EEDI ships need more assistance in ice

The purpose of the Energy Efficiency Design Index (EEDI), introduced by the International Maritime Organization (IMO), is to promote energy efficient ships and thereby reduce CO_2 emissions per ton-mile of transported cargo. According to the latest research, ships with low power-to-dead-weight ratio fulfilling EEDI requirements need more assistance in ice, compared to ships with higher installed power, built before the requirements entered force.

An ongoing concern regarding the new legislation is that new vessels built according to EEDI requirements would not manage well in ice conditions. Development Engineer Teemu Heinonen from Aker Arctic recently finished a research project, funded by the Finnish-Swedish Winter Navigation Research Board, in which he compared new vessels designed to meet EEDI criteria and older vessels not required to fulfil the latest energy efficiency requirements with regard to the need of icebreaker assistance to Finnish and Swedish harbours during the three past winters (2016-2018).

"When investigating all Finnish and Swedish ports in the northern Baltic Sea, the conclusion was that 20–30 % of EEDI compliant vessels required icebreaker assistance during the time with traffic restrictions, whereas only 5–10 % of non-EEDI compliant vessels needed help in ice," Heinonen says.

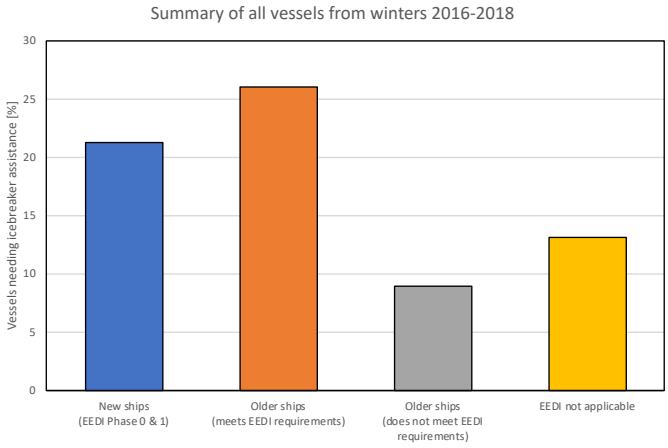
Map of the researched area.

Comparing data

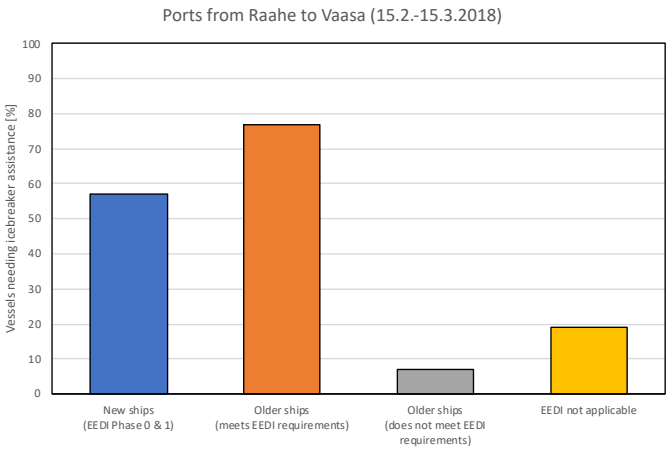
Heinonen compiled and reviewed data regarding the number of vessel harbour calls, the vessel type and the need of icebreaker assistance. When assistance was needed the distance and length of assistance provided, as well as the distance and time under tow, was evaluated.

Vessels were divided into four categories: new ships designed and built to meet EEDI requirements applicable to them; older ships that predate EEDI but nonetheless meet the requirements through good energy efficiency; older ships that do not meet EEDI requirements for similar ships built today; and ships of any age not covered by EEDI.

"I then grouped all harbours into smaller geographical areas for a clearer overview," he says



Summary of all vessels needing assistance during the winters researched.

