



American-Made Water Prize

# WAVES TO WATER



U.S. DEPARTMENT OF ENERGY

# DRINK STAGE

Official Rules

September 2021

The U.S. Department of Energy (DOE) Waves to Water Prize DRINK Stage will be governed by this Official Rules document, which establishes the rules and requirements for the Waves to Water Prize. The prize administrator and DOE reserve the right to modify this Official Rules document and will publicly post any such notifications as well as notify prize participants.

Date	Modification
October 14, 2021	<ul style="list-style-type: none"><li>• Revisions in Appendix 2 to the National Environmental Policy Act Compliance (NEPA) list of environmental concerns</li><li>• Corrected stage name in Appendix 1</li></ul>

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# Executive Summary

Offering competitors up to \$1,000,000 in cash prizes, the DRINK Stage represents the fifth and final stage of the Waves to Water Prize. The DRINK Stage asks competitors to build and deploy a functional prototype or proof of concept of their system at Jennette's Pier in Nags Head, North Carolina, in April 2022. Only those competitors who are selected as winners of the CREATE Stage will be able to participate in the DRINK Stage.

In June 2019, the U.S. Department of Energy (DOE) Water Power Technologies Office (WPTO) launched a prize to develop wave energy-powered desalination systems. The Waves to Water Prize is a five-stage, \$3.3-million contest to accelerate the development of small, modular, wave-powered desalination systems capable of providing potable drinking water in disaster-relief scenarios and remote coastal locations.

In June 2020, WPTO announced that the final stage, the DRINK Stage, of the competition will culminate at Jennette's Pier test site in Nags Head, North Carolina. This test will be conducted and coordinated by WPTO, the National Renewable Energy Laboratory (NREL), the North Carolina Aquarium (manager of Jennette's Pier), and the Coastal Studies Institute (CSI). CSI is a multi-institutional research and education partnership led by East Carolina University in collaboration with North Carolina State University, the University of North Carolina at Chapel Hill, the University of North Carolina Wilmington, and Elizabeth City State University. CSI's interdisciplinary research focuses on pressing coastal issues, including renewable ocean energy development. For almost a decade, the state-funded North Carolina Renewable Ocean Energy Program, a collaboration between CSI and the colleges of engineering at North Carolina State University, the University of North Carolina at Charlotte, and North Carolina Agricultural and Technical State University, have been researching and developing new ways to bring ocean energy technologies to market sustainably while working with the private industry to test devices in the waters off the Outer Banks. CSI operates a renewable energy testing site in partnership with Jennette's Pier, a North-Carolina-Aquarium-operated facility. The research experience, technical expertise, and infrastructure available for deployment and testing make CSI and Jennette's Pier an optimal location and partnership for the DRINK Stage of the Waves to Water Prize.

The Waves to Water Prize aims to attract dedicated teams of highly capable individuals and provide them with sufficient incentives to advance their technologies through completion of the prize. While the technology-development goals of the prize are specifically tailored to address the unique circumstances of disaster response or remote coastal community water needs, the purpose is also to advance technologies that could have broader applications for wave energy and desalination technologies. Through the competition, participants will develop skills and knowledge that will contribute to general improvement and proliferation of wave-powered and desalination technologies.

## Technology Development Goals

The purpose of this program is to incentivize the creation of wave-powered desalination systems that meet the following goals:

- **Flexible in Varied Wave Conditions.** Competitors must develop systems that can survive harsh wave conditions and operate under different wave conditions and different sites without major tuning to ensure operation at a wide variety of locations. All solutions that make it to the DRINK Stage will be evaluated in an open-water test at Jennette's Pier, which experiences average- to low-energetic wave resources.
- **Easily Deployed.** Systems must be able to be deployed in less than 48 hours, addressing the need to deploy quickly and easily in a disaster-response scenario where there is large uncertainty in site conditions.
- **Shipped in a Standard Container.** Technologies must fit into a predefined container to standardize the shipping constraints that face many disaster-response and recovery scenarios. The internal dimensions of the container are approximately 41 by 44 by 35 inches.
- **Operated Without Environmental Degradation.** Brine discharge, or other salt concentration issues resulting from the process of desalinating water, will need to be managed without creating environmental issues.
- **Deliver Minimum Water Quality.** The maximum total dissolved solids (TDS) quantity for this competition is 1,000 milligrams per liter (mg/L).

# Prize Stages



## STAGE I: CONCEPT—CLOSED

**90 DAYS: June 13, 2019, to Sept. 11, 2019**



Competitors described how their proposed solution meets the goals of the program, as described in the Technology Development Goals of this document. Submissions detailed the functionality of their wave-powered, energy-generating technologies, desalination technologies, and their proposed integration methods. This included describing the risks and difficulties of their system and proposed solutions to their issues. Competitors were evaluated based on the level of innovation of their proposed idea, the feasibility of their system, the ability to scale up and provide other benefits, and their team. On November 14, 2019, DOE announced the [20 winners](#) who received a \$10,000 prize.

