Automated Neutron Noise

Background

As the fleet of operating pressurized water reactors operates beyond its initial design life, the reactor vessel internals (RVI) components are beginning to experience age-related degradation. The RVIs are difficult to inspect because inspection typically involves removing the core barrel from the reactor vessel. This action is normally part of the reactor refueling outage critical path for the plant to return to operation.

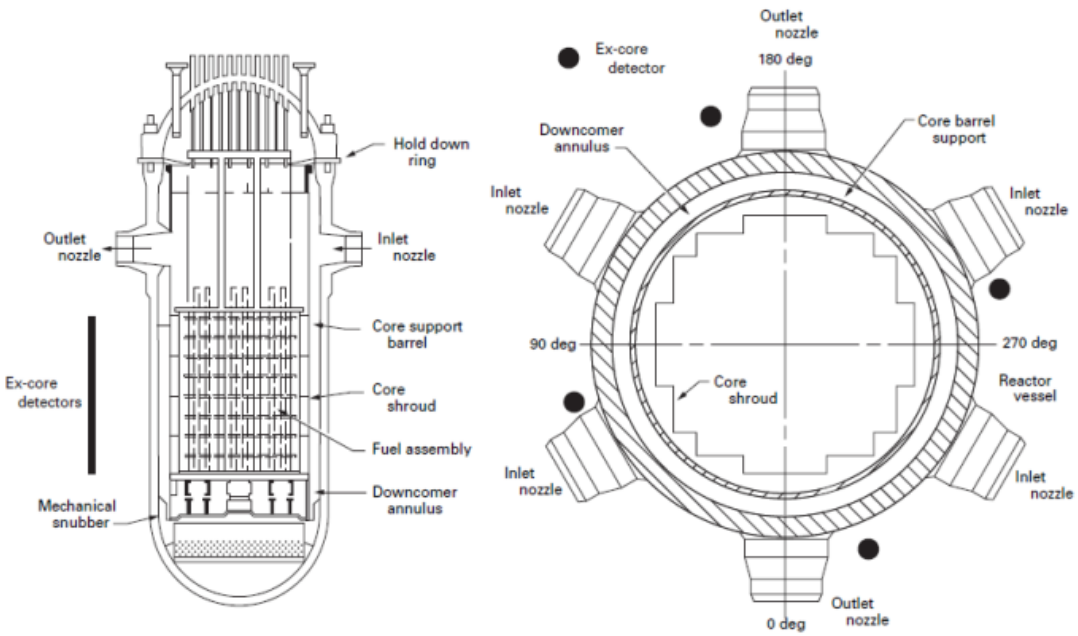
An alternative to visual RVIs inspection has been to remotely monitor the behavior of the RVIs using the Nuclear Instrumentation System (NIS) ex-core neutron flux detectors. All Westinghouse and CE PWRs have in their NIS, ex-core detectors to measure core power level. The ex-core detector signal is a random, time varying signal with a large DC component and a small time vary component. The time varying component is the Neutron Noise.

Neutron noise data collection and assessment provides a means for online monitoring of major lower internals components (e.g., core barrel, thermal shield, etc.) and fuel assemblies. This data is used to monitor abnormal vibration from failed, or degraded components, including:

- Broken or degraded thermal shield flexures.
- Hold down spring relaxation.
- Wedged loose parts evaluation.
- Fuel assembly vibration/baffle bolting health (baffle jetting).
- Contact at the lower radial supports (leading to wear).
- BMI thimble tube vibration and wear.

Neutron noise can detect the onset, track the progress, and sometimes disprove the existence of these conditions, aided by our database of FEA analyses, in-plant and scale model tests.

Fig. 1 Reactor Arrangement Showing Typical Ex-Core Detector Locations



(a) Reactor Arrangement

(b) Ex-core Detector Locations

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Product Description & Benefits

The automated neutron noise system was developed to make remote condition monitoring of the RVI more efficient, eliminating the need for Westinghouse to travel to the plant and perform manual analysis of every data recording.

The automated system is delivered to and owned by the site. Each system will have a customized set of baseline data (if baseline data doesn't exist, a baseline recording will be taken as part of system installation). When data is to be recorded, site personnel will connect the system to the NIS ex-core detectors and record the data. Once data collection is complete, site personnel will execute the data analysis software (the component modes from the data collected will be compared to the baseline data), which will inform the user whether the RVIs are stable, or an anomaly is detected in the data that warrants additional data analysis.

The goal of an automated monitoring system is to ease the burden of regularly performing the online monitoring. The system includes a portable data acquisition system with data gathering and analysis software, utilities can connect to perform monitoring as frequently as desired/necessary and can receive near "real-time" feedback on the results of the monitoring.

The automated neutron noise monitoring system provides autonomy to the utilities to monitor as frequently as they desire. It's also a shift from Westinghouse analyzing every data set collected to only analyzing data sets with an abnormal signal. There will be no costs associated with evaluating data that has no significant changes from prior data sets.

The automated system is a cost-effective solution for plants that want/need to perform regular monitoring.

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