



Maryland Engineering Challenges 2017 Cargo Ship Challenge High School Level – Grades 9 to 12

Supported By:
Technology and Engineering Educators Association of Maryland

Engineer Contact:
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Important Dates

Coaches' Information Session

⇒ **Thursday, November 17, 2016** **4:00 p.m. to 7:00 p.m.**

This "drop-in" event is designed for adults interested in coaching a team to stop by and chat with engineers. Find out if a particular Challenge is a good fit for your students. The Information Session is not required and there is no cost. Registration is strongly encouraged. Contact James at jkeffer@thebmi.org

Coaches' Hands-On Workshop

⇒ **Saturday, January 28, 2017** **Beginning at 10:00 a.m.**

Learn the practical aspects of this Challenge. Work with engineers to explore design and constructions aspects of the project. Especially helpful for first-time Coaches and/or those with little previous engineering knowledge. Registration required prior to 1/25/17. Contact James at jkeffer@thebmi.org

Registration and Written Report Due

⇒ **April 14, 2017** **Prior to 4:00 p.m.**

In order to be a registered team, each team must have their adult Coach do the following:

- Register online at <http://survey.constantcontact.com/survey/a07edfbzc0fiv44fzek/start>
- AND submit the team's Written Report as a HARD COPY to the Baltimore Museum of Industry
- AND pay a \$5 Coach's Fee, details at <https://48278.blackbaudhosting.com/48278/MEC-Coach-Fee>

Cargo Ship Competition

⇒ **April 23, 2017** **Beginning at 12:00 p.m.**

Full details about the Challenge will be emailed to Coaches after the registration deadline.

Questions about Challenge specifications or judging should be sent to the Engineer Contact:

Paul Wiedorn Paul_Wiedorn@hcpss.org

A sample report from this challenge is available to help teams overcome any barriers to entry they may have.

Other questions?

James Keffer jkeffer@thebmi.org

THE CHALLENGE

A local Baltimore company would like 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 is 600 feet long and the minimum depth in any port is 40 feet. As part of your solution you should build a 1" to 10'0" scale, radio controlled model to be tested in the inner harbor.

CRITERIA

The competition involves five main components: a written report submitted two weeks prior to the actual competition, an oral report on the day of the competition, the actual design and construction of the entry, the reliability of the entry, and the demonstrated performance. Basic requirements for the reports and guidance for preparing for the competition are given in the High School "Guide to Entry", which should be read in connection with these details which are specific to the cargo ship challenge.

I. Written Report (includes drawings) (30 points)

Provide a written report in the required format (see "High School 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? How was the hull shape chosen? What testing was performed? What were the results? Be sure and include working drawings of the propulsion system and wiring diagrams and a final lines drawing of your hull.

II. Oral Report (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 5 minutes of questioning by the judges.

III. Design and Fabrication (30 points)

Design a mono-hull ship to meet the requirements and construct a 1" to 10'0" (1:120) scale model with the hull constructed of any rigid material. The model should be robust enough to withstand minor collisions and must have enough watertight integrity to protect the cargo, the propulsion plant and the radio controls. The model should conform to the constraints listed below.

IV. Reliability (5 bonus points)

Up to 5 bonus points will be awarded by the judges to vessels that are consistently ready to test when called, need few repairs, and operate reliably.

V. Performance Demonstration (30 Points)

The performance of the vessel will be based on Required Freight Rate (how much the operator must charge per ton-mile to break even). The vessel with the lowest Required Freight Rate (RFR) will be declared the performance winner.

Once loaded, each entry will perform a timed run consisting of getting underway from a wharf, running a specified course around buoys, and maneuvering back alongside the wharf. This simplified formula for Required Freight Rate will be used:

$$\text{RFR} = (L+T) / (CD)$$

Where:

L = Length of Vessel

T = Time to run course in seconds

C = Pounds of Cargo carried

D = Scale Distance of course (considered to be 4 scale miles).

Example: 50" Long model with a full load of 40 pounds around course in 3 minutes

$$\text{RFR} = (50+180)/(40 \times 4) = 230/160 = \$1.44 \text{ per ton-mile}$$

CONSTRAINTS

- A motor, reduction gear, and speed control will be obtained by using the whole or parts from one 3/8-inch cordless drill that uses 12 or 18 volts and costs no more than \$75. Be prepared to show your receipt.
- If teams are having trouble finding a propeller of the size they need, one or two propellers can be custom produced for each team. The teams need to specify the number of propellers, the pitch, the diameter, the hub diameter (default value 20% of diameter), the number of blades, and the Blade Area Ratio. Unless otherwise requested, propellers will be sized for a 13/64-inch shaft. Expect a one month lead time on all propellers. If your propeller diameter is less than 2.8 inches, there are propellers readily available for purchase.
- The battery that came with your drill, or any other battery of up to 18 volts, may be used.
- A standard multi-channel radio control unit functioning in the R/C band must be used, capable of controlling at least forward/off/reverse, and the rudder.
- The overall length of the model, including all appendages, may not exceed 60 inches.
- The navigational draft may not exceed 4 inches. That is to say, no part of the vessel (propeller, rudder, etc.) may extend more than 4 inches into the water.
- The depth of the hull (keel to deck edge), measured everywhere along the length, must be at least 8 inches.
- The vessel must be provided with a collision bulkhead at least 10% of the overall length aft of the bow. No cargo may be loaded forward of this bulkhead. A bulkhead must also be provided between the cargo and the propulsion plant. All cargo must be carried inside of the hull.
- The vessel must have a deckhouse that rises at least 5 inches above the gunwales (top of the hull sides). This deckhouse should be removable to provide access to the engine compartment for repairs and inspection.

- While there is no need to make a model of an actual ship, credit will be given for adding details that make your vessel look like it might actually be able to put to sea.
- Paint the vessel for ease of identification. The quality of workmanship and finish is a factor in the judging. The design draft (waterline at full load) must be marked on the hull.
- 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 reasonably resistant to water intrusion during testing.
- The vessel should be designed to carry 40 pounds of sugar in ten 4-lbs. bags or eight 5-lbs. bags. The bags may be encased in plastic wrap but must be filled with sugar. Sand or other materials are not acceptable.
- The vessel must have adequate stability when fully loaded.
 - The vessel may be inclined to show a meta-centric height (GM) of $> \frac{3}{4}$ 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.

GOOD LUCK TO YOUR TEAM!