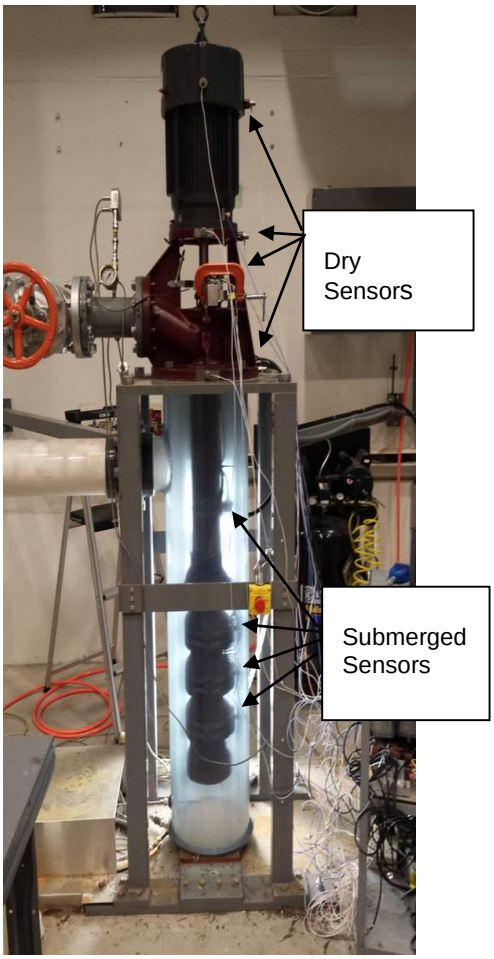
Fault Finding in Vertical Pumps…With Virtual Sensors

EPRI is exploring how virtual sensor technology could be used to help identify faults in vertical pumps.

Diagnosing faults in vertical pumps at nuclear power plants can be challenging because such problems can develop at the opposite end of the machine from where practical physical measurements can be made. EPRI is developing a model-based, virtual sensor technology to diagnose common pump faults using limited vibration data. By creating a model that recognizes characteristics of common pump problems based on vibration data taken at the motor end of the pump, this tool could serve as a "virtual sensor" (as opposed to a physically installed sensor) and assist in troubleshooting and fault diagnostics.

If development and testing is successful, this technology will assist nuclear plant operators in making informed decisions about pump health. For vertical pumps used at nuclear plants to move raw water or circulating water, the ability to diagnose faults prior to intrusive maintenance would help avoid costs associated with rigging and pulling these large pumps up for inspection and repair.



Profile of the three-stage vertical pump being used for fault trials and virtual sensor development

Progress to date in developing the virtual sensor model includes:

- Proof-of-concept testing: In 2013, EPRI incorporated a seven-horsepower, 150 gallon-per-minute, three-stage vertical pump into an instrumented test loop. In parallel, researchers developed a reduced-order finite element analysis model using initial testing results and demonstrated that the model could predict and match real sensor responses. The instrumented test pump allowed the team to compare real sensor response to imposed faults with predicted pump response from the virtual sensor model. More information is available in *Initial Development of Virtual Sensors for Vertical Pumps* (3002002446).

- Fault trials: In 2014, EPRI conducted more in-depth fault trials using the test pump to assess the virtual sensor model's response to mass unbalance, wear ring erosion, and simulated cavitation damage. Of these trials, mass unbalance proved to be the only

fault that produced a large enough vibration output that could be picked up by the installed sensors and then correlated with the virtual sensor model. Although the model's correlation for this fault was promising, the team agreed that additional trials would be required to validate the capabilities of this technology. More information is available in *Pump Virtual Sensors Project: Feasibility Results* (3002004993).

Activities in 2015 will explore additional faults, refine the model, and examine whether outputs from an additional monitoring technology – motor current signature analysis (MCSA) – could be incorporated into this virtual sensor.

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