COLLEGIATE
WIND COMPETITION

COLLEGIATE WIND COMPETITION 2026

Regional Rules

August 25, 2025

Preface

This competition will be governed by this official rules document, which establishes the requirements for the competition. The contest organizers reserve the right to modify this official rules document if necessary and will publicly post any such notifications as well as notify registered participants. In case of a discrepancy with other competition materials or communication, this document takes precedence.

Date	Modification

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1 Introduction

1.1 Overview

The Collegiate Wind Competition (CWC), also referred to as the "competition," invites interdisciplinary teams of undergraduate students from a variety of academic disciplines to solve complex wind energy challenges. The intent of this competition is to offer students direct industry experience, valuable exposure to wind energy career pathways, and greater knowledge of wind energy's potential to contribute to America's energy mix.

Each year, the competition introduces a new challenge and set of activities that reflect real-world research questions, giving students the opportunity to apply and develop the skills needed for careers in wind and other renewable energy industries. While past competitions have been held at the national level, this rules document outlines a regional model of the competition, in which the event is hosted by a participating institution and makes use of its facilities, including an on-site wind tunnel.

The CWC requires participants to compete simultaneously in two contests:

- **Turbine Design and Testing Contest:** Teams design, build, and present a unique, wind-driven power system, then test their turbine in a wind tunnel at a regional event.

- **Project Development and Engagement Contest:** Team research key siting and development factors and create a site plan and financial analysis for a hypothetical wind farm, while also conducting industry and community engagement activities.

It is expected that each team will participate in both contests.

1.2 Background

The competition enhances students' readiness for careers in renewable energy by providing real-world, hands-on experience. Specifically, the CWC aims to prepare students from a range of disciplines—including science, engineering, education, project management, business and sales—to enter the energy workforce with the skills and knowledge needed to succeed.

1.3 Competition Overview

The competition will be held in two stages: the Qualification Stage and Event Stage. Finalists will have the opportunity to compete for trophies; no monetary prizes will be awarded.

- **Qualification Stage:** Teams will submit an application outlining their motivations for participating and demonstrating their ability to successfully meet the competition's requirements.
- **Event Stage:** Selected teams will participate in a regional competition. Submissions will be evaluated during culminating regional events, where teams will present to industry experts, test the model turbines in a wind tunnel, and engage in networking opportunities with professionals in the field. Each regional event will be hosted by a participating institution, typically near the end of the spring semester.

2 Submission Requirements and Review Process

The CWC encompasses all activities leading up to and including the final event. At the final event, teams present their results from both required contests. To participate, teams must also submit their written reports by the deadlines established by the regional hosts.

Throughout the competition year, teams are encouraged to seek mentorship and sponsorship opportunities early, as these relationships can help strengthen their technical designs and project development strategies. Faculty advisors, graduate student advisors, and invited industry mentors may offer guidance, provide feedback on design concepts, and support students in validating the technical rigor and feasibility of their work. **However, only undergraduate student team members are permitted to take an active role in any competition-related activities.**

Nonstudent team members, including faculty advisors, graduate advisors, mentors and sponsors, play a supportive, educational role. Their responsibility is to help create an environment that fosters student learning and success. **Faculty advisors may advise, coach, and provide input on skill development, but must not directly contribute to turbine construction or decision-making.**[1] **During in-person competition events, only undergraduate students may actively work on the turbine or make competition-related decisions. Any nonstudent found doing so will be asked to leave the competition premises.**

2.1 Submissions

The details of required submissions for each challenge are provided in the following sections. Refer to Appendix A for submission requirements and scoring, format requirements, and submission instructions. Teams are strongly encouraged to submit early to minimize technical difficulties. Required submissions are as follows:

Competition Application:

- Application Form

Upload to Competition Organizers prior to the event (due date to be determined and shared based on the region and time frame of each region's final event):

- Tech Inspection Prior to Competition documentation
- Turbine Design Report
- Project Development and Engagement Report

[1] Any student who was an undergraduate student member of the team during the competition year may continue to act in that role throughout the competition year.

Bring to final regional event:

- Turbine design and testing presentation
- Project development and engagement presentation
- Test turbine and load system
- Poster (optional)
- Digital or physical display of social media campaigns (optional)

2.2 How Award Winners Will Be Determined

The competition organizers assign judges to independently score the applicable content of each submission. The judges comprise federal and nonfederal subject matter experts. Judges will review submissions according to the evaluation criteria. The competition organizers will tally the scores using the scoring criteria. Overall winners will be determined by rank-based scoring, with the lowest-numbered rank beginning at one (1) going to the team with the highest score in each contest. Ties will be broken by total score. This is shown in Table 1:

Table 1. How Award Winners Are Determined

Award	Criteria*
First Place	The team that earns the lowest sum of the ranks in the Turbine Design and Testing Contest and the Project Development and Engagement Contest. Ties will be broken by total score.
Second Place	The team that earns the second-lowest sum of the ranks in the Turbine Design and Testing Contest and the Project Development and Engagement Contest. Ties will be broken by total score.
Third Place	The team that earns the third-lowest sum of the ranks in the Turbine Design and Testing Contest and the Project Development and Engagement Contest. Ties will be broken by total score.
Individual Contest Awards	The team that earns the lowest individual contest rank in the Turbine Design and Testing Contest and the Project Development and Engagement Contest.
Bonus Challenge Awards (optional)	People's choice award for each of the Best Poster and Best Social Media Bonus Challenges.

*Details on earning points for each award are included in the following sections.

3 Qualification Stage Requirements

Each team is required to designate a student leader who will take primary responsibility for developing and submitting the application, in collaboration with the team's faculty advisor. Application submissions will be reviewed and scored using the evaluation criteria listed in the Table 2 scoring rubric.

Table 2. Application Rubric

Criteria	Description	Maximum Points
Introduction (up to 1,250 characters)	Provide a brief overview of your team, your motivation for participating in the competition, and your commitment to engaging in CWC educational activities (e.g., webinars, subject matter expert talks, tool overviews).	10%
Educational Objectives and Integration (up to 2,000 characters)	Describe how the team will integrate the competition into academic experiences. This may include coursework, research projects, independent study, scholarships, or other programs that support competition-related work. If formal integration isn't possible, explain alternative strategies such as remote learning, industry partnerships, mentorships, or student clubs.	35%
Organization and Project Planning **(up to 2,000 characters)**	Provide a detailed plan for how the team will organize and execute competition activities. Address: • How the team will manage project tasks, including overcoming scheduling and collaboration challenges • Institutional departments engaged in supporting the team and how they will contribute • Student recruitment strategies, including outreach beyond engineering disciplines • Planned team structure, meeting frequency, and key milestones • Plans for building and leveraging industry connections	30%
Institutional Support and Fundraising (up to 1,250 characters)	Explain how the team will secure resources needed for participation, such as travel funding, software, materials, and project management tools.	25%

4 Event Stage Contest Descriptions

The CWC includes two contests, (1) Turbine Design and Testing and (2) Project Development and Engagement, and two optional bonus challenges, (1) a poster and (2) social media outreach. The following sections (Sections 4.1 through 4.2) are organized by contest and explain the submission requirements for each.

All formatting requirements are detailed in Appendix A. Where relevant, each contest section lists page limits and number of supplemental images that will be accepted for each submission. Anything beyond the limits will not be considered during scoring.

4.1 Turbine Design and Testing Contests

The Turbine Design and Testing Contest comprises of three basic components: design report, presentation, and test sequence for the constructed turbine.

4.1.1 Turbine Design Report

As a part of the wind turbine design submission, teams will be required to develop a 15-page (maximum) technical design report and a 10-minute presentation during the final event.

The technical design report explains the wind turbine concept development process from an engineering perspective. The report must detail the turbine to be tested in the competition wind tunnel and should detail the complete design process as well as the installation approach that will be demonstrated in the competition wind tunnel.

At a minimum, the report must include the following sections:

- **A cover sheet.** Begin the report with a one-page cover sheet that includes the team affiliation and contact information. It should indicate the team roles/hierarchy and approximately how many students, faculty, and others (e.g., sponsors, volunteers, and family members) are involved in the project.
- **A table of contents.**
- **An executive summary.** The executive summary discusses components from all sections of the report and includes a short, high-level description of the team project. Teams should use their judgment when deciding how long to make the executive summary; however, one page is often sufficient.
- **The technical design.** Teams should provide enough detail for an engineering review of the baseline and operating properties of the wind turbine and its subsystems, including mechanical loading requirements, operational limits, control algorithms, and software. At a minimum, the following topics should be included **<u>in the prescribed order</u>**:
    - A description of the design objective and how the design components support this objective.
    - If applicable, a clear and concise list of similar submissions to prior competitions from the affiliated school, and why. This list should demonstrate an understanding of how previous research and design decisions have shaped the team's approach. If a team's school did not compete in a previous year's competition, they should

address whether information in previous year's winning design reports influenced their own design and if so, how.[2]

- A description of the basic static rotor and turbine performance of the design over a range of operational parameters. This could include plots of C_p versus λ, C_p versus λ versus pitch, rotor and/or generator power versus wind (aerodynamic or electrical power curves), generator speed versus wind speed, and so forth. The plots should be chosen to describe the operational concepts underlying your turbine design.
- A basic engineering diagram of all mechanical systems and an analysis of the expected mechanical loads and associated safety factors within the design, both for operational and parked conditions.
- An electrical, one-line diagram of the overall system and electrical analysis comprising the generator model, power electronics (e.g., canonical model and one-line diagram), electrical load model, and operating voltage, including how the team plans to regulate voltage.
- A control model analysis of the operational modes (i.e., the control states diagram and a description of primary operational modes) and how the control software was tested and validated.
- A description of the assembly of the wind turbine's subsystems. Where relevant, include how a distributed team environment was managed.
- An assembly and commissioning checklist that can be followed during installation of the turbine in the wind tunnel to ensure it is functioning as expected before starting the scoring portion of the test. Note that this list should extend beyond a simple step-by-step assembly, and students should think carefully about how to ensure proper functionality of their wind turbine before commencing testing.
- The results of laboratory and/or field testing of turbine prototypes.

This report should be no more than 15 pages in length, including images, and formatted according to the specifications provided in Appendix A. Cover pages, tables of contents, and bibliographies or references do not count against the page limits, but executive summaries, and appendices do. Pages submitted beyond this limit will not be reviewed.

4.1.2 Presentation and Question-and-Answer Session

In addition to the written report, each team will present their design to a panel of reviewers followed by a question-and-answer (Q&A) session to answer any remaining questions that the reviewers may have from the written report. This presentation should begin with a brief overview that conveys the most important details of the technical design and clearly communicates the team's approach to design and development.

