Nuclear Services/Field Services

Fuel Assembly Position Verification System

Background

In the spring of 2012, during removal of a power plant's upper internals from the reactor vessel, Operations identified a fuel assembly attached to the bottom of the upper internals. Similar events have occurred in the industry with either attached or damaged fuel assemblies resulting from interference between reactor internals and the fuel assembly top nozzle. The Institute of Nuclear Power Operations (INPO) Level 3 Event Report 12-50 cites the root causes of the most recent stuck fuel assembly as (1) the gap inspection process was not accurate enough and (2) "the on-load sequence did not incorporate the vendor guidance recommendation to load no more than one half of a row in the same direction." The report states that "plants are expected to review this document and consider corrective actions applicable to the plant." The gap inspection process that had been in place prior to the above event was subjective and relied on judgment and experience of the gap inspector. The process also did not take into account diagonal misalignment of fuel assemblies.

Description

In response to the INPO report and these events, Westinghouse is pleased to offer fuel assembly position verification services, using the NM200E built by Newton Research Labs Inc. The use of this equipment (often called gap measurement) has been a proven best practice in the industry to identify misaligned fuel assemblies, prevent damage to fuel assemblies and reactor components, and prevent the outage delays when recovering from such an event.

NM200E system hardware includes ruggedized control console, underwater camera with built in LEDs, underwater cable and false fuel assembly.

The process for verifying fuel assembly position begins pre-outage with an acceptance criteria calculation. Westinghouse has developed a process for determining alignment acceptability criteria that incorporates as-built reactor component dimensions, fuel assembly dimensions and system accuracy. This data, as well as the location of new and spent fuel assemblies in the core, are input into the software to create a plant and unit-specific project file.

Westinghouse

February 2013 NS-FS-0165

False fuel assembly on refueling machine gripper

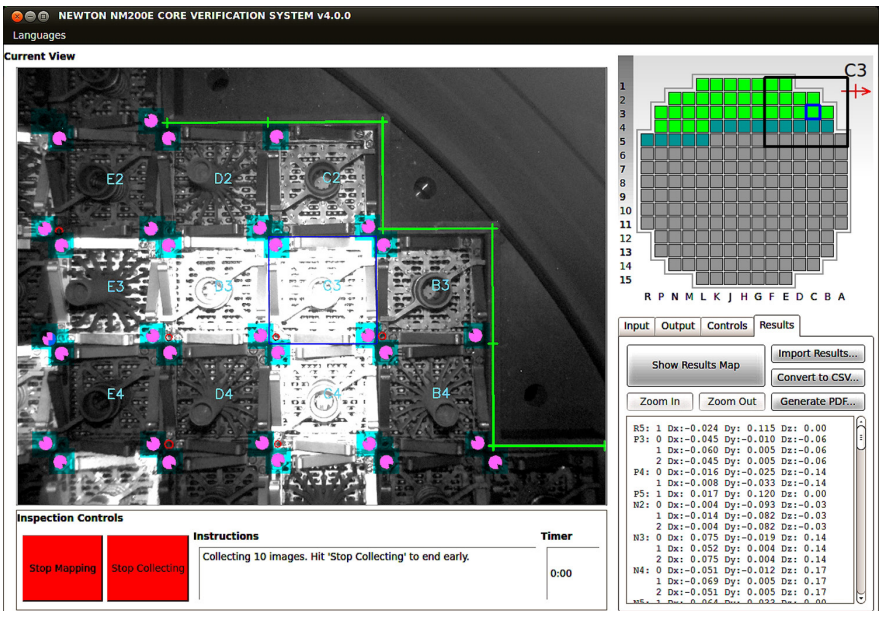
Following core reload on-site, a "false fuel assembly" that houses a robust underwater camera is lowered into the reactor cavity. The camera is then gripped by the refueling machine and moved to several pre-determined locations throughout the core. At each stop the system collects data, and using proprietary machine vision software, computes the actual position of the fuel assemblies within the core. Using the inputs previously entered into the project file, the system then analyzes the data and calculates where the fuel assemblies are compared to where they should nominally be located. This process is repeated real-time at each stop, with results becoming more accurate and complete as more data is collected. The end result is an output file showing the ideal and actual location of each fuel assembly, and whether or not they are within the calculated acceptable range.

Benefits

- Quantitative analysis removes the subjectivity from previous "gap verification processes"
- Actual position of alignment features (e.g., S-holes) is determined. Other methods relying only on gaps, a relative measurement, leave room for error and do not incorporate any twist or rotation in top nozzles
- System is quickly and easily deployed/retrieved
- Efficient process reduces outage critical path. Real-time analysis means no more waiting for digital caliper measurements or video recording and review
- Robust hardware is designed and built to prevent foreign material from entering the reactor coolant system

Experience

Westinghouse has successfully performed a fuel assembly position verification service at a U.S. power plant in November, 2012. The full process was completed in less than three hours, and the system concluded that all 157 fuel assemblies were safely positioned within the core. Several other power plants have also successfully deployed the NM200E system.



Screenshot of live video overlay

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

www.westinghousenuclear.com