Robotics Challenge winning design helps speed up spent fuel verification

By Adem Mutluer

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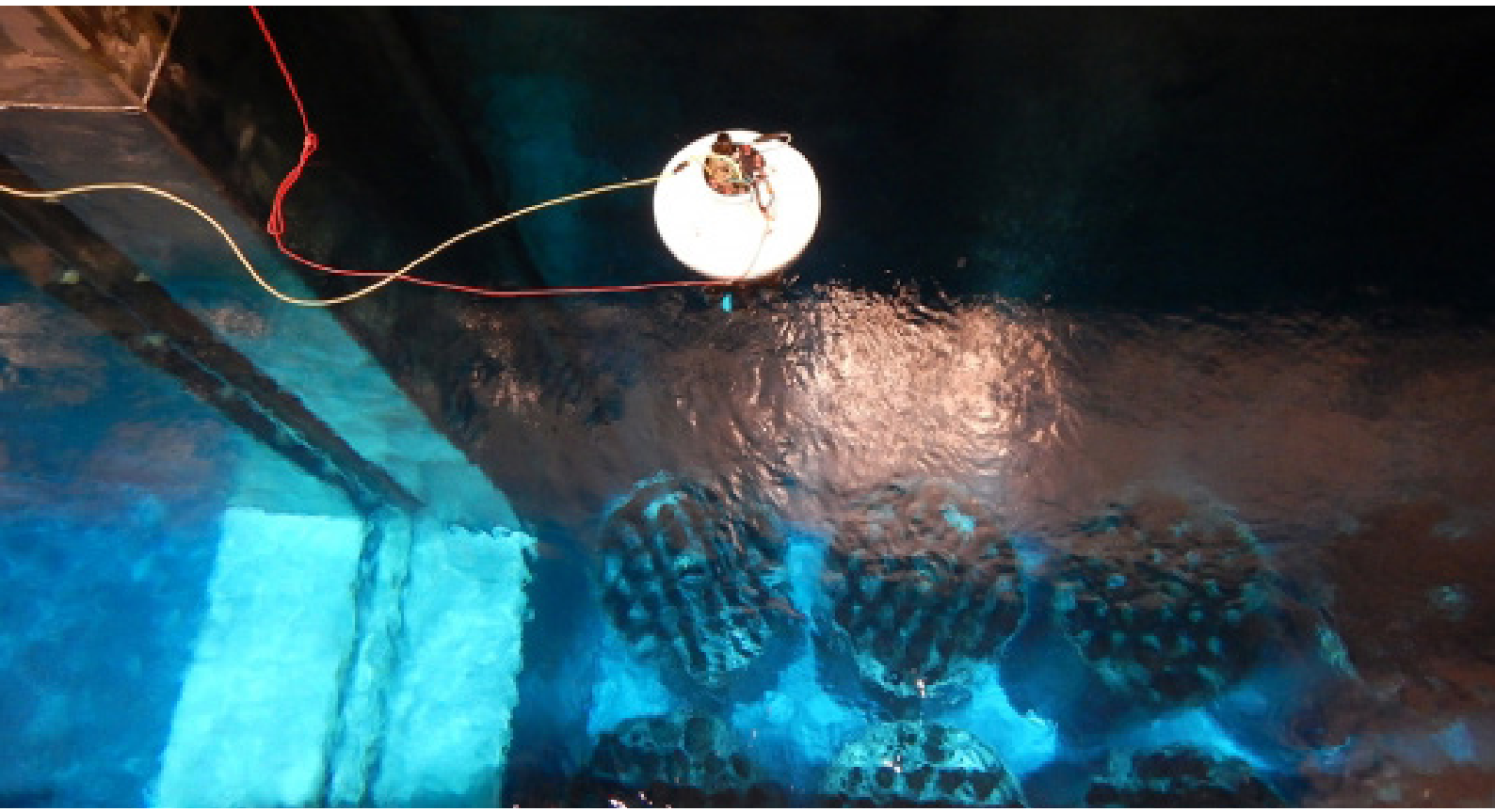
—Peter Kopias, owner and Chief Executive Officer, Datastart

While spent nuclear fuel no longer sustains nuclear chain reactions that can generate electricity, it still contains nuclear material for potential use in weapons. This is why the verification of spent fuel is a central component of the IAEA's nuclear safeguards work.