Presenters must be student team members and should showcase their wind turbine prototype using posters, charts, PowerPoint slides, or other visual aids to engage the reviewers and/or help clarify any questions the reviewers may have after reading the written report. Presentations are limited to 10 minutes, which will be followed by a 15-minute Q&A period with the competition

[2] Past winning reports can be found at: https://www.energy.gov/eere/collegiatewindcompetition/past-collegiate-wind-competitions.

reviewers. Additional attendees are allowed in the Q&A session as observers at the discretion of the student lead.

The reviewers will use the content from this project overview and Q&A period to make final adjustments to the technical design report score. Answers provided during the Q&A session will also be evaluated to gauge the depth of students' technical understanding of wind turbine design.

Table 3. Scoring Rubric for the Technical Design Competition

Description	Possible Points
Turbine Design Report	
Concise, readable, and descriptive with logical flow and clear communication	15
Sections are in the prescribed order and all sections include relevant content	15
Comprehensive design objective description for test turbine, float, and moorings	15
Clear and concise enumeration of what elements of their technical design are the same as last year, why,[a] and what has changed from the previous year	15
Thoroughness and validity of the static performance analysis	15
Quality and clarity of the mechanical loads analysis and associated safety factors of structures	15
Clear description of the electrical system design choices and analysis of its performance	15
Quality and clarity of the engineering diagrams including mechanical and electrical drawings	15
Quality of controls analysis, including states and algorithms, and how the software was tested and validated	15
Documentation of assembly including how things go together, stay together, and are adjusted in tunnel testing	15
Completeness of commissioning checklist with logical flow	15
Quality of laboratory and/or field-testing process	15
Subtotal	**180**
Presentation and Q&A	
The presentation is delivered clearly and professionally	15
Presentation to reviewers tells an effective story as it relates to the team's decision-making process	15
Demonstrated understanding of technical design during Q&A session	20
Subtotal	**50**
Total	**230**

[a] It is recommended that teams whose schools did not compete in the previous year address whether and how previous years' reports from other teams have influenced their current design decisions.

4.1.3 Turbine Testing Contest

Part of the design process is to construct, test and iterate on the design. As such, a prototype will be constructed; the final result of the iteration process is a turbine that will be tested at a regional site in a wind tunnel. As part of the turbine design and testing contest, teams will be required to conduct a technical inspection prior to testing at the regional competition.

4.1.3.1 Technical Inspection Prior to Competition

To test at the final event, teams will be required to pass a technical inspection. To make this process as smooth as possible, student teams must go through a practice inspection prior to the competition, working with someone who is qualified to interpret the rules and understand the competition as well as possible. Ideally, this person should be someone other than the faculty advisor to provide a fresh perspective at the end of the year. As part of the tech inspection process, each team must:

- Submit a short write-up summarizing the qualifications of the inspector, certify that both the student team and inspector have read Appendix B and include a signed tech inspection sheet that includes all of the inspection points listed in Appendix B.
- Detail any deficiencies and plans on how to remedy those deficiencies before competition.

The purpose of the inspection is to identify areas that would not pass technical inspection at the competition, thus giving the teams time to correct those deficiencies before the competition begins. This deliverable will be scored on a pass/fail basis and is worth 50 points. However, this deliverable is required before teams are allowed to complete the competition tech inspection and test in the wind tunnel. Failure to turn it in will result in ineligibility for competition tech inspection or tunnel time until it has been completed and turned in.

New for this year, student teams will perform technical inspections on each other at the competition. They will utilize this rules document and the worksheet in Appendix B as a guide. Judges will be available to answer questions, oversee the process, and spot-check results. Additional teams will arbitrate, should a conflict occur. As such, teams are encouraged to read the rules carefully and take the Tech Inspection Prior to Competition milestone seriously. The milestone can be used to prepare for their turbine at the competition and for the process of shared tech inspection.

4.1.4 Wind Turbine Performance Testing

Testing provides teams with the opportunity to demonstrate their wind turbine's performance through objective tasks; the outcomes help determine if they succeeded in developing a durable, safe, high-performing machine. Performance is a strong indicator of a wind turbine's ability to compete successfully in the marketplace.

Each turbine, along with its corresponding load system, will be tested in the competition wind tunnel. The contest will include the following tasks over a range of wind speeds: power curve performance task, safety task, and durability task. Table 4 shows the possible points for each of these tasks. This section describes the requirements of the individual tasks in which the wind turbine is expected to perform, the parameters of the testing conditions, and details on scoring algorithms and point allocations between individual tasks.

Students will use their load for all tasks. Although the prescribed testing order will be the same for each team, the exact amount of time at each set point could vary. Thus, teams are expected to design their turbines to sense the local conditions within the tunnel and react accordingly for each task.

Table 4. Scoring Summary for Wind Turbine Performance Testing

Description	Possible Points
Technical inspection prior to competition	50
Power curve performance task	50
Control of rated power task	50
Safety task	50
Durability task	50
Total	**200**

4.1.4.1 Power Curve Performance Task

The objective of this task is to test each wind turbine over a range of wind speeds to determine a power curve. It is meant to be a direct comparison of power performance between turbines, which is one factor by which real wind turbines are evaluated.

Each turbine will be tested at integer wind speeds between 5 and 10 m/s (inclusive) for a duration of 30 seconds or less, with the stated intent of obtaining a "stable" power reading. Stability of the power reading will be at the discretion of the judge(s) and will be based on whether or not the judge can read a steady value from the device used to record power.

A total score for this task will be calculated according to Table 5 by multiplying each power measurement in watts in 1-m/s wind speed intervals from 5 to 10 m/s by the factor given. If power is not stable, the score for the bin will be zero.

Table 5. Weighting for the Power Curve Performance Task

Wind Speed (m/s)	Factor
5	0.7
6	0.8
7	0.8
8	0.7
9	0.4
10	0.3

4.1.4.2 Control of Rated Power Task

Wind turbines must withstand high winds without damaging their mechanical or electrical components. Because wind power is proportional to the cube of wind speed, the energy available in the wind quickly becomes very high as wind speed increases. To control rising mechanical and electrical loads, turbines must be able to limit their rotational speed and output power in these high-wind conditions.

In this task, each turbine will be subjected to one wind speed bin chosen by the competition organizers between 11 m/s and 13 m/s (inclusive) and turbine performance in that bin will be compared to the performance in the 10-m/s bin. The turbines are expected to keep the power at or below the power determined at 10 m/s and to keep the power at the same level as is determined at 10 m/s.

Scores for power will be calculated according to the following:

$$r_p \equiv \frac{measured\ power\ in\ bin\ of\ interest}{measured\ power\ at\ 10\ m/s}$$

$$Bin\ Score = 50\,\frac{\left[\tanh\left(-20 * \left|r_p - 1\right| + \pi\right) + 1\right]}{\left[\tanh\left(\pi\right) + 1\right]}$$

In Figure 1, a ratio, r_p, of 1.000 represents perfect power control at the same value that was measured in the 10-m/s bin. The weighting shown will be multiplied by 50 for the selected bin to obtain a score.

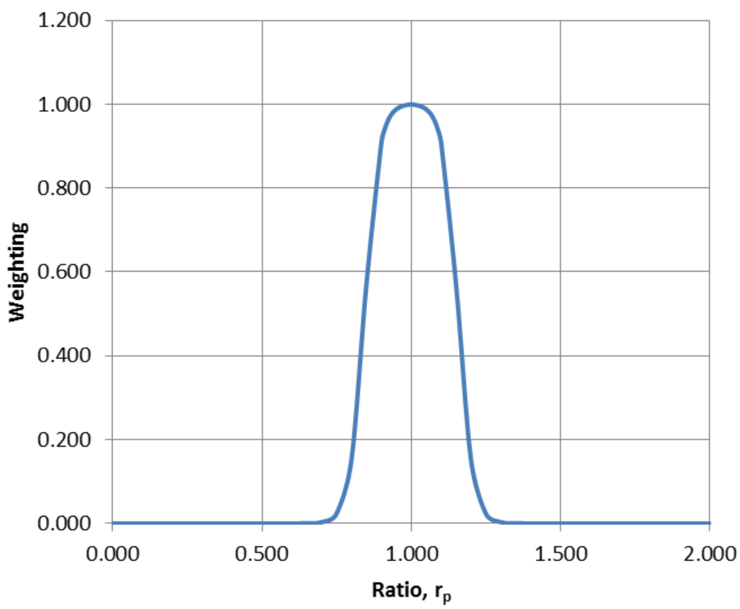

Figure *1. Score weighting based on power ratio for control of rated power task*

4.1.4.3 Safety Task

Safety is of the utmost importance to wind turbine designers and manufacturers. To be certified, turbines must be able to safely shut down rapidly and with a fail-safe shutdown capability. Turbines must shut down when disconnected from the grid, as well as manually upon command. Each team may choose to address these shutdown scenarios with one or two systems or mechanisms.

In this task, the wind turbine will be required to safely shut down[3] at two different times during the testing period at any wind speed, up to the maximum continuous operational wind speed specified in Appendix A. For each turbine, the shutdown process will be initiated once "on command" and separately by disconnecting the load from the point of common coupling.

The safety task is scored on a pass/fail basis in two parts. If the wind turbine achieves a successful shutdown upon manual initiation, the team will receive 15 points. If it automatically restarts, the team will receive an additional 10 points. If the team must manually restart the turbine, they will receive zero points for the restart. If the turbine achieves a successful shutdown when disconnected from the load system, the team will receive an additional 15 points. If the turbine automatically restarts when reconnected, the team will receive an additional 10 points. If the team must manually restart the turbine, they will receive zero points for the restart.

The wind turbine must also be able to restart at any wind speed above 5 m/s. If the turbine fails to successfully restart, the team may work on their electronics to manually restart their turbine, resulting in a zero score for the restart portion of the task. The manual restart, if necessary, will occur with the tunnel running between 6 and 10 m/s.

4.1.4.4 Durability Task

Wind turbines are expected to perform over the long term and will be subjected to a wide variety of weather conditions. Producing power effectively and over the course of the turbine's lifetime are desirable design qualities.

In this task, each turbine will be subjected to a higher wind speed than will be encountered during the power performance testing. The wind speed for this point will be determined by tunnel capabilities but will be on the order of 13 m/s. Turbines that both stay online (produce positive power) and survive will be given 50 points. This task is scored on a pass/fail basis.

Turbine Design Basis

4.1.5 Wind Turbine and Load Design Requirements

Each team will design and build a prototype wind turbine. It must be designed to withstand continuous winds of up to 13 m/s at sea level. Each prototype must also be designed for testing inside the regional wind tunnels.

