TESTING LIFESAVING GEAR FOR HARSH ENVIRONMENTS

By: Andrew Safer

The life of mariners hinges on the performance of lifeboats, immersion suits, and other equipment relied upon in maritime emergencies. These high stakes have motivated António Simões Ré to dedicate his career to evaluating their performance in extreme conditions and making recommendations for safety improvements.

Working out of the National Research Council (NRC) Canada facility in St. John's, Newfoundland, Simões Ré has been leading the Marine Safety Technologies for Extreme Environments (MSTEE) initiative for the past 15 years. A senior research engineer, he and his team of six researchers and six technical staff test physical models in a tow tank, ice tank, and offshore engineering basin; conduct full-scale field trials; and translate their findings into numerical models to validate their conclusions from the field trials and simulate a full range of scenarios for various sea states and conditions. They have partnered with Dr. Brian Veitch of the Faculty of Engineering and Applied Science at Memorial University since the program began and, more recently, with Dr. Scott MacKinnon of Memorial's School of Human Kinetics and Recreation.

Whereas lifeboats and immersion suits are typically tested at low sea states and in calm conditions, Simões Ré notes that the reality of working in northern environments requires a different approach. "There's an assumption with some regulations that performance remains constant and that you can work in any conditions," he said, adding that the performance decreases as the sea state and wind increase. "It crosses over to a point where it's no longer safe."

Lifeboats have been a specialty for Simões Ré's team. In one project designed to identify the conditions that may cause structural damage to the fiberglass, they conducted lab tests followed by a field trial in which they tested a lifeboat in an ice field 10 minutes outside of St. John's. On the west section of Paddy's Pond, they pre-cut pieces of ice averaging 0.34 m in thickness into rectangular pieces measuring 1.6 x 2.2 m and 1.6 x 3.2 m. They also cut ice pieces 0.5 m long by about 0.3 m wide to perform tests to measure the ice flexural strength in kilopascals. Instrumentation on the boat recorded positioning, speed over ground, pitch, roll, and heading. A camera was installed at the water line behind an acrylic window. On the acrylic window, 10-mm grids were used as a reference to measure the actual ice thickness impacting the acrylic panel, and a 6-component dynamometer recorded the impact loads in kilonewtons (kN). Lab tests had indicated that the boat's 6.7-mm thick fiberglass would puncture at 94 kN. The lifeboat proceeded at a maximum speed of 3.2 kts, and the maximum force recorded was around 35 kN. Higher impacts were measured this winter.

IMO regulations specify a maximum speed of 6 kts in open, calm water. Currently, there are no regulations for operating a lifeboat in ice or wave conditions. Simões Ré says that going through waves can reduce the speed by up to 2 kts. His team is currently developing a system for the coxswain whereby a green light would indicate "OK," a yellow light "Be Careful," and a red light "Danger of Damaging the Lifeboat." Based on this research, they will also be making recommendations for emergency evacuation ice management, indicating the maximum size of ice pieces that can be left behind by an icebreaker. Noting the differences between operating a lifeboat in the North and in calmer southern latitude waters, Simões Ré recommends requiring that coxswains train in navigating in ice.

Working in partnership with Memorial University, Simões Ré's team was called upon to determine the effectiveness of the Preferred Orientation and Displacement (PrOD) boom at the Terra Nova floating production storage and offloading (FPSO) unit in aiding the launch of a lifeboat. (The PrOD boom stabilizes the lifeboat as it is being deployed, directs it away from the FPSO once it hits the water, and provides additional force as it moves forward.) The MSTEE team built models of the FPSO, lifeboat, and PrOD boom and tested them in the NRC's offshore engineering basin. Their tests confirmed that the PrOD system oriented the lifeboat away from the installation and reduced the amount of setback common to conventional lifeboat deployment systems. (A rule of thumb is that a 10-m wave may push the lifeboat back up to 20 m, depending on the type of evacuation system being used.) Similar projects were performed to recommend where to locate the lifeboat station for different types of installation.

