National Shipbuilding Research Program
Advance Shipbuilding Enterprise

NAVAL VESSEL ICE CAPABILITY OPTIMIZATION EFFORT STUDY

Project Results Executive Overview

Prepared by:
ICE BELT Project Team

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1 EXECUTIVE OVERVIEW

The Naval Vessel Ice Capability Optimization Effort (NVICOE) Study was completed in four phases, which built upon each other to develop a “user guide” to the NVICOE Study design template process. The goal of phase one was to develop generic computer spreadsheets, addressing the scantling requirements of the ABS 2012 Ice Class Rules. Using the spreadsheets developed in phase one, phase two applied the spreadsheets to a single-skin ship to produce a baseline ice belt structural set, meeting the scantling requirements found in the ABS 2012 Ice Class Rules. Phase three expanded upon scope the studies conducted in phase two to include both double-skin hulls and light-scantling, high density structures. Phase four consisted of consolidating all work completed in phases one through three into a “user guide”.

This user guide will act as an aid for shipyards and others involved in ice class ship design to better understand the methodology and processes associated with the Naval Vessel Ice Capability Optimization Effort Study template toolset.

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2 CONTACT INFORMATION

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3 COLLABORATORS

American Bureau of Shipping (25% of labor hours)
American Bureau of Shipping (ABS) hosted a workshop on ice class ship design requirements in Houston, Texas. ABS hosted a workshop on ice class vessel design considerations in Alexandria, Virginia. ABS developed the spreadsheet for Polar Class vessels and vetted the First-year Ice and Baltic Ice class spread sheets.

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4 DESCRIPTION OF METHODOLOGY

The goal of phase one was to review information pertinent to the American Bureau of Shipping Ice Class Rules and develop a baseline set of rules that will be implemented on the next update of American Bureau of Shipping Ice Class Rules. These updated rules were then used to develop spreadsheets, which address the new performance requirements set forth by each set of the ice class rules. The information used to develop these updated rules and spreadsheets consisted of:

- 2012 American Bureau of Shipping Ice Class Rules
- Review of a previous ice belt design effort completed at GD NASSCO

Phase two built on the spreadsheets to develop full templates for a single-skin type ship. The templates and associated items developed include:

- Sectional specific draft templates for the bow, midbody, stern of the ship

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- Two sets of direct calculation of scantling schemes for typical structure for bow, mid-body, and stern arrangements
- Comprehensive build strategies for each sectional area of the ship to compare relative cost

The goal of phase three was to expand upon the studies conducted in phase two to include double skin hulls and light scantling, high density structures. This increased scope required the developments of the following tasks and templates:

- A double skin template based on the single skin ship structure with modifications to the bow, mid-body, and stern sectional arrangements to fit a typical double skin structure
- Two sets of direct calculation of scantling schemes for typical structural bow, mid-body, and stern arrangements
- Scantling schemes for ABS Polar Class and Finnish Swedish Ice Class Rules (Baltic) notations
- A light scantling, high density structure template based on the single skin ship structure with modification to the original bow, mid-body, and stern sectional arrangements to reflect typical light scantling, high density structure.
- Create two sets of direct calculation of scantling schemes for typical structural bow, mid-body, and stern arrangements.
- Develop scantling schemes for ABS Polar Class and Finnish Swedish Ice Class Rules (Baltic) notations

The goal of phase four was to consolidate all information from the previous three phases into a "user guide". This user guide will act as an aid for shipyards and others involved in Ice Class Ship Design to better understand the methodology and processes associated with the Naval Vessel Ice Capability Optimization Effort Study template toolset.

5 RESOURCES NEEDED

To initiate phase one of the project, ABS led a workshop on ice class ship design requirements in Houston, Texas for the NASSCO team members.

Phases two and three required the use of Microsoft Excel to develop the spreadsheets and calculations and the templates. Development of the spreadsheets required a proficient level of understanding to ensure all aspects of the updated requirements were accurately accounted for. ABS hosted a workshop on ice class vessel design considerations in Alexandria, Va. A team of six people from NASSCO with support from ABS was created to make certain this proficiency was present throughout all phases of the project.

Software Resources

- Windows XP/2000 (Also tested with Windows 7 64-bit)
- Microsoft Excel 2003 or greater

NASSCO recommends contacting ABS for ice class training course(s) prior to using the spreadsheets provided by this project.