4.1.6 Physical Design Constraints Within the Tunnel

At zero yaw angle, the entire wind turbine must fit within the volume specified and shown in Figure 2. The turbine must have the following maximum geometry:

- All turbines must fit through the tunnel door. Door size will be released as part of the regional location announcements.

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[3] For the purposes of this task, "shutdown" is defined as rpm dropping by approximately 10% of the rpm during power performance testing as determined by the judge(s). This reduction in rpm must occur within roughly 10 seconds and remain below the limit indefinitely until the shutdown condition is removed. In order to alleviate the risk of subjectivity, students are encouraged to design their turbine to slow substantially or even stop completely.

- Rotor and non-rotor turbine parts must be contained in a 45×45×45-cm cube. This cube may be shifted fore or aft of the tower centerline when the turbine is aligned with the flow.
- Non-rotor turbine parts must be contained in a 15.8-cm-diameter cylinder extending from the turbine/float interface plane to the bottom of the previously mentioned cube. This cylinder should be centered on the mounting flange. For this purpose, these parts will be defined as anything that does not capture energy from the moving air, including the mounting flange.
- The rotor midplane must be within 10 cm of the center of the competition tunnel used in your region. This target height will be published during the academic year.

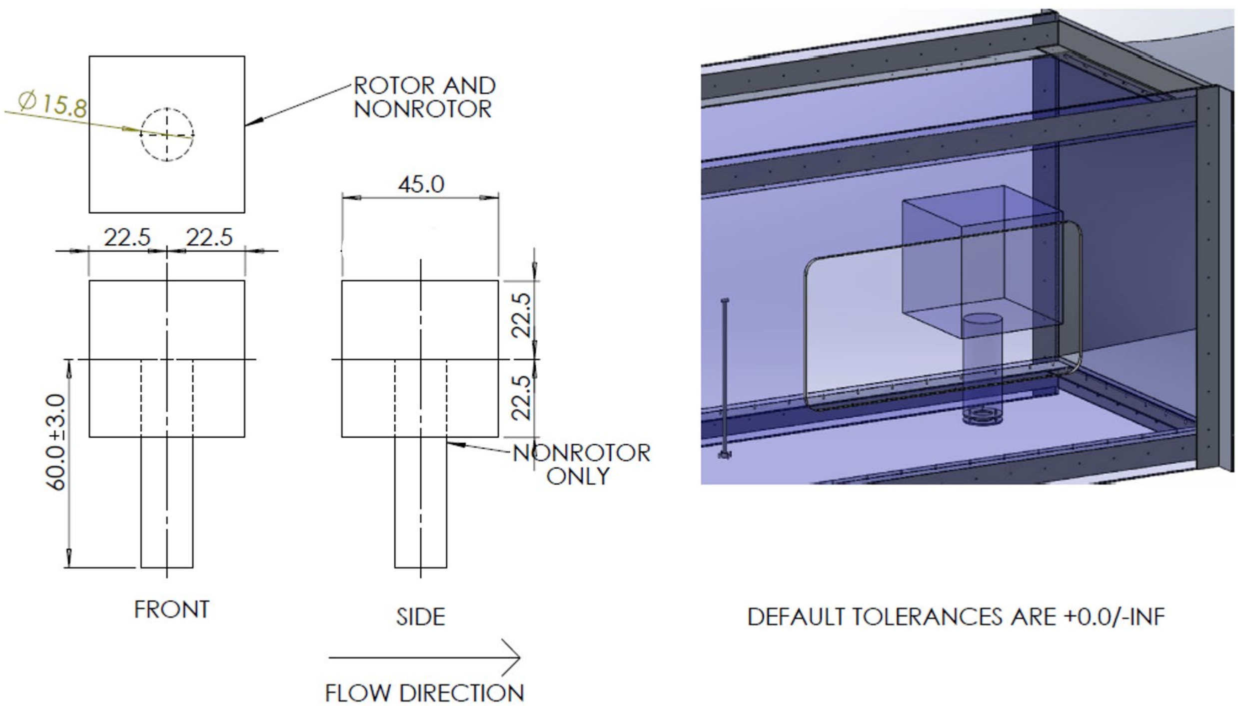

Figure *2*. Allowable wind turbine volume. Dimensions are in centimeters*.*

Image created by Jason Roadman, NREL

- It is suggested that the electrical cable between the wind turbine and electrical components outside the tunnel (e.g., point of common coupling [PCC], load) be unbroken (without connectors) inside the tunnel. Any connections on this cable should be outside the tunnel, for example, at the turbine controller or load box, or at the PCC. Cables must pass through the hole in the center of the mounting flange, as shown in Figure 3, on their way to the PCC and the team-supplied electrical enclosures.
- If the wind turbine experiences excessive movement, sliding, twisting, or tilting, the tunnel will be immediately stopped, and no further points will be awarded.
- The tunnel used in each region will have a base flange with mounting studs (see Figure 3).
- The turbine base flange must be constructed of material no thicker than 16.1 mm. It should be designed and constructed with adequate tolerances to smoothly fit over three studs, where it will be secured to the tunnel base flange/float with wingnuts. Figure 3 shows the bolt pattern and sizing of this flange and the dimension for the hole in this base flange to allow cables and connectors to pass through.

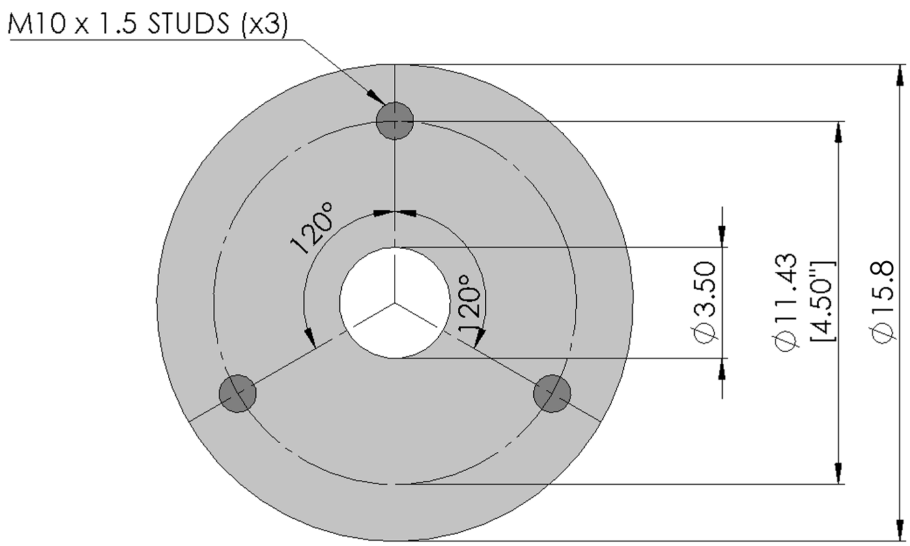

Figure *3.* **Base flange dimensions for wind turbine attachment to the tunnel** *and cable pass-through (dimensions in centimeters).*

Image created by Jason Roadman, NREL

4.1.7 Physical Design Constraints Outside the Tunnel

There are no size specifications for components located outside the tunnel. However, the size of such components must be within practical limits. These components must be incorporated into closed enclosures that are firesafe and meet or exceed a National Electrical Manufacturers Association (NEMA) Type 1 rating. All components must be electrically insulated from the enclosures. Teams should also pay careful attention to the standards for ventilating these enclosures, which include:

- NEMA Type 1 characteristics. Enclosures are constructed for indoor use to provide a degree of protection for personnel against access to hazardous parts as well as a degree of protection for the equipment inside the enclosure against ingress of solid foreign objects (should not be able to insert fingers or tools through the enclosure when closed). It is important that the intent of the NEMA Type 1 rating be preserved once all connectors and/or pass-through devices are installed.
- All cable pass-throughs in enclosures must use cable glands or other similar devices that provide both strain and chafe protection.
- Tape is not considered adequate sealing of penetrations or pass-throughs in the enclosure.
- All electrical cables external of enclosures must be in cable form (no individual strands except ground, if desired) and include connectors that are quickly connectable. No more than three cables including ground are permitted between the wind turbine and its external electronics. Ground may be an individual strand if not included in the other two cables. **Individual strands or bare wires will result in disqualification from testing until remedied**. Twisting two or more strands together is permissible if the resulting multistrand cable has a connector on the end. Multistrand cables are encouraged when used in a logical way. For example, there could be one cable for all power wires and one for all control wires.

- Neither screw terminals nor spade- or fork-type lugs are acceptable connectors outside of enclosures. Each cable connection from the wind turbine to the enclosure should employ a quick-attach connector. Ideally, teams should be able to connect all their cables in a few seconds.
- All electrical components must be mechanically secured to the enclosure.

4.1.8 Electrical Requirements

Figure 4 illustrates the electrical configuration of the prototype turbine, competition data acquisition system, and PCC, which is the point of electrical measurement for the competition.

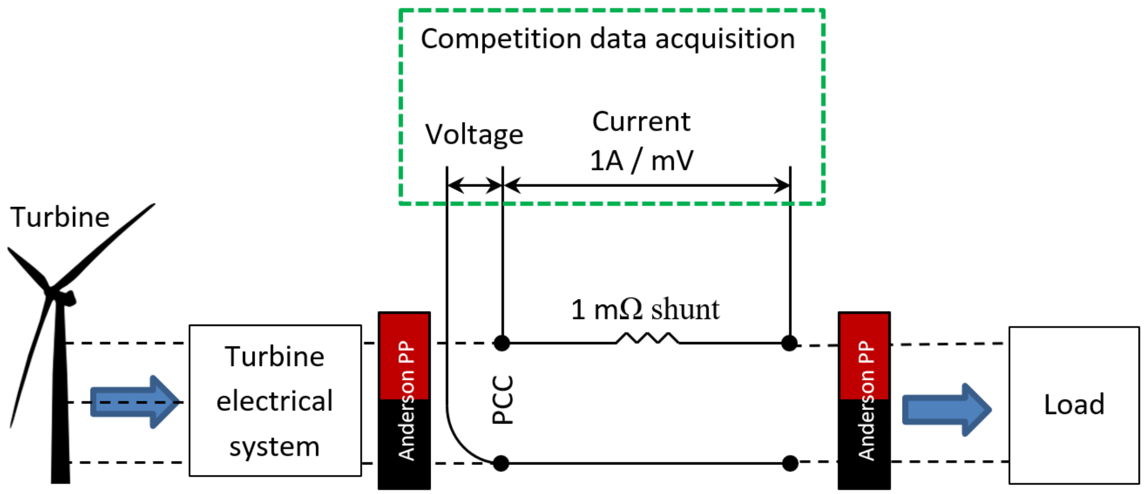

Figure *4.* Load, turbine, and point of common coupling arrangement.

