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#5-49 Effect of turbulence on ultrasound propagation for vibration measurements of PWR assemblies in the HERMES P loop of the POSEIDON platform.

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In the frame of the partnership between Électricité de France (EDF), Commissariat à l'énergie atomique et aux énergies alternatives (CEA) and FRAMATOME, ultrasonic acoustic instrumentation is developed to measure mixing grid vibrations on assemblies in the HERMES P loop on the POSEIDON platform at CEA Cadarache. This facility is a full-scale model of a Pressurised Water Reactor assembly, reproducing the temperature, pressure and flow conditions of a reactor without the irradiation aspect. This project is being carried out by the Institut d'Electronique et des Systèmes (IES) and the Laboratoire d'Essais et d'Etudes Hydromécanique (LETH) at CEA Cadarache. The loop will be instrumented with ultrasonic devices that will measure the vibrations of the assembly's mixing grids due to an earthquake, or due to flow turbulence ('fretting'). The advantage of using ultrasonic instrumentation is that the vibrations can be characterised remotely, without modifying the structure of the assembly and without disturbing the flow.
In this abstract, we focus on the influence of the propagation environment and in particular on ultrasound propagation in turbulent flow. The literature shows that flow influences the propagation of ultrasound. For example, in laminar flow, ultrasound is accelerated or slowed depending on the direction of flow. For a turbulent flow, the presence of vortices disturbs the ultrasound, for example with known vortices such as those of Kelvin Helmotz or for a Von Karman alley.
A series of tests was carried out to quantify the disturbance to the ultrasonic measurement at different flow rates, i.e. for uncharacterised turbulence. The tests were performed at near-ambient temperatures, in a mock-up that reproduce a flow similar to the HERMES P loop. We studied reproducibility and repeatability of the measurements. The transmission tests showed an increase in the dispersion of the measurement as a function of the turbulence, although this dispersion can be corrected by averaging the measurements. The reflection tests showed a slight influence of turbulence on ultrasound propagation. This phenomenon can be explained by considering the flow as frozen and assuming that the phenomena accelerating the ultrasound on the way out slow it down on the way back.
With high frequency sensors (5 to 10 MHz), these first results allow us to measure displacement smaller than 50 micrometres (which correspond to earthquake assembly vibrations) in laboratory configuration. Effect of temperature is under investigation before performing measurements in Hermes P loop conditions.

Primary authors: PAVEYRANNE, Aubin (IES, Univ Montpellier / CNRS & CEA/DES/IRESNE/DTN/STCP/LETH); BAUDRY, Florian (IES, Univ Montpellier / CNRS); Mr LATIL, Philippe (CEA/DES/IRESNE/DTN/STCP/LETH); ROSENKRANTZ, Eric (IES, Univ Montpellier / CNRS); Dr RICCIARDI, Guillaume (CEA/DES/IRESNE/DTN/STCP/LETH); Dr FERRANDIS, Jean-Yves (IES, Univ Montpellier / CNRS)

Presenter: PAVEYRANNE, Aubin (IES, Univ Montpellier / CNRS & CEA/DES/IRESNE/DTN/STCP/LETH)

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