

ICE CLASS AND ICEBREAKERS

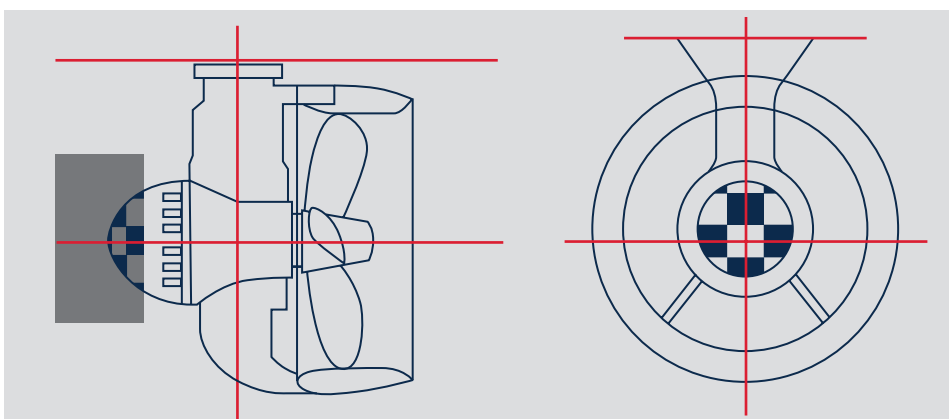
ABS ICE CLASS RULES

Ice class rules have been a part of the ABS *Steel Vessel Rules (SVRs)* for decades and have been progressively updated to reflect new technologies and developments. Today, ABS offers a state-of-the-art rule set for the construction of ice class and icebreaking ships. Our rules incorporate the latest International Association of Classification Society (IACS) Polar Class Unified Requirements (ABS Polar Class), the Finnish-Swedish Ice Class Rules (ABS Baltic Ice Class) and a suite of ABS First-year Ice Class notations. ABS also offers optional Polar Class Enhanced and Icebreaker notations, intended to fill gaps in the unified requirements and provide a more complete rule set for designers and builders. ABS actively participates with international partners on the continuous improvement of the ice class structural and machinery requirements.



PRACTICAL SOFTWARE TOOLS

ABS has developed practical software tools for rapid calculations and scantling checks against the requirements of the ABS *Polar Class Rules*. For structures, ABS *PolarQuickCheck* is a user-friendly spreadsheet-based program to check various ship structural components for compliance with the rule requirements. For machinery, ABS *WebCalc* offers a simple web-based interface for assisting designers and shipbuilders meet the ABS Polar Class machinery requirements.



GUIDANCE ON ICE LOADS FOR AZIMUTHING PROPULSION UNITS (APUS)

Azimuthing propulsion units (APUs) are an attractive option to designers and owners of ice class ships. They offer improved maneuvering and ice clearing performance in comparison to traditional shaft-line propulsion arrangements, a characteristic which is particularly useful in ice management operations. Until recently ice class rules provide limited guidance on

how to strengthen APUs and their surrounding structural supports when subject to ice impact loads. ABS, in collaboration with international experts and leading manufacturers, developed a methodology on the assessment of ice impact loads on APUs of Polar Class ships. Critical ice-interaction scenarios were identified and rule formulations were derived for different configurations and load cases. The formulations were validated against available full scale data, analytical methods, and other existing standards. The final outcome of the project was an ABS *Guidance Note for Design Ice Loads on Azimuthing Propulsion Units*.

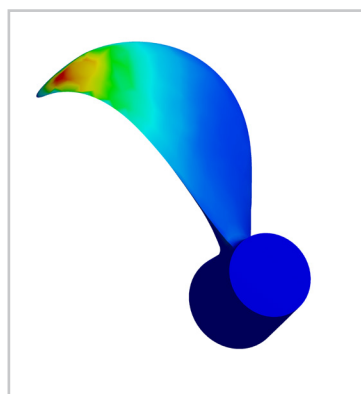
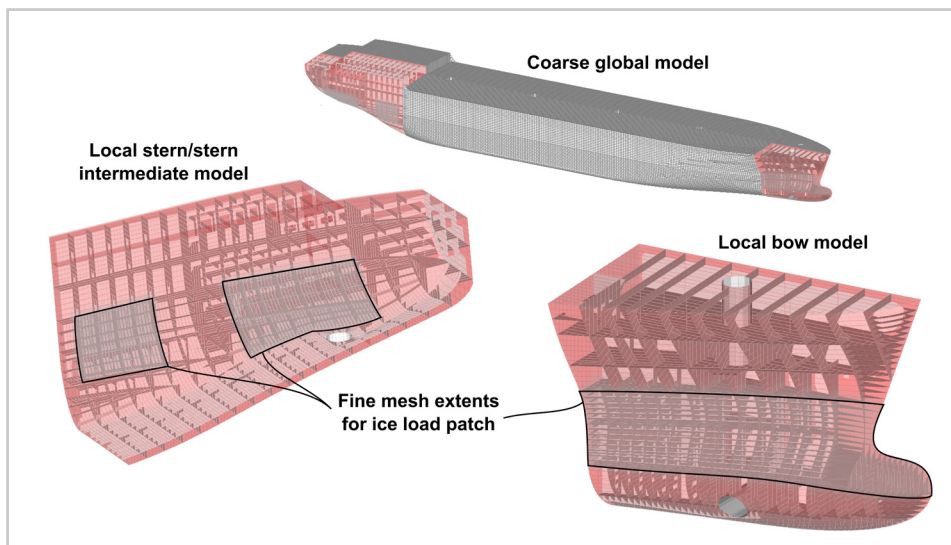
NONLINEAR FEA AND DIRECT CALCULATION GUIDANCE