Image created by Lee Jay Fingersh, NREL

Electrical requirements are as follows:

- Voltage must be DC at the PCC and is required to be at or below 48 V at all times.
- The turbine baseplate must be made from conductive material such that the studs may be used to tie the system ground to earth ground either through the mounting plate or with a competition-provided alligator clip. To prevent overvoltage of the tunnel data acquisition system, turbine electrical system ground(s) must be electrically tied to the studs with a 100-kΩ or lower resistance connection.
- Teams are expected to choose their own generator and design their own wind turbine and load system. Off-the-shelf components may be used, but the turbine and load system should be designed and built by the teams. All components must meet safety requirements, including but not limited to proper wiring practices, shielding of hazardous components, and proper heat rejection.
- The turbine electronics must be in separate enclosure(s) from the load to clearly differentiate load and control during inspection by reviewers. The wind turbine nacelle may also contain turbine electronics, if desired.

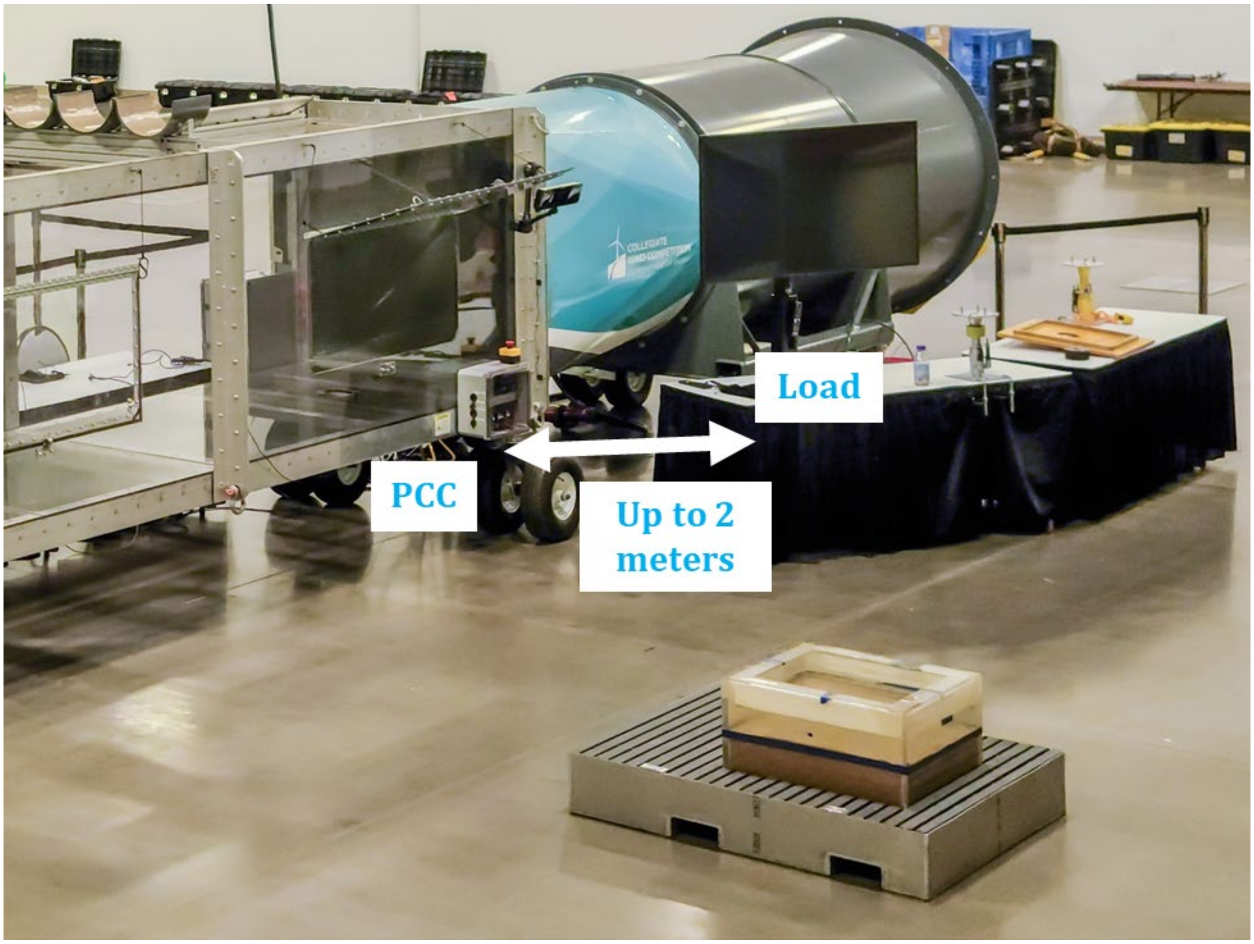

Figure *5.* **Point of common coupling and student load display table layout.**

Image created by Lee Jay Fingersh, NREL

4.1.9 Specifications for the Wind Turbine Side of the PCC

Specifications for the wind turbine side of the PCC are as follows:

- Energy storage elements, such as capacitors and/or inductors, may be used in both the turbine and load, but not for bulk energy storage on the turbine side of the PCC.
- No batteries of any type, capacitors, or combinations of capacitors with nameplate voltage and capacitance ratings corresponding to over 10 J of energy storage ($E = ½CV^2$) will be permitted.
- Turbine components may draw from the load but must register a zero state of charge at the beginning of the test.
- Wired connections between the wind turbine and load external to the PCC are allowed but must be optically isolated. The amount of power transferred through this connection must only be enough to facilitate communication, and that power may only be used for that purpose, not to power any other turbine systems. No appreciable energy may be transferred to the turbine around the PCC, even if that energy is not in the form of electrical energy.

4.1.10 Specifications for the Load Side of the PCC

Specifications for the load side of the PCC are as follows:

- Bulk energy storage is allowed in the load, provided it is used in a safe and reliable manner.
- To run the load, 120-VAC will be provided, if desired. However, new for this year, the load and control boxes designed by the team may input only low-voltage DC power (+/- 48 V and below) from an ***external*** commercial power supply plugged into the 120-VAC source. **No voltages above 48 V to case ground may be present inside any box the teams build.** [4,5] The external power supply can take any form as long as it is enclosed to at least the NEMA 1 standard and it provides only DC power to the load box. Teams should note, this explicitly requires that no exposed AC contacts exist on the power supply.

Figure *6*. Examples of acceptable power supply types that meet the enclosure rules

Image created by Lee Jay Fingersh, NREL

4.1.11 Interfacing With the Competition Data Acquisition System

Protocols for interfacing with the competition data acquisition system are as follows:

- There will be a table provided near the tunnel door to hold these electronics enclosures. Figure 7 shows a typical arrangement. Rough distances are shown in the figure, but teams should provide adequate lengths of wire to run from the PCC to accommodate their desired enclosure arrangement on the table. The arrangement at each regional event may be slightly different and will be detailed in the one-page write-up about each tunnel.

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[4] Occupational Safety and Health Standards: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9880&p_table=STANDARDS
[5] https://www.mouser.com/pdfdocs/Why-are-Power-Designs-Moving-to-48V.pdf

- To interface with the PCC, wires should be terminated with Anderson Powerpole, PP15-45, or a compatible connector (a red and a black for positive and negative, respectively). See Figure 7 for correct polarity. Incorrect polarity must be corrected before testing and wire color must match the connector housing color. Colored electrical tape on each end of the wire will be considered sufficient color matching if the wire insulation is not colored (e.g., black).
- In addition to the Powerpoles on the PCC, all polarized connectors that have colored housings must match between sides to ensure correct polarity and to follow good design practice. For wires that do not connect to the PCC, color is not required to match housing color (for example, if all the wires to a given connector are the same color).
- Teams are expected to provide their own Powerpole connectors of an appropriate size—15 A, 30 A, or 45 A—that are specified to handle wire gauges from 10–20 American wire gauge (AWG). Each team can choose the wire size it wants to use in this range as long as the appropriate current-carrying capacities are considered. All three pin sizes fit into the same housing (PP15-45). Note that locking clips are available to lock Powerpole connectors to each other so that they do not come apart. It is recommended that the teams use them where applicable in their turbine designs or tower base connections. These clips are not usable at the PCC connection.

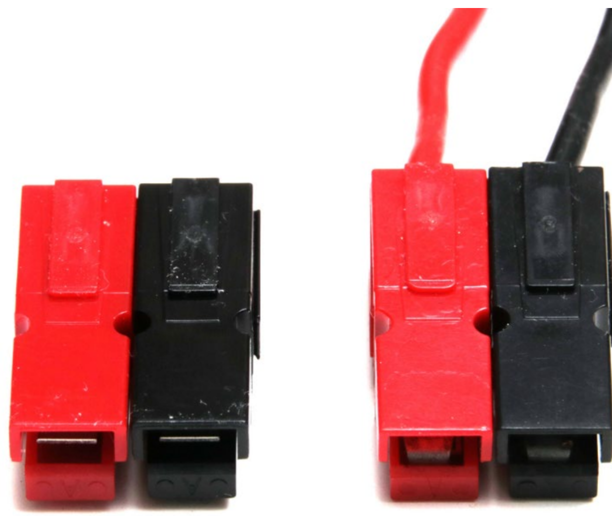


Figure 7. Proper Powerpole polarity to match tunnel wiring.

Image created by Lee Jay Fingersh, NREL

- Wind turbines must be capable of shutting down on command through an emergency-stop button as well as when electrically disconnected from the load. Specifically:
    - The emergency-stop button will be located outside the tunnel. Button location will be specified in the regional tunnel one-pager. It operates in the same manner as an industrial emergency-stop chain. That is, it is closed during normal wind turbine operation and opened during an emergency stop when the button is pressed.
        - In industry, emergency-stop systems use this switch logic so that multiple switches in and around a piece of hardware, such as a wind turbine, can be wired in series in a single wiring loop. In this configuration, opening any switch or a fault in the wiring will cause the whole circuit to open. Thus, an entire emergency-stop system can be monitored by a single channel input. If the

switches used the opposite logic, the system would have to monitor each switch individually.

- The emergency-stop connector (and wiring) is rated for 3 A, thus it is intended to carry a low-current control signal—not high-current power. To ensure that only control signals are fed through the emergency stop, a 10-kΩ resistor is placed in series with the emergency-stop button.
    - Each team must provide a cable containing two wires (no smaller than 28 AWG) that reaches the PCC, as labeled in Figure 8. This cable must be terminated, prior to the competition, with a standard JST RCY female receptacle housing connector (Manuf. P/N: SYR-02T housing using SYM-001T-P0.6(N) for the corresponding male pin contacts) (Figure 8).

