Kleinschmidt Windstorm Challenge 2019
Competition Guidebook

The Kleinschmidt Windstorm Challenge, hosted by the University of Maine, asks teams of students to design and construct a floating platform for a scale model wind turbine, and then deliver a presentation to a panel of expert judges. The event is designed for student teams with a diverse range of experience. We encourage all middle school (teams of 10 students or less) and high school (teams of 4 students or less) students to participate.

For questions, contact: Meghan Collins - (207) 581-2117 - mc@maine.edu

Competition Date

The Kleinschmidt Windstorm Challenge 2019 will be held in the UMaine Advanced Structures and Composites Center Alfond W^2 Ocean Engineering Lab on **Friday, May 17, 2019**. Teams should plan to arrive between 7:45 AM and 8:15 AM and should plan to depart around 2:00 PM. Teams will be emailed directions and parking information the week prior to the competition.

What's the Challenge?

Teams must independently design and construct a floating platform for a 1:100 scale wind turbine, based on a 285 foot tall full-scale 5 MW turbine. This scale would thus be a turbine tower height (to hub and not including blade length) of 33 inches. Designs should maximize stability under various wind and wave conditions. Judges will also score an oral presentation.

While constructing the floating platforms, it is very important for all parties to act safely. The use of any tools and materials should be done with proper knowledge of the tools, personal protective equipment, and adult supervision.

There will be two tracks for Windstorm Challenge: High School Track and Middle School Track. At the end of competition day, the top three teams for both tracks will be announced. Rules and requirements are the same for both tracks.

High School Teams are teams of 4 or less high school students. Members of the top qualifying team will be offered an internship at the University of Maine Advanced Structures and Composites Center, contingent upon their enrollment at UMaine, valued more than $20,000. Note that this award is not a scholarship and is not dispersed to the student a lump sum. Rather, this value is derived from biweekly paychecks assuming 20 hours/week during the academic year and 30-40 hours/week during the summer months throughout a four-year undergraduate career.

Middle School Teams are teams of 10 or less middle school students. These groups will test their platform and provide a presentation, just like high school teams, but they will not be considered for the internship award. An alternative award will be given to the winning team.

Team Resources

Simulated Turbine

Soon after registration, teams will be mailed a basic, model turbine for pre-competition testing to simulate the approximate weights and dimensions of the official test turbine. The simulated turbine is only an approximation of the final test turbine weight. Directions for assembly are mailed with this kit.

Turbine Coupler

In addition to the basic turbine, each team will be provided with a turbine coupler. The coupler will need to be well integrated into each team's platform design, as it is the attachment mechanism for the official test turbine. Failure to include the turbine coupler will result in disqualification.

Moorings

In addition to the required turbine coupler, each team will be provided with three eye hooks that must be integrated into each team's platform design. The eye hooks should be located approximately 120 degrees apart from one another on the platform. The "forward-facing" (*i.e.* facing the direction of the wind and waves) eye hook should be clearly marked with paint or an arrow.

Repair Station

We will have two repair stations available, but teams will be penalized by 10 points for initial use and 5 points for every 5 minutes that they rely on the repair station. Teams who use the repair station will need to provide their team name and name of one team member to the repair station attendants. The attendants will time team usage of the repair station, and points will be deducted from each team's total score accordingly.

IMPORTANT: Please note that the coupler has a specific arrangement in order to work on competition day. The coupler must be attached in such a way that the competition day turbine can screw onto the coupler and must be high quality enough that the attachment can withstand the forces of a wind turbine. If you have concerns about this, please contact Meghan Collins.

University of Maine Media Release Agreement

We request that participants fill out a Media Release Agreement form (parent or guardian signature is required if the visitor is under 18.) Organizers will provide each team's advisor with the document.

Travel Support

A small number of travel stipends are available for schools participating in the Kleinschmidt Windstorm Challenge. Please contact Meghan Collins to indicate your interest in a travel stipend. Requests will be granted based on availability of funds and will be prioritized for schools with the largest number of participants and greatest distance.

Competition Requirements

Platforms submitted for competition must meet the following requirements:

- The cost of all materials used in the platform should sum to less than $100; this is left to the advisor to conduct a 'straight faced' test with respect to cost of materials used.

