EPRI Boiling Water Reactor Instrumentation Nozzle Scanner

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Background

The current standard to detect leaks or cracks in a nuclear plant boiling water reactor (BWR) instrumentation nozzle is insufficient early in a nuclear reactor's refueling process. Current scanning methods must wait until the second week of the outage, once the reactor is drained, before the scan for defects can take place. This delays the reactor coming back online, if a defect is discovered, and could end up costing the company millions of dollars for each day the power outage must be lengthened. By designing a device that can detect a defect of any size and its position early in the two week long refueling process, proper measures can be taken to fix the issue to prevent any kind of outage extension.

Purpose

This device was designed to scan the instrumentation nozzles of a BWR for any defects in the early stages of the refueling outage by allowing the scan to take place before the reactor is drained, and without the need for an operator to descend into the BWR. By detecting these defects early on, proper action can be taken to fix the issue without lengthening the two-week outage.

Design/Method

The device was broken down into several subsystems to carry out the appropriate scan of the BWR instrumentation nozzle. Several ideas and methods were researched and analyzed for each subsystem before a specific method was chosen and further developed. A full integration of the individual subsystems was put together to complete the initial design of the device.

Results

The device was designed to attach to a pole and descend to the appropriate depth of the specified instrumentation nozzle in the BWR. The device, using a suction cup method of attachment, can secure itself to the inside wall of the BWR. The device uses ultrasonic time-of-flight diffraction to scan the initial 4 inches of the nozzle and relay the results and their positions back to the operator outside of the reactor. The device has the ability to conduct the scan in the warm, radioactive water of the BWR at depths of up to 100 feet. The final design was modeled in SolidWorks and an animation was used to verify the dynamic operation and geometries of the final design.

Conclusions

This device will provide the user with a safe and reliable method of scanning instrumentation nozzles of a BWR at an early point in the refueling process, enabling the company to catch and fix defects while cutting back on the risk of extending a scheduled power outage. The team will continue with an implementation phase to manufacture and test the physical prototype during Spring 2013.