

See General Rules, Eye Protection & other Policies on [www.soinc.org](http://www.soinc.org) as they apply to every event.

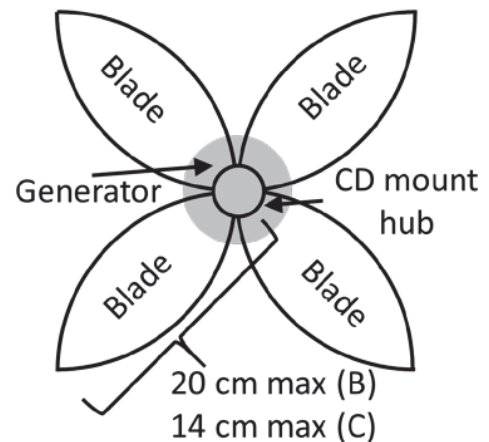
1. **DESCRIPTION:** Teams will build a blade assembly that consists of any kind of propeller/pinwheel/rotor attached to a compact disc (CD), which will be used to capture wind power. Students will also be tested on their knowledge regarding alternative energy.

**A TEAM OF UP TO:** 2    **EYE PROTECTION:** B    **IMPOUND:** Yes    **APPROX. TIME:** 50 minutes

2. **EVENT PARAMETERS:**

- a. All reference materials to be used during Part II of the competition must be secured in a 3-ring binder so that regardless of orientation none can fall out. Materials such as pencils, pens, protractors, rulers, nonprogrammable calculators, and any other similar tools may also be used during the set up and activity.
- b. The blade assembly must be placed in a box (assembly and box must be labeled with the team name and competition #) and must be impounded. Tools and supplies do not need to be impounded.
- c. Competitors must wear eye protection during Part I. Teams without proper eye protection must be immediately informed and given an opportunity to obtain eye protection if time allows.
- d. The supervisor must provide the testing materials listed below (see the event page on [www.soinc.org](http://www.soinc.org) for a sample setup), which must be the same for all teams:
  - i. One or two 20" multispeed box fan(s) to be used as the wind source
  - ii. Support stand(s) that allow for vertical and horizontal adjustments of the blade assembly
  - iii. Motor/generator(s) mounted to the support stand(s)
  - iv. Load resistor(s) between 5 and 7.5 ohms wired in parallel with the motor/generator that must have the same value for all teams
  - v. Device(s) to measure voltage across the load resistor
- e. The motor/generator must be equipped with an adapter to accommodate a standard 12.0 cm CD or if the motor/generator is from a CD player, it must be removed from the CD player and mounted on a support stand. Note: adjacent diagrams do not show CD to scale.

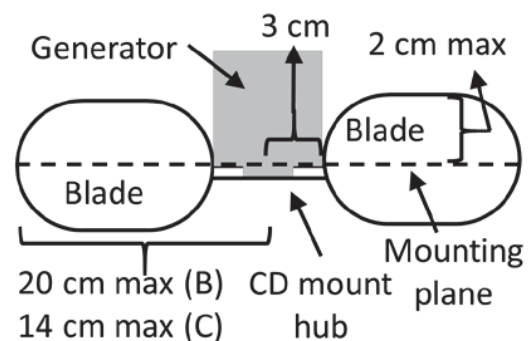
Example Assembly Front View



3. **CONSTRUCTION:**

- a. Each team may bring one pre-constructed blade assembly attached to a 12.0 cm CD.
- b. The CD must fit on the mount found in a standard CD player. Modification of the CD is not allowed (except to affix the blades).
- c. When mounted, no part of the blade assembly may have a radial distance from the center of the axis of rotation of more than 20 cm (Div B) / 14 cm (Div C).
- d. The blade assembly must be made of only nonmetallic substance(s).
- e. Commercial kits or third party designs may be used, but must have at least one functional modification, defined as a modification such that the lack of it will result in the assembly working differently or not working.
- f. When mounted, no part of the blade assembly may extend behind the mounting plane of the CD for a radial distance of 3 cm. Beyond a radial distance of 3 cm the blade assembly must not extend more than 2 cm behind the mounting plane of the CD. This is to ensure clearance with the motor/generator and support stand. There is no limit on how far forward the blade assembly may extend.
- g. Competitors must be able to answer questions regarding the design, construction, and operation of the blade assembly per the Building Policy found on [www.soinc.org](http://www.soinc.org).