Figure *8.* Team-provided connection to the manual shutdown interface

Image created by Lee Jay Fingersh, NREL

- The competition switch will be terminated with the corresponding polarity JST RCY male plug (Manuf. P/N: SYP-02T-1 plug housing using SYF-001T-P0.6[LF][SN] socket contacts) (Figure 9).

Figure *9.* Competition-provided connector for manual shutdown interface.

Image created by Lee Jay Fingersh, NREL

4.1.12 Safety Specifications

Competition staff will perform a safety inspection of the wind turbine and load system, which must be passed before they can be installed in the wind tunnel. Appendix B contains a draft version of the safety and inspection sheet used to evaluate the turbines. The turbine safety officials make the final and official determination about whether a turbine may be tested in the wind tunnel.

4.1.13 Reuse of Existing Equipment

Teams will not be allowed to reuse designs, components, or code designed and/or built during past competition cycles. The teams will be required to certify, during tech inspection, that no previous team-created designs, components, or code were reused. Evolution in design is encouraged as long as the final design is substantially created by this year's team.

Teams are permitted to reuse commercial off-the-shelf components but not if they have been significantly modified previously. Modifications rendering a component ineligible include welding additional components to it, altering the way it behaves from the commercial off-the-shelf state, machining it to a different shape, or similar activities. Simple assembly activities like drilling holes or soldering to a board do not make a component ineligible for reuse. Basic, building-block components, such as screws, nuts, resistors, and capacitors, may be reused.

This rule only applies to the hardware and software components used inside and at the wind tunnels during testing. During design, development and testing, teams may reuse equipment such as meters, dynamometers, wind tunnels, and tools, plus any design, development, or analysis codes created in past years.

Violation of any part of this rule will render the team ineligible to receive a score in the wind turbine testing portion of the competition.

4.1.14 Turbine Testing Specifications

Testing provides teams with the opportunity to demonstrate their wind turbine's performance through objective tasks, and the testing outcomes help determine if they have succeeded in developing a durable, safe, high-performing machine. The following additional constraints apply to testing the turbine:

- The installation and commissioning process will be timed. Teams will have up to 5 minutes to install turbine and tighten the fasteners on the mounting studs, as well as install all electronics; route their cables and connect all necessary connectors to the PCC, safety system, and external enclosures; complete any final installation steps; and declare that they are ready for commissioning or testing. Once installed, the competition organizers will attach the grounding strap and close the tunnel door. Teams will be allowed an additional 5 minutes to commission their turbine and become ready for testing.
- During the commissioning period, the teams may ask for any wind speed from 5 to 10 m/s and do any work on their turbine or electronics they deem necessary to get their systems operational. Teams may use as much of their 5-minute installation time and/or 5-minute commissioning time as they desire, keeping in mind that exceeding the limit for either period will result in the run automatically becoming a non-scoring practice run. Teams are strongly encouraged to practice assembly and preparation for testing so that they can beat the 5-minute nominal install time easily and without rushing, as rushing can lead to mistakes, damage, or injury.
- Exceeding the voltage limit set in Section 4.1.8 will result in an immediate abort of the testing sequence, with all points gathered retained but no more points earned after the abort. Teams may then attempt to fix the cause of the overvoltage and use their retest, if available.
- Verification of zero energy at the start of the test will be accomplished using the competition data acquisition system to measure zero current flow into the load at the PCC. Any questionable elements are subject to additional verification of zero energy by the testing team with a multimeter or similar device before the testing begins.

- Only one team’s wind turbine will be tested at a time. The number of team members that may be part of a test is dependent on the region of the event and will be detailed in the regional summary write-up.
- Each team will have 25 minutes of tunnel time to install their turbine, commission it, test it, and uninstall.
- Teams may signal at any time during the test that they would like to stop. In that case, they will retain all points earned to that point. Teams may then turn the remainder of the session into a practice session, but teams must remain cognizant of the time limitations.
- If there are unforeseen delays outside the control of the teams (e.g., a wind tunnel issue or power outage), the time spent rectifying the problem will not be included as part of the team’s allowable minutes. Team members will only be allowed to touch their turbine electronics or controls during commissioning and manually restarting their turbine if they fail to restart after a safety shutdown task. Turbine failure is defined as anything out of the ordinary, such as excessive displacement, cracking, breaking, pieces falling off, smoking, sparking, sinking, or failure to produce an electrical current, and will be cause for immediate stoppage of testing.
- If a team wants to retest their wind turbine for any reason, they may request a single retest during the provided makeup sessions later in the competition. The retest will be a full test, and all scores from the first test will be replaced, regardless of the turbine’s performance in the retest. Teams must confirm their desire to retest with the competition organizers by 5:00 p.m. on the first day of testing. **If the judges do not hear from a team by this time, they reserve the right to cancel a team's makeup slot.**
- Students are encouraged to bring spare components and/or assemblies and design their turbines so that damaged parts or assemblies can be easily replaced. However, it is important to keep in mind that the turbine configuration throughout the entire competition should remain substantially the same as what is documented in the written report. For example, the number of blades, rotor axis, configuration, and operating voltage must remain the same. Teams with questions about any changes or altered turbine components or assemblies are encouraged to raise questions to the competition organizers well ahead of the competition to ensure they are adhering to this requirement.

4.2 Project Development and Engagement Contest

The Project Development and Engagement Contest is a yearlong effort to investigate key aspects of wind farm siting and project development activities through the development of a hypothetical project. This investigation should include assessing wind resource data and performance estimation, factors that affect project economics, setbacks, terrain effects, environmental issues, transportation constraints, transmission design, permitting requirements, turbine technology, and performance variables (e.g., wakes, turbine availability, and site-specific losses). This contest also asks teams to forge connections between competition participants, the wind industry, and the team's local community by hosting engagement activities.

For this contest, teams must assess wind farm development opportunities within the defined project area, which will be identified for each competition region, create a rough development plan and project financials, and organize and run at least two community/industry outreach events. Team members must be prepared to explain their process to reviewers at the competition.

Project Development

The following steps describe the procedure for developing the site plan and preliminary wind farm design and reflect the information needed to complete the submission.

1. Select a specific area within the defined area. Teams should:
    - Be prepared to explain how and why this site was chosen.
    - This site cannot be on an existing wind farm or one that is under development.
    - Include some considerations, such as wind resource, terrain, landowners, access to transmission, transportation access, and environmental and community factors.
2. Develop a preliminary design. This should include:
    - Researching site characteristics and permitting requirements, such as:
        - Wind resource information, terrain, wildlife, and land ownership.
        - Relevant ordinances and regulations.
    - Drafting a preliminary site design, including:
        - Wind turbine type, hub height, rotor diameter, and number of turbines.
        - Grid connection.
        - The project boundary.
3. Conduct a cost-of-energy and cash flow analysis for the expected life of the project. The analysis should, at a minimum, consider each of the following elements:
    - **Initial capital cost.** This covers the costs associated with development, wind turbine procurement/installation, and balance of station. Costs include but are not limited to site preparation, wind turbines, foundations, electrical hardware, electric collection system and transmission lines, substation equipment, wind farm control and monitoring equipment, operations and maintenance facilities and equipment, shipping, resource assessment, preconstruction environmental monitoring, surveying, legal counsel, project management, permits, construction insurance, title insurance, engineering services, and sales and use tax. Costs must be expressed in dollars and dollars per kilowatt.
    - **Annual operating expenses.** Key cost categories here include operations and maintenance costs (including preventative maintenance, corrective maintenance, and spare parts), landowner payments, annual property tax, asset management, operational insurance, and scheduling fees. Teams should consider the potential of increased costs year over year. Costs should be expressed in dollars and dollars per kilowatt per year.
    - **Annual energy production.** The total amount of electrical energy the wind farm expects to produce in a year, expressed in megawatt-hours.
    - **Market conditions.** This includes research as to what the market is willing to pay for the megawatt-hours produced and compare this with the cost of energy.
    - **Financing plan.** This should include consideration of construction financing, tax equity, sponsor equity, permanent (long-term) debt, financing fees, debt and equity return requirements, depreciation, and income tax.
    - **Incentives.** This includes national incentives, tax credits, and any regional incentives. The team should research potential abatements sales and use tax.
4. Develop a risk management plan to consider the unknowns, uncertainties, and potential delays. Teams should demonstrate their understanding of how this risk management

approach (including probability of occurrence and consequence of each identified risk) can affect their schedule including financing and manufacturability of their proposed project development plan.

5. Finalize detailed design of the site plan, which may require several iterations to balance financial and technical elements.

Industry and Local Community Engagement
Each team must organize and conduct at least two outreach activities, with one focused on developing industry connections and one focused on community engagement. These activities may be done virtually or in person and could include but are not limited to:

- Participation with an established science, technology, engineering, math (STEM)-focused organization/event, such as KidWind
- An event at a local school
- An event at the team's university that may include recruitment but must also incorporate outreach
- An event within the team's local community
- An event that fosters industry connections
- Industry interviews.

Although these engagement activities are part of the project development and engagement competition and are similar to the outreach activities a developer might conduct, they should NOT be focused on the hypothetical project the team is investigating (to avoid confusion in the community).

4.2.1 Project Development and Engagement Submissions

As part of the project development and engagement submission, teams will be required to develop a project development and engagement report and a presentation.

4.2.1.1 Project Development and Engagement Report

The project development and engagement report is the primary means for a team to provide detailed information about the project to the reviewers, given that the reviewers have a limited opportunity at the competition event to evaluate the yearlong project development activities.

At a minimum, the report must include the following sections in the prescribed order and represent all five steps specified in the project development process:

- **A cover sheet.** Begin the report with a one-page cover sheet that includes school affiliation, contact information, project name, team roles/hierarchy, and approximately how many students, faculty, and others (e.g., mentors, sponsors, or other volunteers) are involved in the project.
- **A site description and energy estimation.** This section should include information about the wind resource, site layout, wind turbine type, sensitive environmental or social factors, reason as to why this site was selected, and risks and fatal flaws (i.e., "fatal flaw" being circumstances that can lead to the project's demise).

- **Financial analysis.** This section should outline the financial potential of the project, noting required capital, financing, and key assumptions (e.g., project marginal costs). The team should demonstrate the path to solvency and outline the project's potential through cash flow analysis. Full *pro formas* (*pro formas* being financial statements forecasted for future periods typically used for Securities and Exchange Commission filing) are not required; however, it is recommended that higher-level, longer-term summaries be included to communicate the attractiveness of the project for investment.
- **Discussion of optimization process.** This section should describe the iterative process of optimization that occurred between the preliminary site design and the financial analysis.
- **Summary of engagement activities.** This section should describe the activities conducted and their impacts, including objectives for the activities and the extent they were achieved, participant types and numbers, and key learnings.

