A New Control Rod Drive Mechanism Design for the ISU AGN-201M Reactor

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ABSTRACT:

The Aerojet General Nucleonics (AGN) model 201-Modified, known as the AGN-201M reactor, plays an essential role in the educational and research activities at Idaho State University (ISU). The licensed AGN-201M at ISU is used to advance the Nuclear Engineering (NE) science knowledge through laboratory courses and offers a unique opportunity of 'hands-on' experience for students before entering the nuclear workforce. Licensed Students from ISU gain experience with operating the AGN-201 reactor after completion of a high-quality training course and passing an exam administered by the United States Nuclear Regulatory Commission (NRC). The AGN-201M reactor can demonstrate the steady-state and dynamic behavior of the reactor system and serves as a fundamental tool in the training of reactor operators. Research studies on radioactive isotopes and the interaction of radiation with matter can be performed using the AGN-201M. This facility is also available through collaboration with State of Idaho and other regional educational and research institutions that do not possess similar capabilities.

The ISU AGN-201M, including its original control rod drive mechanism, has been operating for more than 50 years. The control rod drives are required to eject the fuel rods within one second during a SCRAM event (also known as a 'reactor trip') and adjust the control rods insertion speed and sequence. The existing control rod drive mechanisms are meeting these criteria but experience a few concerns due to the system aging. These concerns include difficult maintenance and costly repairs for old electromechanical components, rod position feedback errors, and the impediment of the SCRAM due to the binding of the two lead screws of the existing mechanism. The drive mechanism becomes locked, preventing the control rods from moving in or out under the normal and emergency operating conditions of the reactor during the binding event. The binding occurs approximately frequently almost every three months and requires up to a full day to fix. This scenario results in improper functionality of the control rods, which creates a safety hazard and significantly reduces the reactor operational time and increases maintenance frequency and cost.

Efforts are continually being taken by ISU to increase the reactor safety and overall performance and reliability of the AGN-201M reactor. In this theme, researchers at ISU are proposing to replace the existing control rod drive mechanism with a newly developed alternative design. In general, the new design reduces the overall complexity and probability of failure and improves the overall reliability and safety of the reactor. With proper material selection and improved structural design, the new drives are lighter with little to no change in structural integrity. The new control rod drive mechanism eliminates the binding scenarios by using a single lead screw and implementing additional guide rods. An advanced linear position sensor and microswitches replace the existing and aging Synchro system for accurate rod position feedback and hence, a better reactivity control. The new design meets the average reactivity insertion rate of 0.065% $\Delta k/k$, which corresponds to a full control rod insertion time of 19.23 seconds, while the control rods ejection time remains less than one second during a SCRAM event, as indicated in the facility technical specification manual and safety report. The new design ensures the reactor's long-term viability for educational and research activities and increases the reliability and safety of operation.