Ice Passport for Icebreaker "Pierre Radisson" and Passport’s Concept: Further Development

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ABSTRACT

In 1997 the Department of Ship Performance of AARI on the order of Transport Canada and Canadian Coast Guard under management of NRC-Canadian Hydraulics Centre developed the ice passport (IP) for icebreaker “Pierre Radisson”. The paper contains the description of main stages of IP developing illustrated by results for icebreaker “Pierre Radisson”. The paper contains also the suggestion for improving of IP.

KEY WORDS: navigation in ice, safe navigation, ice passport, ice loads, ice belt structure, ship performance in ice.

INTRODUCTION

A Maritime administration of any country, shipowner, navigator are interested in navigation safety. The problem of maintaining safe navigation becomes especially important while sailing in ice condition. The most general indicator of safety of ship operation in certain ice condition is ice class (ice category) under some Classification Society. The disadvantage of ice classes is the absence of recommendations for ship control in certain ice condition or certain region of a freezing sea.

Early in the 60-th the Russia began to grow the cargo transportation along Northern Sea Route. The increasing cargo transportation led to a growing amount of damages of hull structures and rudder-propeller equipment. The increasing of hull structures damage amount in describing period is a main reason of development of a mean for regulation of ship motion regimes in certain ice condition. The Ice Passport (IP) is the approach used in Russia. Since 1973 17 ice passport were developed for various types of ships which are used for transport operation in Arctic seas. The main orders of ice passports are Murmansk Shipping Company (from Murmansk), North Shipping Company (from Arkhangelsk).

The Department of Ship Performance of AARI on the order of Transport Canada and Canadian Coast Guard under management of NRC-Canadian Hydraulics Centre developed the IP for Canadian Coast Guard icebreaker “Pierre Radisson”, and described the methodology of IP developing. This paper contains the description of IP-general concept, main stages of IP developing illustrated by results for icebreaker “Pierre Radisson”: attainable speeds diagrams, safe and dangerous speeds diagrams. The paper contains also the suggestion for improving of IP.

GENERAL CONCEPT OF ICE PASSPORT

The ice passport is operated mainly with two ice performances of ice going ship.
1. The ship ability to keep certain speed in certain ice condition.
2. The ability of ship hull structure contacting with ice to resist ice pressure. This area of hull structure is called ice belt.

The ice passport investigates the balance between these two ice performances of ship while moving in various ice conditions. The ice passport concept is based on the assumption about the influence of both ice performances as navigator operation parameters as ice condition characteristics. The main operational parameter is a ship speed \( V \), the main ice condition one is the ice thickness \( h \). The IP diagram consists of two kind of curves: attainable speeds curve (fig. 1, curve 1) and safe or dangerous speeds curve (fig. 1, curve 2).

Fig. 1. Diagrams of ice passport: 1 - attainable speed curve, 2 - safe or dangerous speed curve, 2' - safe or dangerous speed curve taking into account structure wear or reflected impact.

The attainable speed of ship is a speed which a ship can achieve operated with a constant shaft power in prescribed ice condition (Likhomanov, V.A., Polferov, S.Yu. and others 1993) and (Likhomanov, V.A., Timofeev, O.Ya. and others 1995). The safe or dangerous speed curves are the set of couples \( (V,h) \) for which an ice belt structures are failed based on one of two strength criteria: for the safe speed is an yield criterion, and for the dangerous speed is the ultimate strength criterion.

Operating in the area below safe speed curve doesn’t lead to hull structure damages because the ice belt structures are working in the elastic area. Operating in the area above the dangerous speeds curve...