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#5-204 Different Approach Method for RCS Flow Rate Measurement to be Used in i-SMR

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The small modular reactor which of development is underway has 170 MW power. As supposed, this reactor is a type of integrated with core, pressurizer, steam generator, and reactor coolant pump, which are all enclosed by the containment vessel as pressure barrier. Despite lots of advantage of the small modular reactor like enhanced safety and less severe accident risk, the narrow space in the structure leaves many constraints of sensors and their assembly installing. Moreover, the environmnetal condition inside containment vessel gets much severer than ever including radiatioin condition. In particular,the area surrounding core is expected so high neutron flux that may impair the sensor function and accelerlate degradation by embrittlement.

The reactor coolant is forced to circulate by four channels of reactor coolant pumps which keeps running during normal operation including startup and shutdown. This parameter is so vital to run reactor operation by keeping cooling margin to the safety level and should also be continuously monitored as a safety variable that send a signal to the reacotr protection system and post accident monitoring system in order to ensure the safety of the plant.
The way to accurately measure the flow rate in the reactor coolant of the small modular reactor is firstly using ultrasonic flow meters, challenges such as turbulent flow conditions and thick wall-induced signal attenuation must be addressed. This study explores technical solutions to mitigate these issues, enhancing measurement accuracy under such constraints.Mitigating turbulence effects should be firstly considered and employing multi-path ultrasonic flow meters was designed so that it can reduce the impact of turbulence by averaging velocities across multiple paths, improving measurement accuracy in complex flow conditions. Additionally, optimizing piping configurations, such as lengthening straight pipe sections or installing flow conditioners, can help stabilize flow and minimize turbulence near the sensor.

The next issue is thick wall attenuation and using low-frequency ultrasonic signals, which are less prone to attenuation through thick walls, is effective for this applications. Furthermore, signal amplification and advanced filtering techniques can enhance signal quality, compensating for attenuation as the ultrasonic waves travel through thick-walled structures. Through these methods, ultrasonic flow meters can be effectively applied in SMR RCS systems, providing reliable flow measurements despite structural and operational challenges.

Primary author: BAE, Sanghoon (Korea Atomic Energy Research Institute)

Presenter: BAE, Sanghoon (Korea Atomic Energy Research Institute)

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