ABS ice class rules represent a comprehensive set of structural and machinery requirements for the design and construction of Polar Class, First-year Ice Class, and Baltic Ice Class ships. However, in some cases prescriptive rules can be constraining to a designer and alternative direct calculation methods are needed. Furthermore, recent ice class rule revisions are promoting the use of direct strength calculation as a means for evaluating the capacity of icebelt structures. ABS has developed procedures and

guidelines for evaluating polar ships structures subject to design ice loads and accidental overload scenarios. This involves the application of nonlinear finite element analysis methods and establishing robust structural response criteria.

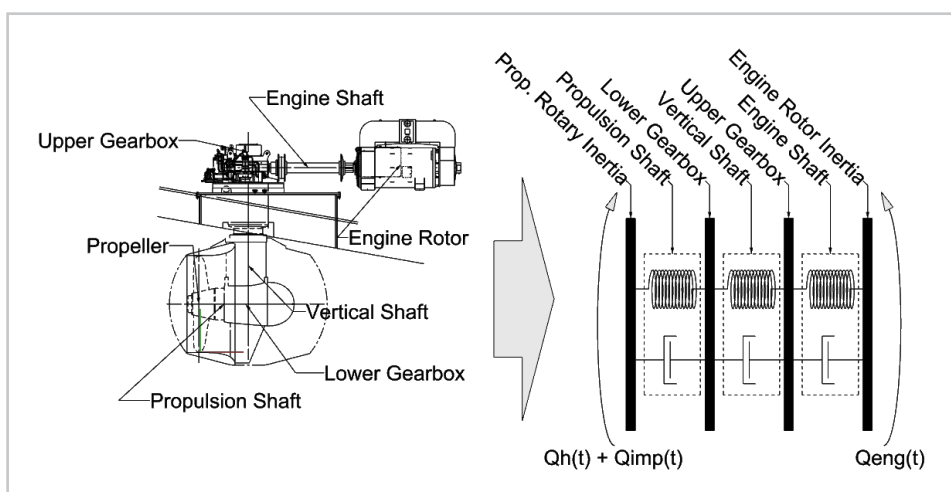
PROPELLER BLADE LOAD ANALYSIS

The Polar Class and Baltic Class rules contain propeller blade strength requirements under various ice loading conditions. The rules prescribe a stress analysis which is typically carried out through the use of finite element (FE) analysis methods. ABS has developed tools and procedures to assist designers in the development of propeller finite element models, application of ice forces, and evaluation of the blade response against permissible stress criteria. The FE analysis results are also the basis of the assessment of the fatigue life of the propellers.



TRANSIENT TORSIONAL VIBRATION ANALYSIS

The Polar Class rules require a torsional vibration analysis to determine the peak torques for each component in the drive-line when subject to excitations from ice milling. ABS has capabilities to conduct transient torsional vibration analysis on driveline systems with electric and/or turbine prime movers. The peak torques and the torque amplitudes from the analysis are used to dimension the drive-line components and conduct fatigue analysis.



ABS HARSH ENVIRONMENT TECHNOLOGY CENTER (HETC)

The ABS Harsh Environment Technology Center (HETC) was established on the campus of Memorial University in St. John's, Newfoundland and Labrador in 2009. The primary objective of the HETC is to develop technology for the design

and assessment of ships and offshore structures that operate in harsh environments - particularly the Polar regions and low temperature areas. It is an extension of ABS' robust Polar and harsh environment program located within ABS' Technology department headquartered in Houston, Texas.

Newfoundland was considered a prime location to establish an Arctic research center due to its excellent educational program, offshore oil exploration and development activities in the region, and progressive approaches in supporting research activities.



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