



OTC 20002

Scenario-Based Assessment of Risks to Ice Class Ships

A. Kendrick and B. Quinton, BMT Fleet Technology Limited, and C.G. Daley, Memorial University of Newfoundland

Copyright 2009, Offshore Technology Conference

This paper was prepared for presentation at the 2009 Offshore Technology Conference held in Houston, Texas, USA, 4–7 May 2009.

This paper was selected for presentation by an OTC program committee following review of information contained in an abstract submitted by the author(s). Contents of the paper have not been reviewed by the Offshore Technology Conference and are subject to correction by the author(s). The material does not necessarily reflect any position of the Offshore Technology Conference, its officers, or members. Electronic reproduction, distribution, or storage of any part of this paper without the written consent of the Offshore Technology Conference is prohibited. Permission to reproduce in print is restricted to an abstract of not more than 300 words; illustrations may not be copied. The abstract must contain conspicuous acknowledgment of OTC copyright.

Abstract

The rise in resource related projects in the Arctic has created the need for new approaches to assessing and minimizing risk. The new tankers and drill ships required for the Arctic will be larger and stronger than any previous ships, but will be very carefully designed and operated. The paper presents a methodology for assessing risk to large Arctic ships in a variety of scenarios. For the purpose of illustration of the approach, two ice collision scenarios are described. One is the case of a large ship with a bulbous bow hitting an iceberg head-on. The second is an aft waterline collision with a sea ice floe. Both scenarios are outside the conditions formally considered in standard ice class rules but are significant issues. The paper provides owners/designers/regulators with an example of a methodology to examine ice loads using a rational set of design scenarios. The results show that vessels can easily be operated in a manner that can create dangerous load levels. The results are directly relevant to the structural design of new large Arctic tankers (oil and LNG) and large Arctic drill ships. The second part of the paper presents some initial results from consideration of plastic structural response to moving ice loads. The significance of the movement (sliding) of the load increases as the response level increases. Elastic responses are only slightly influenced by the movement of the load along the hull, while the larger plastic responses are greatly affected by movement. This paper is mainly intended to raise this as an issue of potential concern.

Nomenclature

A_n	ice crushing area
C_o	mass reduction factor (Popov)
F_n	ice crushing force
I_E	indentation energy
KE_e	effective kinetic energy
M_e	effective collision mass
M	collision mass
P_{av}	ice pressure
P_o	ice strength parameter
R	paraboloid nose radius(for bulbous bow impact)
r	contact area radius (for bulbous bow impact)
ex	ice pressure-area exponent
f_A	geometry function
h	basic ice thickness
w	width of contact (aft body case)
ζ	normal ice indentation
ϕ	wedge opening angle