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# Comprehensive Evaluation of Hull Form Design for an Icebreaking Vessel in the Kashagan Field

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## Abstract

Both the ice-going and structural capability were analyzed in a comprehensive way for the IBEEV, a small-sized, shallow draft icebreaker vessel, equipped with two pulling type thrusters and operated by AGIP KCO in the Kazakhstan sector of the Northern Caspian Sea. To this end, a number of activities involving Navalprogetti and Krylov Shipbuilding Research Institute was implemented, encompassing analytical and numerical computations, model tests in open water, shallow water and ice towing tanks and full-scale measurements in ice.

To evaluate performance of IBEEV all year long, the power-speed relationship was estimated in both open water and ice conditions. As regards open water, the ultra-shallow water depth showed dramatic influence on the vessel's resistance, hull-propeller interaction, and bollard pull capability. The performance in ice was analyzed through analytical and numerical models, experimental model testing and full-scale trials. The full-scale campaigns allowed determination of (i) maximum ice-breaking capability of the vessel in level ice, (ii) gyration radii of the vessel running both ahead and astern, and (iii) capability of channel break out for the vessel.

Finally, to determine service restrictions of IBEEV based on hull ice strength a number of strength criteria was identified, namely, not-exceed the service line load under normal operation; value of the ultimate strength of ice strengthening structures, and damage limits to avoid water leakage. To this end, theoretical analyses were carried out by means of the hydrodynamic model of the vessel impact against the ice. The numerical results were validated by full-scale experimental results and confirmed that IBEEV complies with given constraints.

Figure 1. IBEEV-07 at ice sea trials