

EPRI Continues Investigation of Jet Pump Flow-Induced Vibration Phenomena

The full-scale jet pump facility constructed for this research has successfully reproduced flow-induced vibration and is currently evaluating mitigation techniques from various vendors.

More than one-half of the U.S. boiling water reactor (BWR) plants, as well as several non-U.S. BWR plants, have experienced jet pump degradation caused by flow-induced vibration. Through the Boiling Water Reactor Vessel and Internals Project (BWRVIP), EPRI has been conducting a research and demonstration program to investigate the phenomenon thought to cause the degradation and to demonstrate jet pump mitigation techniques that can be installed in BWR plants. Testing in the first half of 2012 demonstrated that the flow-induced vibration phenomena experienced in the field could be successfully reproduced in the jet pump facility. Several vendors will be evaluating mitigation techniques in the facility over the next few months.

BWRVIP's role in investigating the flow-induced vibration issue includes analyzing the relationship between operating parameters and degradation histories at BWR plants, managing construction of a full-scale test facility, conducting validation and exploratory tests, and testing vendor mitigation hardware in the facility. The full-scale, full-flow test facility (see figure), is configured to represent prototypical BWR/4 or BWR/5 jet pump assemblies (one riser and two jet pumps). The facility can accommodate flow rates up to 10,000 gpm and pressures up to 555 psia, and is equipped with automated temperature and pressure control. Multiple parameters can be controlled remotely, including set screw gap, wedge position, water temperature, M ratio (suction flow/drive flow), and slip joint differential pressure.

Key accomplishments to date from the multi-year jet pump research program include:

- Performed a BWR plant operational and degradation survey (published in late 2011 as EPRI report 1022838)
- Conducted BWR/5 phenomenological testing in 2011 and 2012, which met all design objectives, including system pressure, temperature, flow, and specific jet pump operating ranges.
- Completed construction, shakedown, and initial testing of the full-scale jet pump facility. The system successfully reproduced all jet pump flow-induced vibration phenomena, including turbulent fluctuating pressures, recirculation pump vane passing fluctuating pressures, and slip joint leakage flow instability. Tests evaluated the effects of drive flow, M ratio, set screw gaps, water temperature and recirculation pump vane passing frequency on jet pump vibratory response. A draft test report is expected to be completed by the end of June 2012.
- In June, vendors began testing their flow-induced vibration solutions at the facility in the BWR/5 configuration. At least four vendors are expected to conduct such testing. Test results will be reported according to a "demonstration test protocol" defined by the BWRVIP. Testing of the BWR/4 jet pump configuration and associated mitigation devices is under consideration as well.

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