What is unique about Simões Ré's team is that it brings together thermophysiologists and engineers who address both structural/mechanical issues and human factors. In their work with immersion suits, they investigated the durability of neck and wrist seals and how ocean conditions affect their effectiveness. They found that wind and waves degrade the thermal characteristics of the suits. The human-factors study indicated that with the lifeboat hatch closed and operating for about 2 hrs with two people inside, the temperature inside the boat reached 34°. "Their core temperatures were now rising and they were sweating," explains Simões Ré. Referring to previous tests that showed that water leakage degrades the suit's effectiveness by approximately 30%, he points out that sweating due to body heat is equivalent to letting water in. He adds that since thermal instrumented manikins do not vaso-constrict the way humans do, his team is in the process of establishing correction factors that will enable drawing realistic conclusions from tests with manikins in heat conditions.

Other tests conducted with the human-factors lens examined light, noise, and air quality inside the lifeboat. "The only person who sees light is the coxswain," says Simões Ré, who recommends adding, for example, portholes. When the boat is idling, the noise level ranges from 94 to 99 decibels (db); when going through ice, it increases to 110 db. He adds that it is important for the coxswain to communicate with the crew, but at these noise levels a lot would be lost in conversation. He likens it to talking while an airplane is landing nearby. Regarding air quality, Simões Ré notes that lifeboats rely on passive ventilation via two holes in the front and on the engine to force air movement. In one test on a calm day with no wind, a lifeboat in heavy ice remained stationary, resulting in a build-up of carbon monoxide inside the boat. "With an active ventilation system, we could control the air quality," he says.

Whereas in the first few years the MSTEE program concentrated on lifeboat evacuation, the industry has shifted the focus to recovery in recent years. Because the regulations recommend that lifeboats be towed in calm water, Simões Ré's team has been investigating the consequences of towing in a variety of sea states. They have determined that fast-rescue craft are able to maintain control of a 16-person life raft, whereas maintaining

control of a 42-person life raft is considerably more challenging. And, this towing operation becomes extremely challenging with a 150-person life raft (15 m x 5 m x 3 m high, deployed from ferries and cruise ships). Simões Ré points out that the size of the fast-rescue craft that is typically installed on ships has not increased along with life raft size. He also notes that prescriptive regulations have continued to specify that all life rafts must be equipped with one-m long paddles, adding that from the perspective of a person in a 150-ft life raft, this size paddle does not reach the water. "This is why I like performance-based regulations rather than prescriptive," he says. As an example of a regulator that is keeping pace with the need to modify requirements, he cites the Canada-Newfoundland and Labrador Offshore Petroleum Board (CNLOPB). Conventional lifeboats are designed for people who weigh 75 kilograms, but he points out that the typical offshore worker weighs up to 100 kilograms. "The CNLOPB has been very proactive," says Simões Ré. "They have been taking the research we have been doing in collaboration with Memorial University and asking the operators to respond to the new findings and include them in their emergency response plans."

Another facet of MSTEE is "to develop an environment combining researchers, graduate and work term students, entrepreneurs, and industry that foster innovative application of research to the creation of new products and techniques," says Simões Ré. As an example, before he founded ExtremeOcean Innovation, Peter Gifford joined the MSTEE research team as a graduate student in Ocean and Naval Architectural Engineering. The team also interfaces with private sector firms by sharing data and providing numerical modelling and advice in support of new product development. The freefall lifeboat simulator that Virtual Marine Technology recently developed for training purposes incorporated data that Simões Ré's team had collected as well as numerical models they developed in their research. When Mad Rock Marine Solutions—recently sold to Survival Craft Inspectorate (Canada) Inc.—designed the hull for a new lifeboat designed for ice operation, the MSTEE team assessed the effect of the design on performance.

A 2-min walk separates the NRC Canada from Memorial University's Faculty of Engineering and Applied Science; their proximity facilitates collaboration. Within NRC is the Ocean Technology Enterprise Centre, an incubator for start-up companies. The centre currently houses three companies, but the number has been as high as seven. "This creates a small research park," says Simões Ré. "There seems to be a group of people here with similar interests who are making sure the right things get done. It's something very real. There's good collaboration between all the parts."