The report should be no more than 18 pages in length including images and formatted according to the specifications laid out in Appendix A. Cover pages, tables of contents, and bibliographies or references do not count against the page limits, but executive summaries, and appendices do. Pages submitted beyond this limit will not be reviewed.

4.2.1.2 Presentation

At the competition, teams will present their proposed wind farm site plan and engagement activities during an assigned presentation session with the reviewers who will represent potential project owners or investors. This presentation should convey the most important details of the project and engagement activities, which may include items from the report. Slides are required.

The teams will have 15 minutes to present their project and another 10 minutes for questions from the reviewers.

Table 6 describes the components of the Project Development and Engagement Contest and the associated points.

Table 6. Project Development and Engagement Contest

Description	Possible Points
Project Development and Engagement Report	
The written report is concise, readable, and descriptive with logical flow; communicates technical information clearly	20
Wind farm design includes a detailed layout and resource assessment	20
Environmental impacts and mitigation approaches are clearly articulated	20
Levelized cost of energy (cost/kilowatt-hour) is realistic and adequately justified	20
Balance-of-station elements are adequately represented and considered in the financial analysis (capital expenditures)	20
Evaluation of annual operational costs (operational expenditures) are fully presented and adequately justified	20
Financial plan and bid price are fully presented and adequately justified	20
Understanding of market opportunities and constraints (e.g., power markets, equipment supply chains, ownership structures, taxes, policies, and incentives) are portrayed fully with adequate justification	20
Inclusion of a holistic risk management plan	20
Summary of the execution of community engagement activities and impact	20
Summary of the execution of industry engagement activities and connections	20
Subtotal	**220**
Presentation	
The presentation is delivered clearly and professionally	15
The presentation is concise and visually engaging, professional and clear, and tells an effective story as it relates to the team's decision-making process for project development	20
The presentation is concise and visually engaging, professional and clear, and tells an effective story as it relates to the team's engagement activities	10
Subtotal	**45**
Total	**265**

4.3 Poster and Social Media Bonus Challenges (Optional)

Two optional bonus challenges will be scored by friends and stakeholders of the CWC through an online survey tool at each of the three regional events.

4.3.1 Poster (People's Choice Award)

Teams will submit one poster summarizing their work in the technical challenges over the course of the competition. Teams are encouraged to showcase their creativity to tell a story of their efforts over the year. Teams will bring their poster to the final event. Poster dimensions should be 36 inches by 48 inches. The team with the most votes will win a trophy for "Best Poster."

Why participate? The poster provides a valuable opportunity to showcase your team's work to a wide audience, including industry professionals, potential employers, and peers. It also helps sharpen your ability to communicate complex ideas visually and concisely—an essential skill in any technical or business career.

4.3.2 Social Media Outreach (People's Choice Award)

Teams are encouraged to maintain a social media presence throughout the academic year. Some ways to create impact include: sharing your team's story, cultivating inspiration, addressing misperception, and/or providing tools and messaging that others can reuse to amplify your intended effect. Teams will display their social media accounts at their team booth (either physical or digital) at the final event. The team with the most votes will win a trophy for "Best Social Media."

Why participate? Maintaining a strong social media presence provides an opportunity to share stories about your journey and forge stronger connections between competition participants, the wind industry, students, and the team's local community.

Appendix A. Communications, Submissions, and Contest Details

It is each team’s responsibility to stay abreast of the latest competition communications from the competition organizers. Communication between the teams and the organizers occurs via virtual meetings and direct emails. Competition organizers may also set up additional online communication platforms to communicate with teams.

Branding

Teams are expected to set up a professional space in their booth to highlight their branding. This setup can include their concept design, posters, team logo, and school information. The team booths provide the opportunity to showcase all the work the teams have put into their project over the course of the year and are the best way to communicate their efforts to others.

Reviewing and Scoring

A panel of judges will be scoring team performance in each challenge and for each submission. The judges will come from diverse backgrounds and have expertise related to the content they are responsible for evaluating. This diversity helps the reviewers evaluate performance from a variety of angles.

Competition organizers will ensure that judges will not:

- Have personal or financial interests in, or be an employee, officer, director, or agent of any entity that is a registered participant in the competition
- Have a familial or financial relationship with an individual who is a registered participant
- Discuss team performance with other teams or their advisors.

Team Feedback

To provide as much feedback as possible, teams will receive their scores following completion of the competition. Teams will also receive a short narrative derived from the contest reviewers’ deliberations after each team’s presentation.

Submittals and Submission Locations

Competition organizers will provide a link for teams to submit their deliverables through an online platform.

Scoring Penalties

Scoring penalties include the following:

- No points will be awarded for a submission that is late.
- Five percent will be deducted for each file that doesn't contain the university name and the proper submission abbreviation.
- Substantive and incorrect report formatting will be penalized up to 30% at the discretion of the reviewers. Formatting requirements are in place (and included in this appendix) to ensure an equal amount of space for all teams to tell their stories to the reviewers. Therefore, teams must not use more than the allotted space allowed.

- Pages in excess of the page limit will not be reviewed or scored.

All submissions must be saved in the formats indicated.

Use of Artificial Intelligence

The following are requirements regarding the use of artificial intelligence (AI) in competition deliverables:

- Teams must indicate if generative AI was used in any part of their deliverables, including which tool and prompts.
- Teams are not allowed to use verbatim text from a generative AI chatbot as part of their competition deliverables. Chatbots may reuse text from other sources, causing inadvertent plagiarism.
- All human authors of a deliverable are responsible for all of its content. ChatGPT and similar tools cannot be held accountable.
- Citations recommended by any generative AI chatbot must be verified with the original literature because chatbots are known to generate citations that are inaccurate and/or do not exist.
- AI-generated images and/or multimedia used in competition deliverables will not be accepted.
- The competition organizers may decline to move a deliverable forward in the competition if AI is used inappropriately according to the requirements outlined.

Written Submission Formatting Requirements

The following format requirements apply to the written reports:

- Pages must be 8.5-by-11 inches, paginated, and have 1-inch margins at a minimum.
- References must begin on a new page with a distinct page number format from that used for the body of the report.
- Content must be single-spaced.
- The body of the report must use an 11-point font size at a minimum.
- Images should contain no tables and little text, only what is necessary to identify the image, such as a one-line figure caption. Extensive text in the figure section will be ignored and not count toward the team's score.
- Captions for figures and tables must be numbered for easy navigation.
- The final documents must be submitted as an Adobe PDF file, adhering to the following criteria:
  - Report sections must be bookmarked
  - Fonts must be embedded
  - All images must have a minimum resolution of 300 dots per inch
  - **Do not** create a PDF from scans or by outputting the content into a raster image format (e.g., .jpg, .tiff, .png, or .gif) and then creating a PDF from the images
  - **Avoid** all-raster PDFs. Although they are large files at 300 dots per inch, they are of unacceptable quality at lower resolutions and are not scalable without degradation.

Audiovisual Presentation Format Requirements

The following format requirements apply to audiovisual presentations. Teams should bring the file on a USB drive and a laptop with an HDMI port to their presentation slot. Specific requirements include the following:

- Videos must be recorded in a 1,920-by-1,080 frame size with a frame rate of at least 30 frames per second.
- Videos must be recorded horizontally rather than vertically.
- Teams may use any video recording software and file format they prefer.
- If the video includes narration, please include a transcript.
- No background music that violates U.S. copyright laws is allowed; all incorporated music must be an original or royalty-free composition, and proof of licensing must be submitted with the file and transcript.

Posters

Posters cannot be larger than 3 feet wide by 4 feet tall.

Electronic File-Naming Instructions

The required file-naming convention for all electronic files is:

[TEAM ABBREVIATION]_[SUBMISSION DATE (YYYY-MM-DD)]_[CONTEST ABBREVIATION]_[SUBMISSION ABBREVIATION].[EXTENSION]

Teams will choose their own team abbreviation and must use that same abbreviation for all submissions. Table A-1 lists submission names and abbreviations.

Example: A design report submitted by California Maritime Academy (as part of their deliverable) would have the following file name: CALMARITIME_2026-04-18_TDT_Design Report.PDF.

Table A-1. Submission Names, Contests, and Abbreviations

Submission Name	Contest Abbreviation	Submission Abbreviation
Turbine Design Report	TDT	Design Report
Technical inspection prior to competition	TDT	Tech Inspection
Project Development and Engagement Report	PDE	Final Report

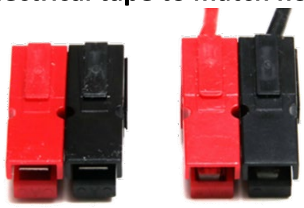
Appendix B. Sample Safety and Technical Inspection

A sample of the sheet used to evaluate test wind turbines prior to competition is provided in Table B-1. Teams are required to work through this process in advance of the competition with a qualified technician, advisor, or similar personnel as part of the Tech Inspection Prior to Competition project submission. **If a team makes a change to their system after passing tech inspection that could affect anything evaluated during that inspection, they must notify the competition organizers and undergo a revised inspection. Failure to do so may lead to disqualification.**

Table B-1. Sample Inspection Sheet for Evaluating Test Turbines

	Collegiate Wind Competition 2026 Safety and Tech Inspection Sheet
	Team Name: ____
BOLD – Cannot practice or test if noncompliant Regular – Can practice but must fix prior to official testing	
General	
O	Students certify no team designed and built designs, components, or code are re-used from previous years. Only unmodified commercial components are used.
O	Turbine for testing is substantively the same as in the Turbine Design report.
O	Remind teams about timed install—5 minutes for install and 5 minutes for commissioning.
O	**Energized electrical components are adequately shielded—both electrically and mechanically (National Electrical Manufacturers Association Type 1 is preserved) (no tape).**
O	**For the team load: all charging or bulk energy storage follows industry-accepted best practices (i.e., safe circuitry overvoltage/undervoltage protection, flame/spill containment).**
O	**Proper heat rejection.**
Wiring and Enclosures	
O	**Wiring is deemed safe and uses adequate gauges—no electrocution or overheating hazard.**
O	**Droop cable is continuous and unbroken inside the tunnel.**
O	**Voltage is ≤48 volts (V) direct current at point of common coupling (PCC) at all times.**
O	**Any 120 V source is present only in an external commercial power supply that feeds only DC power less than +/-48 V to any box. No voltages above 48 V to case ground may be present inside any box the teams build.**
O	All external wiring is in cable form and utilizes commercial connectors (no screw terminals or spade- or fork-type lugs); no single-pin connectors except ground; maximum three connections including ground.
O	Turbine electronics and load electronics are in separate enclosures.
O	Cable pass-throughs in enclosures provide strain and chafe protection (e.g., cable glands).
O	All electrical components are mechanically secured to the enclosure.
O	Turbine side of PCC: no batteries or excessively large capacitors (individual or combination nameplate rating is ≤10 J).
O	Wired connections between the turbine and load external to the PCC are optically isolated.
O	**Emergency stop terminated with standard JST *female* receptacle with *male* pins.**  **- student-side connector**
O	Emergency-stop signal (JST connector wiring) never draws more than 3 A and uses normally closed logic during turbine operation (students to describe).