- Teams are encouraged to use recycled or donated items in their designs. By using recycled or donated items, teams can reduce their actual out of pocket cost.

- **Completed platforms (excluding the turbine and anchors) must be less than 30 in. wide, 30 in. long, and 40 in. deep. Platforms must weigh less than 30 pounds.**
- **Each platform must embed the three provided eye hooks in their platform where technicians will attach mooring lines. Each floating platform will be anchored to the side or bottom of the basin using provided mooring lines. As indicated above, if important for testing, the "forward facing," eye hook must be clearly marked.**
- Students will not be permitted to enter the basin and platforms will be placed/anchored by UMaine Composites Center staff.

Testing Procedure

Each team member must know and identify with their team name prior to arriving at the University on competition day.

Teams are encouraged to contact their local community pools for unofficial, pre-competition day testing. Many communities or local University of Maine-system campuses have pools.

Competition Day

Official testing of the platforms will be performed at the UMaine Advanced Structures and Composites Center by trained staff. Each team will couple their platform with the official test turbine.

1. Mandatory Pre-Testing

Prior to being permitted to test platforms in the Alfond W^2 Ocean Engineering Lab, each team must successfully pass two levels of pre-screening. When teams pass both tests, they will be given a "Ticket to Test."

A. Floating Test: Each platform will be placed in a 6,000-gallon immersion tank to determine whether or not the platform floats

B. Inclination Test: During the Floating Test, competition staff will affix a simulated competition day turbine to each platform and then push the turbine approximately 15 degrees from normal to ensure platforms are stable enough to survive waves.

If a team should fail pre-testing, they will be allowed to use a limited amount of supplies from the "Repair Station." However, points will be deducted for use of the repair station as described above.

2. Preparing for Competition Testing

Each team should plan to be in position for Competition Testing at least 20 minutes prior to their scheduled testing period. There will be two lines for testing, *Line A* and *Line B*. Advisors will be given a schedule ahead of the competition date indicating when their teams are testing and which Line they should be in.

Two teams will test during same time slot throughout the entire day, as was done in prior years. There will be two entry points to the basin, resulting in Line A and Line B. This has not changed from 2017.

A. Teams must have their Ticket to Test as described above.

B. Teams must be in their proper line at least 20 minutes before their scheduled testing time.

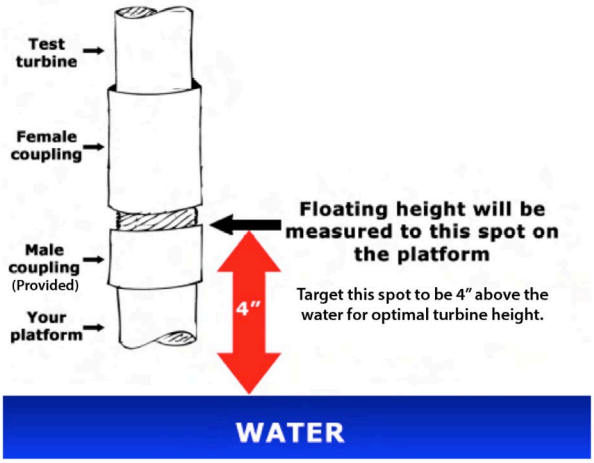
C. Competition Testing for teams who are not prepared as outlined above are not guaranteed.

3. Competition Testing

The diagram below shows how the simulated test turbine AND competition day official test turbine will connect to your floating platform.

A wave generator will be used to create waves of approximately 6 inches (scaling to a 50 foot wave on a full-scale platform), and a wind machine will be used to simulate wind forces on the turbine blades by producing wind speeds on the order of 5 to 6 mph (55 mph equivalent at full-scale).

Each floating platform will be subjected to continuous wave generation for two minutes, during which the maximum acceleration values will be recorded. The overall platform stability will be determined by the magnitude of the nacelle's acceleration. This is explained in greater detail, below.



As shown in the graphic to the right, the male coupling that we provide that each team will embed in their platforms should sit approximately 4" above the water line for optimal turbine height.

Separate from the physical testing, each team will give a three to five-minute oral presentation describing their platform design choices and selling points. This will give teams the chance to defend the feasibility of their design and reflect on their participation in the challenge.