Spent fuel is typically stored under water for cooling. Verifying spent nuclear fuel under water can be a tricky and lengthy process. It requires IAEA inspectors to position themselves above the spent nuclear fuel pools to take pictures of individual spent fuel assemblies, of which there can be hundreds at a time. This process was identified as an area where robotics has the potential to play a useful role, and, in 2017, the IAEA launched a challenge to crowdsource ideas and seek solutions to make spent fuel verification more effective and efficient.

When performing their inspection activities at nuclear facilities around the world, nuclear safeguards inspectors frequently use a small hand-held optical instrument called the improved Cerenkov viewing device (ICVD). The ICVD confirms the presence of spent nuclear fuel stored under water, where it is typically placed for cooling following its removal from the reactor core. Inspectors are tasked with verifying whether the amount of fuel stored matches the amount declared by national authorities, and that none of it has been removed and potentially diverted from peaceful use.

Currently, safeguards inspectors need to hold the ICVD from a gantry suspended above a spent fuel pool and manually peer through a lens at the individual fuel assemblies. For the Robotics Challenge, the IAEA sought designs that could mount the newly developed next generation Cerenkov viewing device (XCVD), capable of providing digital recording, inside a small robotized floating platform that would autonomously propel itself across the surface of a spent fuel pool. By stabilizing the XCVD in a vertical position, the unmanned surface vehicle



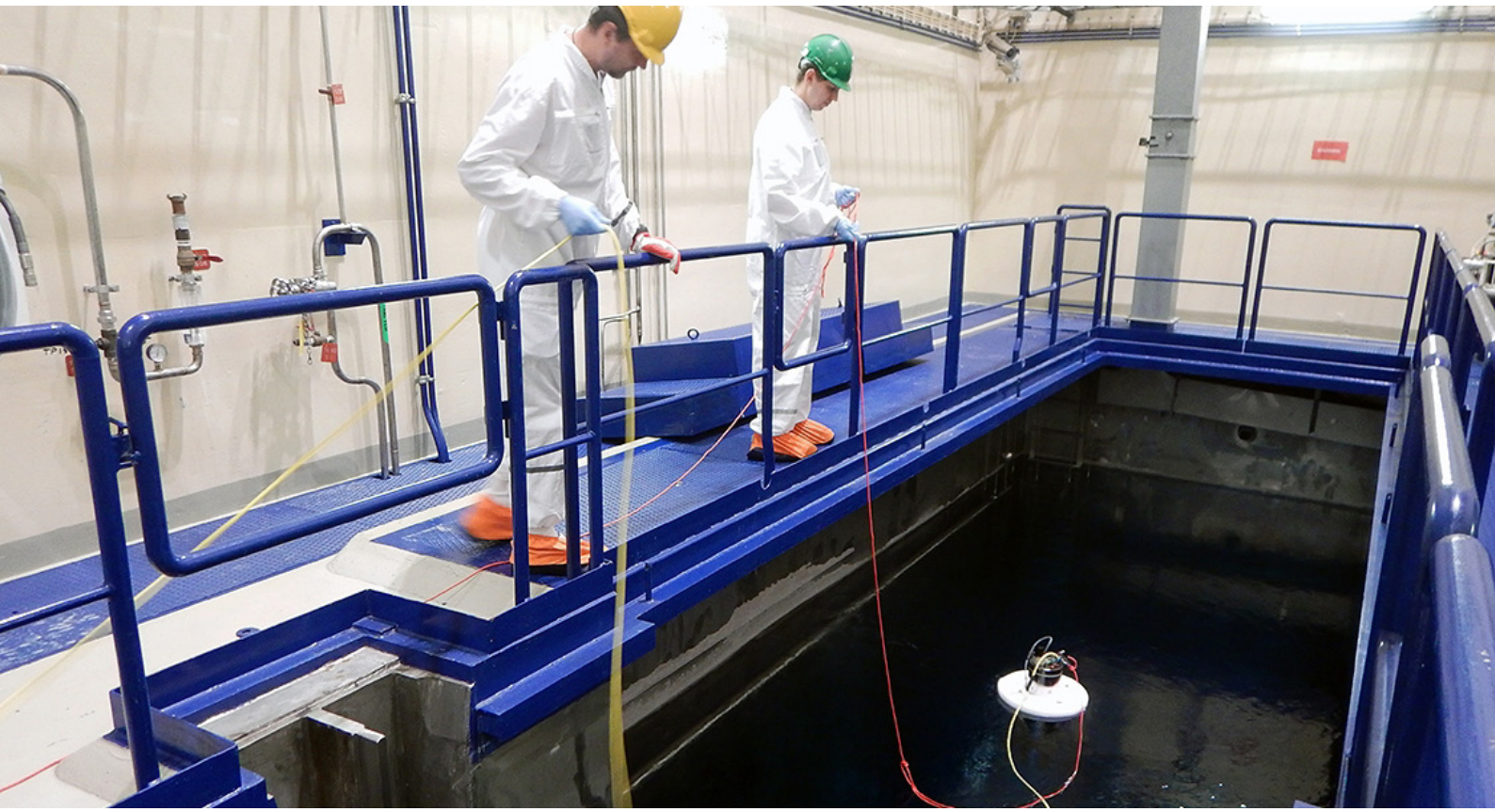
The winning design for the Unmanned Surface Vehicle undergoes real-world testing at the Loviisa Nuclear Power Plant in Finland. (Photo: IAEA)

