Development of the remote inspection module for under-sodium viewing and ranging inspections in PGSFR (Prototype Gen-IV Sodium-cooled Fast Reactor)

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Since a sodium-cooled fast reactor (SFR) uses opaque liquid sodium as a coolant, the typical visual inspection technique cannot be applied to in-service inspection (ISI) of reactor internals. Therefore, several ultrasonic sensors for ISI of reactor internals have been developed thus far from the early development of an SFR. These ultrasonic sensors can be mainly classified into two types, the immersion sensor and the waveguide sensor. The waveguide sensor installs an ultrasonic transducer in a cold region whereas the immersion sensor is directly immersed in hot liquid sodium. In this research, the remote inspection module based on the waveguide sensor technology has been developed for ISI of reactor internals in an SFR. The developed inspection module employs four 10 m long ultrasonic waveguide sensors for various inspections such as ranging, viewing, and identifying, and consists of an upper driving device to actuate the waveguide sensors individually and a lower guiding structure that supports long waveguide sensors. For the control of waveguide sensors and signal processing of measured signals, a remote inspection program was also developed. Several verification experiments were carried out in water to demonstrate the applicability of the developed remote inspection module to an ISI of the reactor internals.