



TOWERS

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Prior to the competition, teams will design and build a Tower meeting requirements specified in these rules to achieve the highest structural efficiency.

A TEAM OF UP TO: 2 **IMPOUND:** NO **EYE PROTECTION:** B **EVENT TIME:** 6 minutes

2. **EVENT PARAMETERS:**

- a. Each team is allowed to enter only one Tower, built prior to the competition.
- b. All participants must properly wear eye protection at all times. Participants without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows. Participants without eye protection will not be allowed to compete and be placed in Tier 4.
- c. The Event Supervisor will provide the Test Apparatus described in Section 5.

3. **CONSTRUCTION PARAMETERS:**

- a. The Tower must be a single structure, with no separate or detachable pieces, constructed of wood and bonded by adhesive. No other materials are permitted.
 - i. Wood is defined as the hard-fibrous substance making up the greater part of the stems, branches, trunks, and roots of trees beneath the bark. Wood does NOT include: bark, particleboard, wood composites, bamboo or grasses, paper, commercial plywood, members formed of sawdust and adhesive. Wood may never be painted, color enhanced, or have preprinted/paper labels affixed. Ink barcodes or markings from the construction process may be left on wood.
 - ii. There are no limits on the cross-sectional sizes of individual pieces of wood. Wood may be laminated without restriction by the team.
 - iii. Adhesive is defined as a substance used to join two or more materials together. Any commercially available adhesive may be used. Adhesives include, but are not limited to: glue, cement, cyanoacrylate, epoxy, hot melt, polyurethane and super glues. Adhesive tapes are not allowed.
- b. The Tower must span a 20 cm x 20 cm opening on a Test Base (5.a.) and may be placed on the Test Base surface in any configuration such that the loading chain is suspended within 2.5 cm of the center of the opening in the Test Base. Bonus Points (6.c.) can be obtained by designing the Tower to span a 29-cm diameter circle, centered on the 20 cm x 20 cm opening of the Test Base.
- c. The Tower must support the Loading Block (5.b.i.) a minimum of 50.0 cm (Division B) or 60.0 cm (Division C) above the Test Base. There is no maximum Tower height.
- d. The portion of the Tower more than 25.0 cm (Division B) or 20.0 cm (Division C) above the Test Base must pass through an 8.0 cm diameter opening or hole (5.f.).
- e. The loading point on the Tower must be constructed to permit placement of the Loading Block (5.b.i.) and suspended chain (5.b.iii) on and through the Tower, to support the bucket (5.c.).
- f. The Tower must be constructed such that only the Loading Block (5.b.i.) supports the chain and bucket.
- g. The Tower may not be braced against any edge of the Test Base (5.a.) for lateral support at any time.
- h. No portion of the Tower is allowed to extend below the top surface of the Test Base (5.a.) prior to testing.
- i. Students must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

4. **COMPETITION:**

- a. **Check-In**

- i. The team will measure the Tower height using provided materials so the event supervisor can determine if it meets or exceeds the minimum Tower height (3.c.) in cm to the nearest 0.1 cm.
- ii. The team will verify the size restriction (3.d) by passing an 8-cm diameter circular ring gauge freely over the section of the Tower and measuring to the point where the ring rests. The ring may not be forced over any tight spots. If the ring is not level when in the resting position, the measurement will be to the high point of the ring. The ring will be removed before testing.
- iii. The team will place their Tower on the scale so the event supervisor can determine the mass, in grams to the nearest 0.01 g.
- iv. The team must submit their Estimated Load Scored (6.b.) to be used as a tie breaker (6.e.).
- v. No alterations, substitutions, or repairs may be made to the Tower after check-in for competition.
- vi. The event supervisor will verify that the combined mass of the Loading Block Assembly, bucket and sand, is at least 15,100 grams but no more than 15,200 grams prior to testing.

- b. **Testing**

- i. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
- ii. Participants will have 6 minutes to setup and test their Tower to maximum load or failure.
- iii. The participants must place the Tower on the Test Base and assemble the Loading Block Assembly and bucket as required to load the Tower. If necessary, participants may disassemble the Loading Block Assembly. The bucket must be mounted to allow enough clearance above the floor for the bucket to tilt or the Tower to deflect.



TOWERS (CONT.)

