



Maryland Engineering Challenges™
2011
Cargo Ship Guide

Supported By:

Maryland Association of Appraisers
Project Liberty Ship

Level:

High School—Grades 9 to 12

Important Dates:

Coaches' Information Session:
Thursday, November 11 2010
4:00 – 7:00 p.m.

Coaches' Hands-on Workshop:
January 29, 2011
10:00 a.m. – 2:00 p.m.

**Registration Deadline and Written Report Due:
Friday, April 16, 2010
4:00 p.m.**

**Competition Date:
Sunday, May 1, 2011
12:00 p.m. – 4:00 p.m.**

Important Information:

All Cargo Ship activities will be held at:
Baltimore Museum of Industry, 1415 Key Highway, Baltimore, MD 21230

For more information on Cargo Ship engineering requirements, please contact Bill Riedel at wmriedel@comcast.net

For registration information or general questions about the Maryland Engineering Challenges, please contact Melinda Cané at mcane@thebmi.org Detailed information about the competition event will be sent to Coaches after the registration deadline.

To register a team, adult Coaches should go to <http://tp1.clearlearning.com/hshealey/EC.tp4> Please note there is a \$5 PER COACH registration fee. Only one Coach is needed per team, although a team may have as many adult helpers as needed.

Written reports must be submitted AS HARD COPIES, either by mail or in person, to:
BMI, 1415 Key Highway, Baltimore MD 21230



The Challenge:

A local Baltimore company has engaged your team to design a bulk carrier cargo ship to deliver 40,000 tons of processed sugar to remote ports. The shortest wharf on the expected route (and therefore the longest ship that can be accommodated) is 600 feet long, and the minimum depth in any port is 40 feet, permitting an equivalent draft. As part of your demonstrated solution, you should build a 1:120 (1 inch to 10 feet) scale radio-controlled model to be tested in the Inner Harbor.

Engineering Team Requirement:

Each team may consist of 1 to 8 students

Challenge Ship Specifications and Judging Guidelines:

I. Written Report (includes drawings) – 30 points

Provide a written report in the required format (see “Guide to Entry”) that presents and explains all facets of the design and the rationale for selecting specific design parameters and selecting/rejecting individual features. For example, what were the overall length, beam, and draft, and why? How was the hull shape chosen? What were the tradeoffs your team made? What testing was performed, and what were the results? The report must include working drawings and a final lines drawing of your hull.

II. Oral Presentation – 10 points

One or more of the team members should present a 5-10 minute oral report that summarizes the written report. This will be followed by questioning by the judge.

III. Design & Fabrication – 30 points

- Any mono-hull design is acceptable and the hull may be constructed of any rigid material. The model should be robust enough to withstand minor collisions and handling and must have enough watertight integrity to protect the cargo, the propulsion plant, and the radio controls for the duration of the in-water testing (at least 15 minutes). It should conform to these basic specifications – all instances of non-conformance will result in points being taken off!
- Propulsion will be provided by a single 12-volt electric motor. A propulsion kit consisting of a specified motor, an optional reduction gear, and optional propeller will be provided to every registered team. (A battery is not provided.) A team may choose to drive two propellers from the single motor, but only a single propulsion kit will be provided.
 - To request a kit, contact Melinda Cané at mcane@thebmi.org
- A standard multi-channel radio control unit functioning in the R/C band must be used, capable of controlling at least engine forward/off/reverse and the rudder.
- Boat hull measurements:
 - The overall length and beam (width), including all appendages, must not exceed 60 inches and 15 inches, respectively.
 - Maximum draft is not to exceed 4”. That means no part of the vessel (propeller, rudder, etc.) may extend down more than 4 inches into the water.
 - The depth of the hull (keel to deck edge), measured anywhere, must be at least 8 inches.
- The vessel must be provided with a watertight “collision” bulkhead at least 10% of the overall length aft of the bow. No cargo may be loaded forward of this bulkhead. An additional watertight bulkhead must be provided between the cargo hold and the propulsion plant. All cargo must be carried inside the hull.
- The vessel must have a deckhouse that occupies at least 5% of the hull overall length. This deckhouse must extend at least 50 feet (5 inches) above the gunwales

- Vessels must be painted and marked for identification, and the design draft should be marked on the hull. The quality of workmanship and finish is a factor in judging. The judges expect the model to look like a ship!
- Each team should consider providing a floor stand for its ship model, high enough to permit working on its entry during the challenge (the table space available in previous years cannot be guaranteed).
- The vessel should be designed to carry eight 5-lb bags of sugar in its hold. The bags may be encased in plastic wrap and/or filled with 5 lbs of sand instead of sugar.
 - The cargo should be visible for inspection prior to testing. Removable cargo hold covers and/or hatches must be fitted that will make the hull reasonable watertight (splash-proof) during testing. Water and weather conditions cannot be guaranteed – just like a real ship, your model should be capable of handling waves and a little spray!
- The vessel should be able to demonstrate adequate stability when fully loaded.
 - It may be inclined to show a GM (metacentric height) of >3/4 inch OR
 - Have a roll (left-right-back again) period of less than 2 seconds.
 - If, on the day of competition, the vessel is unable to demonstrate adequate stability, the judges may elect to remove one or more bags of cargo with the associated performance penalty.

IV. Reliability – 5 bonus points

Up to five bonus points will be awarded by the judges to vessels that are consistently ready to test when called, need few repairs, do not exhibit excessive flooding, and operate reliably.

V. Performance Demonstration – 30 points

The vessel must demonstrate its cargo-moving efficiency by carrying eight 5-lb bags (40,000 scale tons) over a specified open water course of approximately 200', or 4 scale nautical miles. The performance relative to all other entries will be evaluated on its Required Freight Rate (RFR - a factor representing how much the operator must charge per ton-mile to break even). The vessel with the lowest rate will receive the full 30 points; the others will receive lower scores proportionate to their ranking.

Upon arrival at the competition site and after the judges' examination of their entry, each team must load the 8 bags without exceeding the load line or stability limits. Once loaded, each cargo ship will perform a timed run consisting of getting underway from a wharf, running a triangular course around buoys, and maneuvering back alongside the wharf. The goal will be to have the lowest freight rate of all the competitors, which is determined by the following formula:

- $Freight\ Rate = (Length + Time\ to\ run\ course\ in\ seconds) / (Cargo\ Carried\ x\ Distance)$
- *Where: Length = Overall vessel length in inches*
- *Cargo Carried = total number of pounds of cargo*
- *Distance = Scale distance of course (considered to be 4.0 scale nautical miles)*

Example: A 60" long model with a full load of 8 bags (40 lbs) completes the course in 2½ minutes. The calculation is then

$$RFR = (60'' - 150\ seconds) / (40\ lbs\ x\ 4.0\ miles) = 210 / 160 = 1.31$$

GOOD LUCK TO YOUR TEAM!