O **Powerpole polarity for the PCC is correct and wire color matches housing color or has electrical tape to match housing color.**



- student-side connector

O Mating connector colors outside the PCC match to ensure correct polarity.

Wind Turbine

<u>Rotor and non-rotor components are:</u>

O Within a 45-cm cube.

O Vertically, the rotor midplane is ±10 cm from the tunnel centerline.

<u>Non-rotor parts only:</u>

O Base flange is ≤16.1 mm thick.

O Non-rotor components (e.g., tower) fit in a 15.8-cm-diameter cylinder from the base of the cube to the mounting flange.

Fit/Measure

O **Electrical systems are tied to earth ground with 100 kiloohm or lower resistor at the studs; note, the mounting studs of the flange will be grounded or the competition organizers will ground the turbines using an alligator clip on the students' stud.**

O **Turbine mounting flange fits over studs without having to be forced (test fit to tunnel flange).**

O Wiring will reach PCC (test fit).

Inspecting reviewer signature: ____

Date and time: ____________________________________

*Noncompliance checkboxes should be circled above

Reinspecting reviewer – initial compliancy above with date and time of reinspection

Reinspecting reviewer signature when complete: ______________________________

Date and time: ____________________________________

Appendix C. Roles and Responsibilities

Table C-1 shows the competition roles, who is performing in each role, and what the role entails.

Table C-1. Roles and Responsibilities

Role	Individual(s) Assigned	Definition
Collegiate Team	Multiple	Collegiate team members are led by the student lead and subteam leads under the mentorship of faculty advisors within the rules and requirements of the competition. Teams comprise undergraduate students only, but graduate students may be involved as mentors or advisors. There is no limit to team size. However, the number of students that teams may bring to the competition will be limited based on space requirements. Interdisciplinary teams are encouraged in the following areas of study: engineering, business, marketing, environmental science, communications, policy, and social sciences. Only undergraduate student team members who start the competition as an undergraduate student team member may take an active role in any competition event.
Student Lead(s)	Minimum of one and maximum of three per team	The student lead takes on the primary leadership and organizing responsibilities for the team under simple mentorship from the faculty advisor. In addition, the student lead attends informational sessions, represents the team when communicating with competition organizers, and disseminates information received from the competition organizers over the course of the entire competition, including monitoring communications during the event. The collegiate team student lead is effectively the leader of their collegiate team in all aspects of the competition.
Faculty Advisor	Minimum of one per team	Serves as the lead faculty member of a participating school in the competition. This person provides mentorship to the team throughout the competition and provides a supportive environment for student team leads to thrive in. The faculty advisor teaches, advises, and coaches the students on the skills necessary to compete in the various aspects of the competition. Some teams may specify multiple faculty advisors who are contacts for the team, but in this case, one person should be identified as the lead. Faculty advisors can provide feedback about the team's design so the students can identify mistakes, prove technical rigor, or demonstrate feasibility of their concept. It is not appropriate for faculty advisors to be actively working on a wind turbine or making decisions.

Role	Individual(s) Assigned	Definition
Student Mentors	Multiple	Because of their unique perspective, students who have completed their undergraduate degree or graduate students are encouraged to act as mentors to the collegiate team. Similar to the faculty advisors, mentors should provide a supportive environment and the educational background necessary throughout the competition without making active decisions themselves.
Supporting Faculty	Multiple	Supports the faculty advisor in the previously mentioned duties but typically does not directly engage with competition organizers.
Competition Organizers	NREL	The competition organizers provide oversight in all aspects of the competition and leads correspondence with the collegiate teams regarding challenge questions, and team expectations. During the competition, the competition organizers are the primary point of contact for questions related to engagement with the judges, logistics, and protocol. Tasks include developing team schedules, coordinating/collating scores and team feedback from the contests in time for the awards ceremony, and supporting the collegiate teams and judges.
Competition Manager	Regional Host	The competition manager represents the interest of the CWC in their region and has oversight of the execution of a regional event.
Contest Judge(s)	To be announced prior to the competition	Evaluate each contest at the competition.
Head Rules Judge	NREL	Will make all final determinations on disputes. Should a head rules judge from NREL not be available, decisions will be made by a committee of regional hosts for that given year.

Appendix D. Logistics

Many logistical details will be provided throughout the course of the academic year and leading up to the event. Although competition organizers will make concerted efforts to inform teams, teams are responsible for familiarizing themselves with the details provided to proceed accordingly.

Proactive risk management in the face of uncertainty remains fundamental for any line of employment. The same is true for this event. In the event of force majeure, these rules are written in a way that ensures readers will clearly understand all aspects of the CWC in case the in-person event should become a virtual competition.

Should a regional venue change, an announcement will be made as soon as possible.

Teams are encouraged to communicate rules that are unclear, misguided, or in need of improvement. The competition organizers will seriously consider suggestions if they are feasible and intended to improve the competition, its rules, measurable outcomes, fairness, or precision.

Event Schedule

The regional event schedule will be provided to participating teams once it has been finalized. When the competition organizers draft the schedule, slots will be assigned randomly. Teams may send requests for special consideration regarding scheduling; however, organizers are not obligated to accommodate them. The competition organizers will not accept requests for schedule adjustments after the lottery has been completed. Assigned slots will include:

- A safety and technical inspection
- Contest slots, including:
  - Tunnel testing practice
  - Tunnel testing and makeup testing
  - A Project Development and Engagement Contest presentation
  - A Turbine Design and Testing Contest presentation.

Event Registration

All individuals attending the event will be required to register with the competition organizers. The number of individuals that can attend from each team will be limited based on constraints such as event space. This limit will apply to all attendees from each university, including students, faculty advisors, and mentors. The limit for attending participants for the event will be provided closer to the competition date.

Lodging

The competition organizers will provide information to teams on lodging options that are available. It is up to each team to ultimately book appropriate accommodations.

Local Resources

Each team is responsible for considering what local resources may be needed and identifying reasonable options near the event. These resources may include:

- Printing shops
- Shipping services
- Hardware stores
- Machine shops
- Electronic supply stores.

Team Booths

Teams will be provided with a space to use as their home base during the competition. Regional hosts will do their best to locate these where electrical outlets are available to allow students to operate tools, test equipment, or use computers. Appropriate personal protective equipment should be worn in the team booths when working on the wind turbines (see Appendix E for more details). Posters are encouraged to be displayed within the team booth throughout the event (easels and backboards will be provided). Additional materials that display the team's hard work and school spirit are also encouraged.

Shipping

It is each team's responsibility to transport their wind turbine and all supplies to the event safely and on time. It is also each team's responsibility to arrange return transport of those items. It is advised that teams consider how to ensure access to these items quickly upon arrival at the event and the safest way to transport fragile items, minimizing risk of damage. Shipping information will be provided before the competition event.

Storing Items at the Event

Competition organizers are not responsible for the security of supplies stored at the event space. If teams wish to avoid transporting supplies to and from the event each day, they are advised to explore reasonable options to store and secure those items appropriately. Gear that could aid in this might include lockable totes.

Feedback

Throughout the organization and execution of the event, competition organizers will request feedback from participating teams, reviewers, volunteers, and others. This feedback is taken very seriously both during the year and for future competitions as we work to improve the organization and execution of the event. To support that continued improvement, it is crucial that participating teams seriously consider and convey both positive and critical feedback. All participants should expect and plan to provide feedback at the conclusion of the event. Consider opportunities to capture and provide individual and/or team feedback to organizers throughout the year as well.

Appendix E. Safety and Conduct

The Collegiate Wind Competition is a forum for students with an interest in renewable energy to showcase their innovative ideas and demonstrate their knowledge. The event is designed to be safe, fair, and competitive, as well as a fun learning experience and professional growth opportunity. Each team is responsible for the safety of its operations. Each team member must always work in a safe manner during the competition. Participants are expected to conduct themselves in the spirit of the competition by being team players both within their own teams and among competitor teams.

Teams must follow applicable safety and health rules (e.g., Occupational Safety and Health Administration for safety equipment based on expected activities). Competition organizers may issue a stop work order at any time during the project if a hazardous condition, such as using a power tool or soldering iron without safety glasses, is identified.

Personal Protective Equipment

All team members must wear appropriate personal protective equipment when working on, testing, and operating wind turbines and tools. Teams are expected to use the following appropriate protective equipment during wind tunnel testing and other potentially hazardous activities at the competition (note that all of these items must be student-provided):

- Safety glasses
- Hearing protection
- Steel-toed boots if expecting to handle heavy loads[6] such as mooring weights, tools, and shipping boxes
- Electrical personal protective equipment if electrical voltage demands it.

Testing Hazards

Teams may encounter hazardous conditions while testing their turbines. Some examples of these conditions and safety controls that teams should follow are listed in Table E-1.

The list in Table E-1 is not intended to be exhaustive. It is the responsibility of the teams to identify and address potential hazards.

[6] Teams should use their judgment for steel/composite safety-toed shoes. If there is any danger of foot injuries due to a falling or rolling object or objects piercing the sole, safety shoes should be worn. Steel toes are usually rated for 50 pounds dropped from 18 inches.

