through wall hole, 4 surface flat bottom holes, 4 sub-surface flat bottom holes, 1 through wall crack, 4 surface cracks and 4 sub-surface cracks. All reference standards were assembled on the surface of a cylindrical core, reproducing the actual dimensions and shape of the fuel [2].

For IEA-R1 reactor (Aluminium 6061, 0.38 mm in thickness fuel cladding), a set of 17 reference standards was prepared: 3 with different thicknesses, 1 through wall hole, 3 surface flat bottom holes, 3 sub-surface flat bottom holes, 1 through wall crack, 3 surface cracks and 3 sub-surface cracks. To reproduce the actual characteristics found in a MTR element, each Aluminium reference was placed very close (nominally 2.89 mm) to an adjacent flawless plate.

Two probes were specially developed for IPR-R1 reactor fuel cladding inspection. Once there is no access restriction to proceed the inspection, the probes have similarities to conventional surface-type ones, but they have some special characteristics. They can operate underwater and have the same curvature of the cladding surface in their sensitive contact area. This feature is very helpful to reduce lift-off effects.

An experimental prototype probe was constructed at first, for IEA-R1 reactor fuel cladding inspection, in order to demonstrate the functionality and response of the adopted approach in overtaking known difficulties. Remarkable probe features are: high sensitivity for small thickness measurements, high sensitivity for sub-surface flaws detection, good access capacity, excellent immunity to adjacent elements influence and lift-off effects. Fig. 1 shows the aspect of such prototype. As the preliminary operating responses obtained were good, two optimised probes are being constructed at this time.

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Typical response signals, as they appear in the screen of the ECT MAD-8D computer assisted test system [3] can be observed in Fig. 2. In such case, the signals represent different cladding thicknesses, machined in the reference standards for cylindrical IPR-R1 fuel.

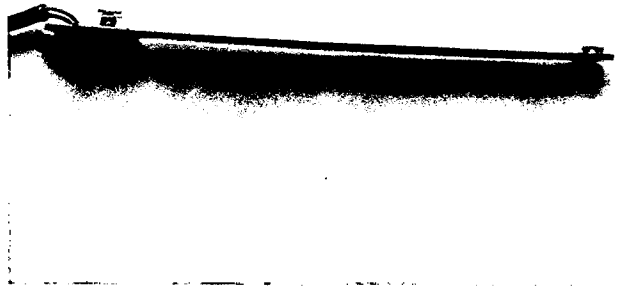


Fig. 1. Developed prototype probe for MTR fuel cladding inspection.

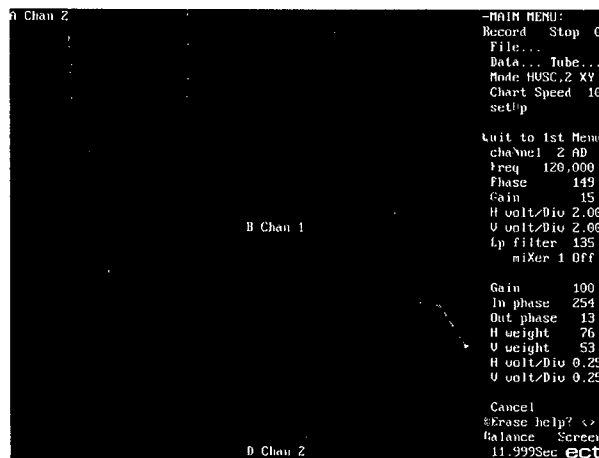


Fig. 2. Signals representing different cladding thicknesses for IPR-R1 fuel.

- [1] ASNT, Electromagnetic Testing - v.4, Columbus, 1986.
- [2] CDTN, Nota Interna CT4-02/99, Belo Horizonte, 1999.
- [3] ECT, MAD-8D Eddy current tester manual, ECT Inc., Virginia Beach, 1999.