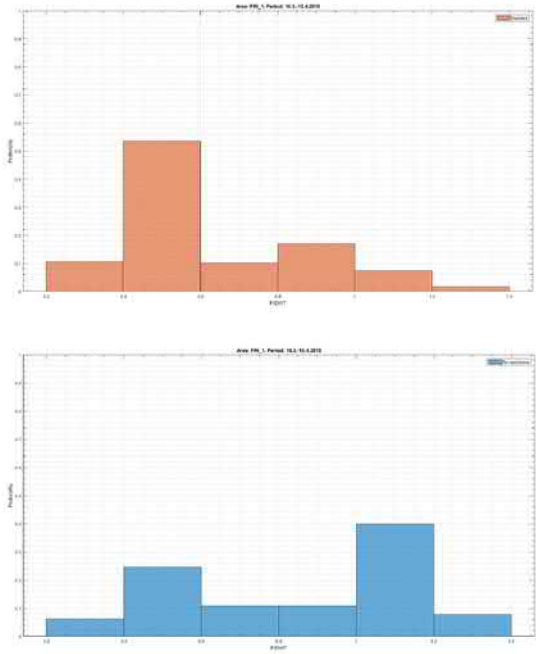


Example of vessels needing assistance between Raahe and Vaasa mid-February to mid-March 2018.

Assistance requirements for EEDI ships

From the three-year data, Heinonen concluded that nearly all vessels requiring towing assistance were EEDI-compliant vessels. "Ships that didn't fulfil EEDI criteria hardly ever needed to be towed," he says. Heinonen underlines that there is a clear correlation between assistance requirements and the power-to-deadweight ratio.

"The data shows that when the power-to-deadweight ratio is below 0.6 kW/ton, the vessel will most likely need assistance or towing in ice by an icebreaker. For power-to-deadweight ratios above this, the likelihood of the vessel requiring assistance decreases significantly."



There is a clear correlation between assistance requirements and the power-to-deadweight ratio.

More icebreakers needed

The number of ice-strengthened vessels built according to EEDI regulations is still relatively small. During the three winters researched, only 23 different new EEDI vessels entered the Finnish and Swedish harbours. However, there are a large number of old vessels which fulfil the EEDI requirements adding numbers to the research.

According to Heinonen, the results tell us that EEDI compliant vessels need more assistance and towing for longer time and longer distances than non-compliant vessels. But, with the sample being relatively small, he would rather focus on the power-to-deadweight ratio as it gives more reliable figures.

"The ratio comparison clearly shows that, if the power-to-deadweight ratio diminishes in the future, i.e. a growing fleet of EEDI vessels with lower installed power, more availability of icebreakers will be required to support these vessels." ■

EEDI bow with improved ice performance

Last year, a series of model tests was performed to evaluate how well the new EEDI compliant vessels manage in ice conditions.

At the start of the project Naval Architect Mikko Elo joined the tanker *Suula*, a conventional product tanker with a bulbous bow designed for ice conditions, to gather facts about the real ice conditions the ship meets during normal operation in Bay of Bothnia. Following this exercise, a testing programme was established, for which a two-part model with interchangeable bows was used.

"The EEDI bow we developed for the test had all the typical characteristics of a vertical EEDI bow, but we included a small wedge at the waterline, which we thought could improve its ice-going characteristics," Elo explains.

The testing programme included level ice conditions, tests in two different ice channels, pack ice and finally tests with a small ice ridge. The aim was to reflect the expected ice conditions the ship meets during normal operation.

Positive results

In general, the tests went well and both bow forms performed relatively effectively in most ice conditions. Surprisingly, the sharp EEDI bow performed better in pack ice and the brash ice channel, as it split the floes and pushed them aside, instead of breaking and submerging them as with the bulbous bow form.

However, the biggest difference was the channel breaking out test.
"The traditional bulbous bow slowly chewed its way through the channel edge, whereas the EEDI bow could not manage it at all," Elo says. "After making contact with the channel edge, the vessel model bounced back into the channel, which in real life might pose a safety risk when passing another vessel."

"We also noticed that the EEDI bow was sensitive to changes in icebreaking mode in level ice. Sometimes the bow worked very well in level ice, breaking the ice by bending, whereas at other times the ice was broken by cutting and crushing resulting in a reduced speed."

The EEDI bow performed better than the bulbous bow in pack ice, by splitting ice floes (bulbous bow left, EEDI bow right).

The main conclusion of the project and the model tests results is that an EEDI bow can have equal ice going capabilities as a bulbous bow in normal brash ice channel conditions. However, in some ice operations, like breaking out of the channel, it can have difficulties.

In June, Elo presented the results at the 25th International Conference on Port and Ocean Engineering under Arctic Conditions (POAC 2019) in the Netherlands.

The Finnish-Swedish Winter Navigation Board funded the research project.