Table E-1. Potential Hazards and Controls for Testing Prototype Wind Turbines

Hazard	Control
Inexperience with potentially destructive testing (Testing a rotor to failure can be hazardous to people nearby)	Work with the faculty advisor to determine appropriate safety measures for reducing the potential for injury. Consult the local safety department to determine appropriate hazards and safety control strategies specific to the team's campus and testing area that meet the school's requirements.
Electrical shock (A shock from contact with energized conductors)	Follow the team's campus electrical safety requirements. Only work on de-energized systems. Lock the system so that it cannot be turned on or start moving inadvertently while someone is in contact with the rotor and test equipment.
Noise (A rotor assembly coming apart can create a loud, sudden burst of sound.)	Wear appropriate hearing protection, such as approved ear plugs or earmuffs, in the test area. Follow manufacturers' recommendations for proper usage.
Hazards to the eyes, face, and head (Projectiles could be thrown with great force from a rotor or component undergoing testing, injuring a person's eyes, face, or head [if debris takes a parabolic trajectory].	Wear eye protection marked with a Z87+ symbol around the rotor and test area. Information regarding eye protection can be found here: https://www.osha.gov/eye-face-protection Wear hard hats if there is potential for injury to the head from falling objects; for more information, visit: https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.100
Thrown debris (A rotor assembly will come apart with great force, sending projectiles into the surrounding test area.)	Check the area to ensure it is clear before moving into the test phase; notify everyone involved that testing is about to begin. Keep people away from the rotor during testing at what the team has determined to be a safe distance with appropriate barriers to keep others out; the barriers should have signage describing the hazard. Station spotters around the perimeter of the area where the test is being conducted to prevent someone unfamiliar with the hazards of the test to inadvertently enter into a hazardous area. Develop controls that allow testing to be done remotely at a safe location and to safely shut down the test. Determine if equipment in the area could be damaged and protect it accordingly. Determine if there are pressurized gas cylinders, hydraulic systems, or chemical storage containers that could be damaged during the test and if they need to be moved or protected. Create housing surrounding the plane of rotation that can withstand the forces of the rotor coming apart. The National Renewable Energy Laboratory uses 0.5-inch-thick polycarbonate. Keep the area downwind and upwind clear of people where debris could be thrown with the direction of airflow or from sudden ricochets.

Sustainability

As renewable energy and sustainability go hand in hand, we expect that participants will embrace and showcase sustainability, where possible, during all aspects of the event (e.g., reducing waste in packaging for shipping, reusing packaging materials that were used in transporting items to the competition, and eliminating the use of nonrecyclable materials such as foam packing peanuts). In addition, we encourage team members to engage in common sustainable activities such as recycling paper and beverage containers. Team creativity to support this intent is encouraged.

Appendix F. Dispute Resolution

Disputes are a serious matter and will be treated as such. Disputes of score, evaluation, processing, or similar must:

- Be submitted to competition organizers by the student team lead.
- Be submitted in writing and accompanied by a direct notification to a competition organizer (e.g., in-person notification, text message, phone call; email is acceptable but does not guarantee a timely response).
- Include a clear description of the action being protested, referencing the appropriate section of this official rules document.
- Regional hosts are encouraged to provide a non-biased representative from their organization or recuse themselves should there be a conflict of interest.

Once submitted, the competition organizers and regional hosts will initiate an internal review of the dispute. Disputes will be discussed among at least three competition organizers who will gather appropriate information through interviews or other means, and a final ruling will be issued. Regional hosts must recuse themselves if there exists a real or perceived conflict of interest. If it is concluded that the issue has a broader impact on the entire competition, the competition organizers will consult with the Competition Manager to determine next steps.

If the competition judge makes a decision that may directly or indirectly affect the strategies of some or all of the teams, the decision will be disseminated through official competition channels within 24 hours. If the dispute is being handled during the competition event, an announcement at the next major address to teams (e.g., opening or closing remarks for the day, lunch) may be substituted for a post on official competition channels.

In all cases, the head rules judge has the final say in all disputes. Should a head rules judge not be assigned during a competition year, a committee of regional hosts will have the same authority. All decisions are final and are not appealable.

Appendix G. Alternative Competition Structure

In the event the in-person conference is cancelled, the following updates to the competition structure will go into effect and are listed in reference to their respective sections of the main document. Should there be extenuating circumstances for some but not all teams, a hybrid solution between a standard contest and what is described in this appendix may be developed and further communicated to the teams with as much advance notice as feasible.

The following modifications are designed to accommodate the possibility that the competition may not occur in person.

In the event an individual team is unable to complete any of the submissions because of extenuating circumstances, please reach out to the competition organizers. The primary goal of the competition is to maximize learning, and the competition organizers will work with each team to determine what is possible.

Background

Competition requirements for the wind turbine will be updated to reflect an effective, **digital-only,** mechanical, electrical, and aerodynamic wind turbine design that is safe and reliable for testing in an on-site wind tunnel. (The turbine need not actually be tested but should be designed as if it were going to be and subcomponents built and tested to the best of the teams' abilities according to the submissions.)

Competition, Contests, Submissions, and Awards

All references to the in-person competition presentations and question-and-answer (Q&A) sessions will shift to virtual execution. There will be no in-person turbine testing or designing of a wind farm during the competition. The planned scores for those sections will not be part of the competition scoring.

Submission Deadlines

The virtual competition sessions will be held as close to the end of the academic year as possible, and specific dates will be selected based on team and judge availability. If any team is unable to make the available dates or complete the submissions as outlined, they must reach out to the competition organizers to work out an alternative.

The expected submissions and the associated timeline will remain the same, except as shown in Table G-1.

Table G-1. Updated Submission Timelines

Submission	Submission Deadline
PRIOR TO COMPETITION:	
Unchanged	
DURING COMPETITION:	
Project Development and Engagement Contest PowerPoint presentation (digital)	Presented on virtual meeting platform
Turbine Design and Testing Contest question-and-answer supporting materials (optional)	Presented on virtual meeting platform

Awards

Awards will shift to include:

- **A first-place winner**. This is the team that earns the highest combined score (not including Turbine Testing).
- **A second-place winner**. This is the team that earns the second-highest combined score (not including Turbine Testing).
- **A third-place winner**. This is the team that earns the third-highest combined score (not including Turbine Testing).
- **A Project Development and Engagement Contest winner**. This is the team that earns the highest combined score from all Project Development and Engagement Contest submissions.
- **A Turbine Digital Design Contest winner**. This is the team that earns the highest combined score from the digital Turbine Design Contest and submissions.

Note: There will be no Turbine Testing, but there will still be an overall competition winner.

Final scores and rankings for the modified contests will be shared with all participants.

Turbine Digital Design Contest

The Turbine Design Contest will remain unchanged except that presentations will move to a virtual format. Presentation dates may change.

Each team must submit their written report and PowerPoint presentation digitally.

Project Submissions

All submissions and due dates will remain unchanged. They are designed to be conducted in an entirely remote learning environment, if necessary.

Private Q&A Session

The Q&A session will continue as planned, albeit in a virtual format.

Presenters should showcase their wind turbine prototype as it exists, if possible, and have the option to use PowerPoint slides or other visual aids to engage with the reviewers. Note that visual aids will not be scored but can be used, if necessary, to help clarify any questions the reviewers may have after reading the written report. See further below in this appendix for virtual presentation best practices and to ensure it will function as intended in advance of presentation time.

Turbine Testing Contest

This contest will become optional remote testing, and wind turbines will not be tested in the competition wind tunnel. Testing will not be scored. Teams are encouraged to test their turbines remotely, using their own facilities, and to document their testing in a short video and present their results via an informal, unscored, public-facing webinar to celebrate this year's student accomplishments. Participating teams will have the option to:

- Conduct remote turbine testing. Teams should attempt to replicate as many of the tasks per Section 4.1.4 as they can, including:
    - Power performance
    - Controllability
    - Safety
    - Durability.
- Use the data they collect from their work on the submissions as a start on the remote testing
- Reach out to the competition organizers for advice on experimental design and instrumentation selection
- Conduct testing at a time most convenient for members, taking into consideration schedules, when resources are available, and the required submission deadline
- Document turbine testing results using photos, video, screenshots, and real-time data logging compiled into a single, edited video no longer than 5 minutes in length, detailing the:
    - Turbine components
    - Experimental setup and instrumentation
    - Testing procedures
    - Results.
- Optional: submit a bloopers reel, which does not count as part of the time limit, in a separate file(s).

Submission deadline for the video will be provided during the transition to the virtual event but will be shortly before the event itself. This approach is meant to balance the time needed for teams to test with the time needed for reviewers.

Teams who submit a video summary of their turbine testing results are encouraged to share their video with other CWC teams if possible. Competition organizers will attempt to provide a time/day for a team-led webinar with judges and the other CWC teams. These virtual sessions are designed to foster deeper learning among participants through direct feedback from the judging panel on the performance of their wind turbine, as well as through interaction with other competitors and the public. Each webinar session will include:

- A review of the submitted video
- Questions from the judges about the team's testing approach as well as feedback on the execution of testing and results
- A brief Q&A with the team, reviewers, and audience.

Project Development and Engagement Contest

This contest will remain unchanged except that presentations will move to a virtual format. It has been designed to be completed in an entirely remote learning environment. Presentation dates may change.

Each team must submit their written report and PowerPoint presentation digitally.

Rubrics

The rubrics will remain unchanged except for removing the scoring of the Turbine Testing Contest.

Logistics

The most up-to-date logistics information will be provided to the teams directly from the competition organizers.

Event Schedule

The event schedule will be provided to participating teams once it has been finalized. Slots will be determined based on preferences provided by each team in a poll, and competition organizers will do their best to accommodate those preferences based on reviewer availability. These slots are not guaranteed. Assigned slots will include:

- A Project Development and Engagement Contest presentation
- A turbine digital design presentation and Q&A
- A remote testing review session
- An awards ceremony.

Virtual Event Login

For teleconferencing best practices, all individuals participating in the virtual presentations should review the Virtual Networking and Career Development section.

Any members of the team, including faculty advisors and mentors, are welcome to observe their team's presentation sessions and the awards ceremony.

Virtual login information for private presentation sessions, access to the event app, and the awards ceremony will be provided closer to the assigned competition date.

More information on scheduling, best recording practices, and specific questions will be provided directly from competition organizers.

Dispute Resolution

Dispute resolution procedures are unchanged.

Virtual Conference Participation Etiquette

The following best practices are highly recommended for remote participation in any event. Teams should:

- Be responsible for knowing their meeting point of contact and ensuring that connections and technology all work prior to their start time. Test the internet connection, audio and video capabilities, and ability to use the virtual meeting program before the presentation time. The competition organizers have built in transition time, but it is limited.
- Use a hard-wired internet connection (i.e., ethernet cord). Wi-Fi connections can be used but are not ideal because they are prone to more connection issues.
- Mute the audio connection (phone and/or computer) when the speaker is not intending to speak. The competition organizers will mute participants with excessive background noise.
- Ensure there is only one audio connection being used. Connect to audio via phone or computer, but not both. Connecting with two audio connections results in electrical feedback that is very uncomfortable for all involved.
- Feel encouraged, but not required, to use the team's webcam for presenting. Audio narration of slides is also acceptable.
- Ensure there is a clean background while streaming video (e.g., no inappropriate or offensive images in the background, or people walking around).
- Avoid window backdrops because of lighting.
- Be sure to dress and speak professionally during the presentation.
- Refrain from distracting behavior while sharing the video and/or audio, such as drinking or eating.