6 EVALUATION AND ANALYSIS METHODS

The math models were vetted by ABS to ensure the ability of the spreadsheets to produce acceptable scantlings for ice class ships. A comparative cost analysis study was done by the cost engineering team at

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NASSCO. The cost analysis indicated that the NASSCO preferred scantlings do lead to measurable cost savings for all three different types of vessels. The double hull and light skin scantlings were evaluated in phase three to ensure the accuracy of the math models and determine the associated cost reduction. No plans have been made to re-evaluate the project in the future. NASSCO does not intend to update the spreadsheets to newer revisions of the ice class rules.

7 TIME ESTIMATE

The project effort spanned forty-eight months beginning with the definition of functional requirements and creation of the design specifications through construction, testing, validation, and implementation of spreadsheets and cost reduction processes. The time estimated another shipyard would need to set up and implement the use of the ice class spread sheets is less than 30 days. Allow time for ABS training classes.

8 LIMITATIONS OR CONSTRAINTS

There are no foreseeable limitations or constraints in the implementation of the Naval Vessel Ice Capability Optimization Effort Study at other shipyards. To properly implement the use of the information obtained from this project within NASSCO's organization, procedures were created to accompany the "user guide" for NASSCO specific processes. While helpful to NASSCO's ship design process, it is not necessary for other shipyards to produce procedures to use the spread sheets. All shipyards, regardless of the size of the yard, should be able to implement the tools to aid the design of future ice class ships created by this project. The spreadsheets focus only on shell structure, the use of ice decks, bulkheads, machinery, etc. were not included.

9 MAJOR IMPACTS ON SHIPYARD

The implementation of the Naval Vessel Ice Capability Optimization Effort enhancements did not negatively impact the use of or require modification to any external systems or processes.

Positive impacts include:

- The ability to analyze scantlings for different ice class ships
- The ability to quickly provide baseline scenario scantlings
- The ability to quickly re-iterate the scantling designs
- The ability to reduce the number of steps required to produce ice class scantlings

10 COST BENEFIT ANALYSIS/ROI

When compared to their ice class baseline arrangements, the following best case optimizations realized the following cost reductions for a single skin scantling ship.

- ABS First Year (A0) alternate scheme three realized a 2% reduction in overall cost
- ABS Baltic (1AA) alternate scheme four realized a 25% reduction in overall cost
- ABS Polar Class (PC 6) alternate scheme one realized a 8% reduction in overall cost
- ABS Polar Class (PC 7) alternate scheme one realized a 8% reduction in overall cost

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All optimized scenarios with lowest overall cost had coincidentally the lowest overall weight and material cost. Weight reduction is generally considered an advantage. Alternatively added weight could be considered an advantage too if there is a reduction in overall cost between labor and material.

11 LESSONS LEARNED

The significant lessons learned as a result of working on this project are:

- The methodology behind optimizing an ice belt for a mid-ship grillage for three different types of vessels (auxiliary cargo ship, tanker, combatant) remained constant
- One spreadsheet can be used for all notations within an ice class (i.e. one spreadsheet provides results for First Year Ice A0, B0, C0, etc…) the same is true for Polar Ice Class and Baltic Ice Class

Improvements to the spreadsheet could include combining all three rule sets into one spreadsheet and testing more sections for the three different types of vessels such as the aft and stern. The vessels had only been tested using the mid body section only.

The advice to other shipyards planning to implement this project is to be familiar with the rule set that is to be used for the ice belt.

12 TECHNOLOGY TRANSFER

To ensure the project is working at NASSCO, engineering personnel have been trained in the use of the spreadsheets. Technology transfer for the project has already been accomplished through technical presentations and demonstrations of the math models at National Shipbuilding Research Program panel meetings and meetings with individual shipyards.

13 IMPLEMENTATION

Implementation of the Ice Capability Optimization Effort Study at another shipyard could be accomplished by adequate training and following the “user guide”. This user guide will aid the shipyard in use of the spreadsheets and cost reduction processes. Prior to strict use of the user guide and templates, it should be ensured that all variations between shipyards are accounted for and the information is modified accordingly, and that the spreadsheets are in compliance with the latest ice class codes.

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