Performance Evaluation of CCGS Icebreaker *Henry Larsen* with Air Bubbler System in Ice

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**ABSTRACT**

The objective of the paper is to provide an assessment of the air bubbler system in terms of ship performance in various ice conditions. In order to measure the ship performance with/without the air bubbler system, various sensors were installed on the CCGS *Henry Larsen* to measure performance information including thrust/torque/RPM from both shafts along with ship speed, heading and location. The National Research Council of Canada (NRC) and C-CORE also installed a Situational Awareness (SA) sensor package. From this ice trial, the air bubbler system demonstrated performance benefits in confined brash ice, snow covered pack ice, and the tightly packed shear zone. The detailed data analysis and results are provided and the recommendations are discussed.

**KEY WORDS:** *Henry Larsen*; Icebreaker; Air Bubbler System; Canadian Coast Guard; Ice Resistance Reduction; Ice Trial.

**INTRODUCTION**

The Canadian Coast Guard (CCG) and the National Research Council of Canada (NRC) teamed up to investigate the effectiveness of the air bubbler system of the CCG icebreaker *Henry Larsen* and to further consider implementation of this system to the future icebreaker fleet (such as the Program Icebreaker). The principle of the air bubbler system is to agitate the water at the interface between the hull and ice by air bubbles, injected via nozzles through the hull below the waterline, to create a lubricating layer to reduce the frictional resistance of the ice. The air bubbler system has been used for various icebreakers/ice-going tankers and various benefits have been discussed (Juurmaa, 1978; Transport Canada, 1985; Wilkman, 2011). Figure 1 shows the air bubbler nozzle location of the *Henry Larsen*. For this system, there were two modes: hull lubrication mode (red box and bottom nozzle of blue box in Figure 1) and thruster mode (blue box). Figure 2 shows the inner pipelines of the air bubbler system and its compressor assembly.

A total of 4 different ice conditions were found and tested: 1. level ice, 2. pack ice at various speeds, 3. heavy brash ice at low speed, and 4. shear zone for ramming. In addition to these ice tests, open water bollard, and speed tests were performed and compared with the model test.