(USV) could enable the provision of clearer images in a shorter timeframe.

The Robotics Challenge attracted more than 300 submissions. Of the 12 proposals selected for demonstration, 3 designs were tested in a real-world setting. In early 2019, a USV, designed by a group of Hungarian engineers was announced as the winner of the IAEA Robotics Challenge. The winning design was selected having first undergone a thorough design and performance evaluation by IAEA experts. "For the final phase of the Robotics Challenge in November 2018, the designs underwent real-world testing in a spent fuel storage pool at a nuclear power plant in Finland," said Dimitri Finker, Technology Foresight Specialist in the IAEA's Department of Safeguards. "This gave our experts the chance to review the merits of each design and evaluate which of them suited safeguards operational needs, had safety considerations built in, and gave the best image quality for verification." The IAEA will now work with its Member States, nuclear facility operators and the designers of the winning USV to finalize the design and ensure it is compliant with all applicable requirements and regulations. Pending this, the IAEA will seek authorization from its Member States to use the USV in the field.

"We are very happy that our design was chosen from among such strong competition. To be able to contribute to nuclear non-proliferation efforts and the important verification work of the IAEA is very exciting," said Peter Kopias, owner and Chief Executive Officer of Datastart, the winning company. "The Robotics Challenge required a creative engineering solution. I'm delighted our unique design met the needs of users."

In addition to the Robotics Challenge, the IAEA also conducts other technology challenges to identify and support the development of promising technologies that have the potential to aid its work. "Usually responses to official tenders for technical equipment with potential applications for safeguards work are only sought from a few highly specialized institutions. With the IAEA's technology challenges, scientific solutions are sought from hundreds of technology stakeholders," said Finker. The latest challenge, the IAEA Tomography Reconstruction and Analysis Challenge, looks to improve the verification process of spent nuclear fuel with advanced data processing techniques to analyse the images taken from ICVDs and, potentially, XCVDs.



IAEA experts review the performance of the winning Unmanned Surface Vehicle design.
(Photo: IAEA)