



Maryland Engineering Challenges™

2019

Cargo Ship Guide

Supported By: Technology and Engineering Education Association of Maryland

Level: High School—Grades 9 to 12

Important Dates:

Registration, Coach's Fee, and Written Report Due by Friday, April 5th, 2019, prior to 4:00 PM.

See important information below about registration, payment of Coach's fee, and reports.

Competition Date: Sunday, April 14, 2019, starting at 12:00 noon.

Important Information:

All Cargo Ship activities: Baltimore Museum of Industry, 1415 Key Highway, Baltimore, MD 21230

For more information on Cargo Ship engineering requirements, written reports, or judging criteria, please contact Paul Wiedorn at Paul.Wiedorn@hcpss.org. For assistance in setting up propulsion and control systems or obtaining propellers contact Douglas Griggs (dbdbgriggs@gmail.com). A sample report from this challenge is available to help teams overcome any barriers to entry that they may have.

For registration information or general questions about the Maryland Engineering Challenges, contact James at jkeffer@thebmi.org. Final details about the competition event will be sent to registered Coaches after the registration deadline. Please note: this registration form is for adult Coaches of participating teams only.

To register a team, adult Coaches should go to:

<http://survey.constantcontact.com/survey/a07efo0c75qjlnxjrqr/start>

There is a \$5 PER COACH registration fee, which should be paid at:

<https://48278.blackbaudhosting.com/48278/MEC-Coach-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 prior to 4:00 PM on Friday, April 5th, 2019. No emailed or faxed reports can be accepted by BMI.

NOTE TO EXPERIENCED MENTORS AND PARTICIPANTS

The last few years we have been using electric hand drills to power Cargo Ships. The advantage was that the power plant is commonly available and comes with its own reduction gear and connection to the propeller shaft. After using drills for a couple of years we have found that they rotate too slowly and the high pitch propeller needed to convert their power into speed is not readily available. This past year we experimented with using an alternative power source and it will be the required power source for this year.

In place of the drill you will use a Kelvin.com, stock number 850962 motor.

Here are some suggestions for using the Kelvin Motor in place of the drill:

The specified Kelvin motor is suitable for direct drive of the propeller shaft. A commercial speed control (such as the Goolsky WP-1060-RTR Waterproof Brushed 2S-3S 60A ESC for 1/10 Tamiya Traxxas Redcat HSP HPI RC Car) can be used, connected to any battery. Speed controls intended for radio control cars are usually suitable for marine use, as they provide forward and reverse operation. Airplane speed controls are generally not usable since they only operate in one direction.

There are commercially available running gear that you can purchase, or you can design your own. The propeller shaft could be any reasonable size and length to suit your design, but it should use a stuffing tube with some internal space for packing compound (*e.g.* Vaseline) to provide a watertight seal. Your design needs to keep the shaft in place radially, and needs to provide something for the shaft to thrust against to keep the shaft from moving forward while the ship is going forward, and some way to keep the shaft from backing out of the stuffing tube as you go in reverse.

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

- The model must be powered by a Kelvin.com, stock number 850962 motor.
- 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. A radio controlled speed control may be used.
- 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 their original packaging of ten 4-lbs. bags or eight 5-lbs. bags. The original packaging 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.

Last updated 25 September 2018

GOOD LUCK TO YOUR TEAM!