Fuel Rod Examination Device and Analysis (FREDA)

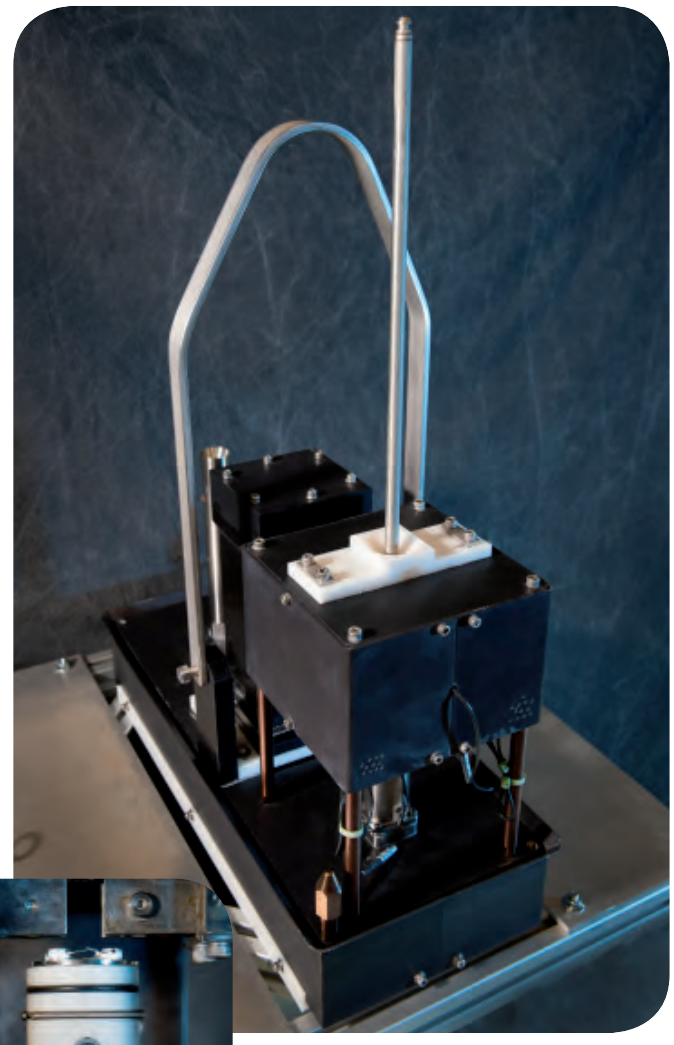
Innovative Use of Proven Technology

AREVA's Fuel Rod Examination Device and Analysis (FREDA) system was developed from technology proven in the determination of control rod wear (AREVA's SCORE system). The FREDA system employs ultrasonic technology to thoroughly characterize Grid-to-Rod Fretting wear scars. The system can also be used to characterize baffle-to-fuel rod wear. High frequency ultrasonic transducers with a sharply focused beam rotate around a fuel rod as the rod is lowered at a constant speed, creating a helical scan pattern. Wear marks are detected as an increase in the length of the water path to the surface of the fuel rod. The system provides a measurement of the depth, circumferential extent, loss of cross sectional area, and azimuthal position at each wear scar. This data can then be used to determine a design's margin to fuel rod failure.

The system has been demonstrated on AREVA fuel designs (14x14 to 17x17 fuel lattices) for Westinghouse and Combustion Engineering plants.

Reliable System Performance

The FME (Foreign Material Exclusion) compliant system is deployable within spent fool pools. It is placed directly on the fuel racks or other appropriate locations. Fuel rods are removed from assemblies using existing methods utilized during standard fuel assembly reconstitution activities and Post Irradiation Examinations (such as the AREVA Rod Handling System or a manual grapple). The fuel rod is lowered and raised through the rotating transducers into a safety tube that fully encapsulates the fuel rod during inspections. Full rod inspection time of 3 minutes is achievable. The system is also able to be configured with an encircling eddy current coil for high speed location of wear marks for quicker measurements.



The data from the ultrasonic instrument is acquired by a computer based oscillographic data acquisition system with a simple real time graphical interface allowing an easy menu driven configuration to run the instrument. This setup allows for poolside data analysis to provide quick results.

The ultrasonic transducers have proven to be reasonably tolerant to radiation with up to 74 fuel rods inspected without replacement of the transducer module.

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Exceptional Data Resolution and Accuracy

The beam diameter at the focal point of each transducer is approximately 0.010 inch, which allows the detection of very narrow flaws. With the ultrasonic module rotating around the fuel rod at a typical speed of 600 RPM while the fuel rod is lowered at a constant speed of approximately one inch per second, the resultant helical path has an approximate pitch of 0.1 inch. The system has a circumferential resolution of around 0.01 inch, which equates to 114 data points per transducer revolution. Data is collected at a rate of 1100 data points per second. Depth of wear has a resolution of +/- 0.0001" with an accuracy of +/- 0.001".

Features and Benefits

- Proven technology to fully characterize individual wear scars due to Grid-to-Rod-Fretting in order to determine a fuel design's margin to fuel rod failure
- Safe and reliable computerized controlled operation providing the ability to perform poolside data analysis of results
- Exceptional resolution and accuracy of results not only providing depth of wear but loss of cross sectional area, circumferential extent and azimuthal position of each individual wear scar

Example of an HTP™ Wear Scar and associated data Acquisition

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