Judging Criteria Explained

The teams with the most stable platform and most professional presentation will win the Kleinschmidt Windstorm Challenge. Stability will be weighted 75% and the Oral Presentation will be weighted 25% in terms of total team score out of 100 points. Use of the repair station will result in points being deducted as explained above, and any platform that sinks will receive 0 points for the stability portion of the score.

Stability: The grading metric for stability of the competing platform will be based upon the magnitude of the nacelle's acceleration. Maximum points: 75.

Global Maximum Acceleration will be based on the peak acceleration magnitude at this location over the entire duration of the test:

$$\text{Global Maximum Acceleration, } A = \max\left[\sqrt{A_x(t)^2 + A_y(t)^2 + A_z(t)^2}\right]$$

where

$$A_x = \text{instantaneous x} - \text{directional acceleration at time } t$$
$$A_y = \text{instantaneous y} - \text{directional acceleration at time } t$$
$$A_z = \text{instantaneous z} - \text{directional acceleration at time } t$$

The platform with the **LOWEST** Global Maximum Acceleration will rank highest in the technical section, with the remaining platforms ranked in ascending order according to their acceleration magnitude.

Stability will be determined using an accelerometer fixed to the nacelle of the competition day turbine. We use an Axivity AX3 3-axis logging accelerometer (http://axivity.com/product/ax3) to record acceleration data.

Note: Each platform will be held in place by mooring lines connecting to the provided eyehooks as described in platform requirements above.

Oral Presentation: Eight minutes are allotted for each team's setup, presentation, and Q&A. Actual presentations should be about four minutes in length. Most teams opt to use PowerPoint (or similar) software to provide a presentation to the panel of judges. Maximum points: 25.

Projectors at UMaine use a standard VGA cable, so please plan to bring whatever adapter necessary to ensure compatibility with your student's computers. While Wi-Fi should be available, students should be prepared to present to judges without internet connectivity.

A sample planning tool for 8 minute presentation slots:

- 2 minutes: Team sets up laptop, plugs into projector screen.
- 4 minutes: Team gives presentation.
- 2 minutes: Brief Q&A with judges, as needed.
- 2 minutes: Teams exit, judges use final two minutes to finish scoring before the next team enters.

Assessment of Oral Presentations:

- Quality of presentation will be based on the following criteria:
    - The team arrives on time and finishes on time (within the 8 minute time slot). This includes setup, troubleshooting, giving the presentation, and an opportunity for Q&A.
    - The team's design process from start to finish is conveyed.
    - Challenges encountered by the team and their solutions are addressed; the presentation demonstrates problem solving and teamwork.
    - The presentation shows an understanding of platform design including advantages and disadvantages.
    - All team members participate in the presentation.

- Judges will use the criteria identified above as well as the table below to award points:

Criteria Met	Points Awarded
6 / 6	25
4 - 5 / 6	15-24
2 - 3 / 6	5-14
0 – 1 / 6	0-4

Pre-Competition Day Checklist for Success

- ☐ The provided male coupling is correctly attached to my platform; the test day competition turbine can easily screw on and off this coupling on competition day.
- ☐ Three provided eye hooks are correctly attached to my platform; the test day technicians will easily be able to clip mooring lines onto my platform on competition day.
- ☐ My platform is designed within the constraints listed in the guidebook.
- ☐ My platform floats and will be able to withstand the mandatory "Pre-Test," on competition day
- ☐ I know that we can use a repair station if something goes wrong with our platform on competition day, but I understand that my team will lose points if we need to.
- ☐ My parent or guardian has authorized the photo release form and I returned it to my advisor.

Competition Day Checklist for Success

- ☐ Upon arrival, after checking in, my team will head to the pre-testing area, complete pre-testing, and get our "Ticket to Test."
- ☐ My team will be in the designated competition testing area at least 20 minutes before we're scheduled to compete.
- ☐ My team will get a photograph with our platform design before testing.
- ☐ We understand that we will give our presentation either in Room 137, which is located in the lobby, or in the W2 Conference Room, which is located near where we test. The final schedule will tell us which room to present in, and we will be near the presentation room at least 20 minutes before we're scheduled to present.