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- iv. The event supervisor throughout testing (e.g., just prior to loading sand, during loading) will verify that no part of the Tower's span touches or is supported within the 29.0 cm diameter circle for the Tower to qualify for the "Load Scored Bonus".
- v. The participants will be allowed to adjust the Tower until they start loading sand. Once loading of sand has begun, the Tower must not be further adjusted.
- vi. Participants will load the sand into the bucket and be allowed to safely and effectively stabilize the bucket from movement caused by sand loading. Direct contact with the bucket by participants is NOT allowed. Teams choosing to stabilize the bucket must only use the tips of the bucket stabilization sticks (5.e.) to touch the bucket.
- vii. Loading stops immediately when a failure occurs or when time expires. The event supervisor will remove any parts of the Tower in the bucket or any sand added after failure or time expiration.
- viii. Towers that fail before supporting 15,000 g will be scored according to the actual weight supported at time of failure (6.a.), measured to the nearest gram, or best precision available. Failure is defined as the inability of the Tower to carry any additional load, or any part of the load being supported by anything other than the Tower. Incidental contact by the chain/eyebolt with the Tower is not failure.
- ix. At the event supervisor's discretion, more than one Test Apparatus may be used.
- x. Teams who wish to file an appeal must leave their Tower with the event supervisor.
- xi. The supervisor will review with the team the data recorded on their scoresheet.

5. TEST APPARATUS:

- a. The Test Base will be a solid, level surface with the following characteristics:
 - i. be at least 55 cm long x 32 cm wide, with a 20 cm x 20 cm square opening at its center
 - ii. have a smooth, hard, low-friction surface (e.g. hardwood, metal, high-pressure plastic laminate) which is stiff enough that it does not bend noticeably when loaded
 - iii. have a 29-cm circle drawn on the surface, centered on the 20 cm x 20 cm square opening
- b. The Loading Block Assembly must consist of:
 - i. a square Loading Block measuring 5 cm x 5 cm x approximately 2 cm high with a hole no larger than 8 mm drilled in the center of the 5 cm x 5 cm faces for a ¼" threaded eyebolt
 - ii. ¼" threaded eyebolt (1" nominal eye outside diameter), no longer than 3", and a ¼" wing nut
 - iii. a chain and S-hook that are suspended from the Loading Block
- c. An approximately five-gallon plastic bucket with handle and hook to be suspended from the chain.
- d. Sand or other clean, dry free-flowing material (hereafter "sand").
- e. Two (2) Bucket Stabilizing Sticks each made from of a piece of ½" dowel approximately 18 inches long with a spring-type door stop screwed into one end. Refer to example on www.soinc.org.
- f. A circular ring gauge with an inside diameter of 8.0 to 8.1 cm, not weighing more than 10 g, that retains its shape and flatness when handled. See the event page at www.soinc.org for designs.

6. SCORING:

- a. Score = [Load Scored (g) + Load Scored Bonus (g)] / Mass of Tower (g). High score wins.
- b. The Load Score is the measured load supported, including the Loading Block Assembly, bucket and sand, but may not exceed 15,000 g. The lowest Load Scored is the mass of the Loading Block Assembly.
- c. Load Scored Bonus: Towers spanning the 29 cm diameter circle receive a 5,000 g bonus. No part of the Tower may touch or be supported within the 29 cm circle throughout testing to earn the Bonus Points.
- d. Towers will be placed in four tiers as follows:
 - i. Tier 1: meeting all the Construction Parameters and no Competition Violations.
 - ii. Tier 2: with one or more Competition Violations.
 - iii. Tier 3: with Construction Violations or both Competition and Construction Violations.
 - iv. Tier 4: unable to be loaded for any reason (e.g., cannot accommodate Loading Block, or failure to wear eye protection), and will be ranked: 1st - Lowest mass; 2nd - Greatest height.
- e. Ties are broken as follows: 1. Estimated Load Scored (4.a.iv.) closest to, without exceeding, the actual Load Scored (6.b.), 2. Lowest Tower mass
- f. Example score calculations:
 - i. Tower 1: mass = 15.12 g, load supported = 12,134 g, Bonus = NO; Score = 802.5
 - ii. Tower 2: mass = 15.12 g, load supported = 12,134 g, Bonus = YES; Score = 1,133.2
 - iii. Tower 3: mass = 12.32 g, load supported = 13,213 g, Bonus = NO; Score = 1,072.5
 - iv. Tower 4: mass = 12.32 g, load supported = 13,213 g, Bonus = YES; Score = 1,478.3

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries the Towers Video and Problem Solving/Technology CD; other resources are on the event page at soinc.org.

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