Structural Performance of Non-Ice Strengthened Surface Combatant In Ice

1.0 OBJECTIVE.

1.1 The objective of the project is to assess the ice-going capability of a steel monohull surface combatant designed to classification society rules, but without ice-classing. The focus of the study is on the structural performance in light ice conditions, with the objective of achieving a technical assessment of the ice-going capability of the vessel as a function of key operating parameters and ice conditions, validated with grillage testing. It is expected that the results will provide guidance for operating existing non-ice class vessels in the northern waters and inform requirements of future designs of surface combatants.

2.0 BACKGROUND.

2.1 Non-ice-class surface combatants may on rare occasions be required to operate in ice-covered waters, e.g., during national emergencies. At these times, safety of ship and crew requires an understanding of performance limits appropriate to the prevailing ice conditions. Given that the hull structure, propellers, sonar domes, rudders, and other appendages may all be vulnerable to damage from sea ice, the proper evaluation of safe speed is a complex undertaking.

2.2 Furthermore, ice conditions are highly variable. The lightest of ice conditions (newly formed frazil) presents absolutely no structural risk to any vessel. At the other extreme, multiyear ice and glacial ice can present a very high risk to all but the highest of ice class ships. The actual risk level is heavily influenced by the specific characteristics of the ice (thickness, mass, strength, shape), the specific form and strength of the hull and the specific maneuvers and speeds (operations) that the vessel performs. It must further be recognized that surface combatant crews will normally have little experience of operating in ice and therefore have limited ability to distinguish between hazardous and benign conditions.

2.3 A vessel's 'Ice Class' defines the additional requirements for a vessel intended to operate in ice. All ice class systems contain a range of classes, in order to reflect the wide range of ice conditions that exist. Each ice class is associated with a nominal design condition at which the vessel can safely operate. Unfortunately, there is little clear guidance on the precise range of conditions that are safe to operate in. It is usually left to the owner to learn through hard experience what conditions their vessel of fully capable of (and not capable of) operating in.

3.0 REQUIREMENTS.

3.1 Scope.

3.1.1 The present project addresses the operating limits of a concept surface combatant vessel in relatively light ice conditions. It was designed to classification society (naval) rules and has not been ice-classed. This vessel design will be used to develop a greater understanding of the capability of non-ice class vessels to safely operate in light ice, and further to develop an understanding of the effect of increasing ice class on the range of ice conditions and operations that can be safely performed. The project primarily considers the ability of the hull structure to resist ice loads in a variety of ice conditions, with other factors (propulsion, outfit) being of lesser focus.

3.1.2 The work will be conducted in two phases. In the first phase, the Contractor shall evaluate ice loads on a concept surface combatant vessel in a range of ice conditions. In the second phase, the Contractor shall design and conduct and experimental program to demonstrate the performance of one or more grillage panels under a range of ice loads.

3.2 Phase 1 tasks.

3.2.1 The Contractor shall review the concept surface combatant design, identifying quantitative and qualitative aspects relevant to ice capability. The focus is to be on structural capacity to resist ice loads, with other factors (i.e. propulsion, outfit) of lesser focus.

3.2.2 The Contractor shall review potential operation ice conditions, including ice information from public and industry sources and ice-going operational records of naval vessels (if obtainable). Based on this, the Contractor shall develop representative scenarios of ice operations for a surface combatant vessel.

3.2.3 The Contractor shall calculate ice loads that would be experienced by the hull for the representative scenarios.

3.3 Phase 2 tasks.

3.3.1 Based on the ice loads determined in Phase 1, The Contractor shall develop an experimental plan for verifying the performance of at least one grillage panel under a range of ice loads.

3.3.2 The Contractor shall design a grillage panel based on the dimensions, scantlings and materials of the concept surface combatant design, with appropriate scaling for the test frame and the available loading mechanism and load range. Provision for an additional grillage design will be made if budget is sufficient.

3.3.3 The Contractor shall fabricate the grillage panel(s) using an appropriate grade of material for winterized vessels. The welding of the panel(s) shall be performed to a welding standard for naval vessels using certified welders.

3.3.4 The Contractor shall execute a series of experiments that demonstrates the performance of the grillage panel(s) under a range of ice load levels and determines the ice loads and conditions at key limit states including initiation of plastic deformation, and ultimate strength.

3.4 Project Timeline.

3.4.1 Phase 1 evaluation of ice loads: 1 month
3.4.2 Development of experimental plan including grillage design: 1 month
3.4.3 Materials acquisition and grillage fabrication: 3 months
3.4.4 Grillage experiments: 3 months
3.4.5 Data analysis and reporting: 1 month

4.0 GOVERNMENT FURNISHED INFORMATION.

4.1 DRDC will provide details of the concept surface combatant design and operation profile data for northern waters.
4.2 The Canadian DND welding standard will be provided upon request.

5.0 DELIVERY REQUIREMENTS.

5.1 The Contractor shall provide a report at the end of Phase 1 detailing the representative ice scenarios developed and result of the ice load evaluation.

5.2 The Contractor shall provide a report at the end of Phase 2 detailing the methodology and findings of the grillage panel experiments.

5.3 The Contractor shall provide quarterly progress reports to the Project Technical Committee, the Ship Structure Committee Executive Director, and the Contract Specialist.

5.4 The Contractor shall provide a print ready master final report and an electronic copy, including the above deliverables, formatted as per the SSC Report Style Manual.

6.0 PERIOD OF PERFORMANCE.

6.1 Phase 1: Awarded to Daley R&E 25 Nov 2014 and is to be completed by 31 Mar 2015.

6.2 Phase 2: Will be completed 12 months after contract award.

7.0 GOVERNMENT ESTIMATE. These contractor direct costs are based on previous project participation expenses.

7.1 Phase 2: Project Duration: 12 months.

7.2 Total Estimate for Phase 2: $50,000