Alfond W² Ocean Engineering Lab Overview

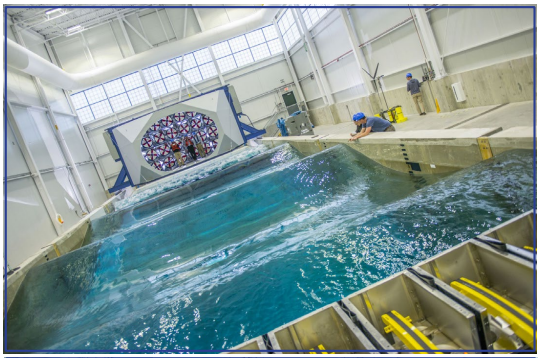
Rev. 2.7

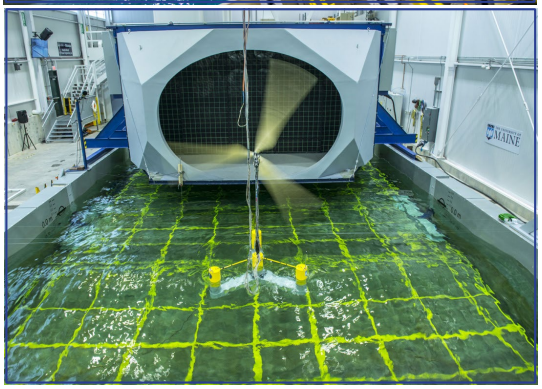
Alfond W² Ocean Engineering Lab

Combined wind-wave simulation basin with tow carriage and variable depth floor

The Alfond W² Ocean Engineering Lab at the Univeristy of Maine Advanced Structures and Composites Center is a unique facility equipped with a high-performance rotatable wind machine over a multidirectional wave basin. The facility will accurately simulate towing tests, variable water depths, and scaled wind and wave conditions that represent some of the worst storms possible anywhere on Earth.

This world-class ocean engineering facility will assist businesses in developing products for the marine economy while offering hands-on training for students. These products include improved boat and ship hulls; ocean energy devices such as wind, wave and tidal energy; aquaculture technology; oil and gas structures; waterfront infrastructure such as bridges, piers, docks and port facilities; as well as systems to protect coastal cities from effects of erosion and extreme storms.





UMaine W² Capabilities

Basin Dimensions:
- 30 m × 9 m (98 x 30 ft)
- Working depth of floor 0 to 4.5 m (0-15 ft)

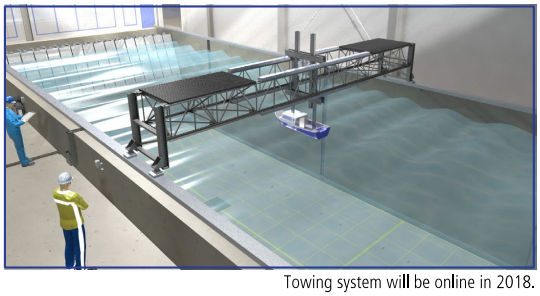
Wind Machine:
- Dimensions: 5 m x 3.5 m (16 x 12 ft) across flow x height
- Wind speed: 0 to 12 m/s (0-27 mph)
- Flow direction relative to waves: 0 to 180°

16-paddle Wavemaker:
- Max height: 0.6 m (24 in) at T = 1.65 sec, 0.8 m (30 in) at T = 2.3 sec
- Regular waves and all standard spectra in addition to custom random seas
- Wave angles in excess of +/- 60 degrees relative to the basin center line

Tow Carriage (Available in 2018):
- Max speed: 5 m/s (16.4 ft/s)
- Max towed model dimensions: 4 m x 4 m x 1 m length x beam x draft (13 x 13 x 3 ft)

Above & Below Water Motion Tracking

Advanced model fabrication capabilities
- Rapid modular 3D printing 0.6 m x 0.6 m x 0.9 m (2 x 2 x 3 ft)
- 3D CNC Water Jet 2.0 m x 4.0 m x 0.1 m (6.5 x 13 x 0.5 ft)
- 5-axis CNC Router 1.2 m x 1.5 m x 3 m (4 x 5 x 10 ft)



Towing system will be online in 2018.

For more information, contact: Dr. Anthony Viselli, Manager, Offshore Model Testing and Structural Design
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