Example Assembly Side View



4. **THE COMPETITION:**

Part I: Device Testing

- a. The blade assembly must be tested once with the fan at a high wind speed and once at a low wind speed. There may be one or two test stations. If there are two, one must be used for all high wind speed tests and

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the other for all low wind speed tests. The load resistors at each station are allowed to be different, but must be consistent for all teams.

- b. The fan(s) must be mounted in a fixed position with the bottom of the grill at least 15 cm above the table.
- c. Event supervisors must verify that the blade assembly meets event rules before a team's testing period begins. This verification may take place during impound. Teams must be notified as soon as possible if a blade assembly does not meet specifications.
- d. Teams may modify the blade assembly during the impound period, their Part I testing periods, or their Part II written test period, if time is available. Modifications are not allowed during the 30-second measurement periods.
- e. Teams must complete set-up and device testing in no more than 3 minutes per wind speed. At 2 minutes, the event supervisor must give the team a warning.
- f. Once the 3-minute testing period begins, teams must attach their blade assembly to the motor/generator mount and position it. The final position of the blade assembly must be no closer than 5 cm from the front grill of the fan. At the request of the students, the event supervisor must turn on or off the fan during the set-up to allow the students to better position the blade assembly relative to the fan. No voltage measurements are allowed during setup. Teams are allowed to adjust, modify, start and stop the blade assembly rotation during the testing period.
- g. No later than 2.5 minutes into the testing period, with the fan already on and the blade assembly rotating, the students must tell the event supervisor to begin a 30 second measurement period. The team must not touch the blade assembly during the measurement period.
- h. The event supervisor must record the maximum voltage that occurs during the 30-second measurement period. Voltage measurement devices that have 'peak hold' or 'max hold' functions are recommended.

## Part II: Written Test

- i. Teams must be given a set amount of time (20-30 minutes is suggested) to complete a written test.
- j. Questions may be multiple choice, true-false, completion, or calculation problems.
- k. Unless otherwise requested, answers must be provided in metric units with appropriate significant figures.
- l. The test must consist of at least 25 questions (five each from the following five areas):
  - i. Wind power rotor/fan blade design (e.g., types of designs, pros/cons of designs, ways to improve designs, sources of loss)
  - ii. Power generator general questions (e.g., generator design for wind, nuclear, coal, gas, solar, or hydroelectric power plants)
  - iii. Power storage questions (e.g., how is the power stored during charging and how is it used during discharge, concepts relating to methods of power storage)
  - iv. Power transmission questions (e.g., ways electricity is transmitted, how power is lost in transmission, ways to reduce power loss)
  - v. Historical wind power designs (e.g., types of windmills, usage, design pros/cons)

## 5. **SCORING:**

- a. The Power Score of the blade assembly is calculated using the equation below:  

$$\text{Power Score} = (\text{Max Voltage})^2 / \text{load resistance}$$
- b. The Part I Score is the sum of the low speed Power Score + high speed Power Score.
- c. If the blade assembly stops turning for a period of 10 or more seconds during the 30 second measurement period, has any pieces that detach from the assembly, or the team exceeds the 3 minute time limit, the Power Score at that fan speed must be multiplied by 0.8 when calculating the Part I Score.
- d. The Part II written test must be worth a total of 50 points.
- e. A team's Final Score must be determined as follows (with highest score winning):  

$$\text{Final Score} = 50 \times (\text{Part I Score} / \text{Highest Part I Score of all teams}) + \text{Part II Score} - \text{Penalties}$$
- f. A 15-point penalty must be applied to the final score for any construction violation or if the team misses impound.
- g. The Part I Score must be zero if a team is disqualified for unsafe operation, modifying a CD, or fails to bring a blade assembly. Teams must still be allowed to compete in Part II.
- h. Ties must be broken by: 1<sup>st</sup> the highest high-speed voltage; 2<sup>nd</sup> the highest low speed voltage.

**Recommended Resources:** All reference and training resources including the **Wind Power DVD** are available on the Official Science Olympiad Store or Website at <http://www.soinc.org>