## Stage II: DESIGN—Closed

**120 DAYS: Nov. 14, 2019, to March 13, 2020**



Competitors developed a technical plan and supporting analysis of their wave-powered desalination system. Submissions had two major components: (1) Modeling Documentation—a description of model results to justify supporting claims of performance if a prototype of the system were built; and (2) Technical Narrative—a detailed design of their wave-powered desalination system and a plan to build a prototype of their system, including how major risks will be addressed if the submission wins and the team advances to the CREATE Stage. Teams that demonstrated they had the technical capability and sufficient plans to build a functional or proof-of-concept prototype were awarded a cash prize. There were [17 winners](#) who each received a \$47,000 prize.

## Stage III: ADAPT—Closed

**180 DAYS: May 18, 2020, to Nov. 13, 2020**



Competitors in this stage had 180 days to document a thorough and robust design of a system specifically for testing at Jennette's Pier that can also be scaled for similar environments for disaster relief or remote community water access. This was done through a combination of thorough engineering analysis, design drawings and documentation, and development of a plan to build their technology in the CREATE Stage. Teams that demonstrated the technical capability and detailed plans to build a functional or proof-of-concept prototype were awarded a cash prize and invited to compete in the CREATE Stage. There were [10 winners](#) who received a \$80,000 prize.

## Stage IV: CREATE—Closed

**180 DAYS: Feb. 9, 2021, to Aug. 9, 2021**



Competitors in this stage had 180 days to provide evidence of a viable system and develop a plan to build and deliver their technology for the DRINK Stage. This was done through a combination of thorough engineering analysis, design drawings and documentation, and physical builds and tests of critical or novel components and subsystems. Only winners of the ADAPT Stage were eligible to compete in the CREATE Stage. Five winners were awarded \$100,000 each from a total prize pool of \$500,000.

## Stage V: DRINK—Open

**180 DAYS: September 2021 to April 2022**



Winners of the CREATE Stage will have up to 180 days to build and ship their systems to Jennette’s Pier in Nags Head, North Carolina, to conduct a test for up to 5 days. Competitors will compete in efficiency, logistics, and system integration metrics and will be scored on the ability to meet minimal thresholds and their performance against the defined metrics. Only winners of the CREATE Stage can compete in the DRINK Stage.

**Grand Prize:** A grand prize in the amount of \$500,000 will be awarded to the competitor with the best overall score.

**Individual Metrics Prizes:** There will be other prizes awarded to competitors from a total prize pool of \$500,000.

## Applications of Interest

The Prize Administrator must conclude that all of the following statements are true when applied to your submission:

- The proposed solution utilizes wave energy to create drinking water.
- The proposed solution represents an innovation that will move the industry beyond its current state.
- The proposed solution is based on sound fundamental technical principles.
- The proposed solution does not target larger (e.g., small, municipal or community-scale) desalination systems.
- The proposed solution does not involve the lobbying of any federal, state, or local government.

If your proposed solution does not meet the requirements, it will not be subjected to additional review, will not receive scores from the reviewers, and will not be considered for a prize under this program.

## Participant Eligibility

This stage of the prize is only open to winners of the CREATE Stage as named by DOE.

DOE employees, employees of sponsoring organizations, members of their immediate families (i.e., spouses, children, siblings, or parents), and persons living in the same household as such persons, whether or not related, are not eligible to participate in this prize. Federal entities and federal employees,

acting within the scope of their employment, are also not eligible to participate in any portion of this prize. DOE national laboratory employees cannot participate in any stage of the prize.

## Background

From 2017 through early 2019, WPTO conducted analysis and stakeholder engagement to identify and study the range of potential applications and markets for marine energy technologies beyond a focus on grid-scale power applications. This work resulted in the release of a report in April 2019 entitled, [“Powering the Blue Economy™: Exploring Opportunities for Marine Renewable Energy in Maritime Markets.”](#) The report identifies potential opportunities and challenges for marine energy in eight different ocean markets, including those far out at sea—like ocean observation and mining—and those nearshore—like desalination and coastal resilience.

The “Powering the Blue Economy” report identifies wave-powered desalination as a potential growth market for marine energy technologies, particularly targeting isolated coastal/island communities with high energy costs. Wave-energy-powered desalination systems could help address coastal challenges, such as resilience, disaster recovery, and water scarcity, especially if systems are competitive in price, water production, and reliability when compared to conventional alternatives. However, even given its theoretical advantages, wave-powered desalination is still an early-stage technology with significant market and technical challenges.

Through this prize, WPTO seeks to accelerate innovation in both wave energy devices and desalination systems and create incentive for teams to build interdisciplinary approaches to integrate wave power and desalination. WPTO aims to leverage the expertise and creativity of academia, industry, government, and other partners engaged in marine energy and desalination technologies through this prize. With its interdisciplinary challenges, this prize seeks to unite the water technology community, the marine renewable energy industry, and the experts and stakeholders working to address water security challenges in remote or island communities. It is WPTO’s hope that by supporting competitors to demonstrate initial viability through this contest, it will provide a spark for additional private sector investment.

While the focus of this prize is specific to remote communities and disaster response, WPTO seeks to uncover innovation to advance marine energy technology readiness for cost-competitive applications of both small-scale and municipal-scale water production or other technological advancements that could advance the state of wave energy for other market applications.

In addition to the work being explored by WPTO, DOE is deeply invested in a variety of technological solutions to solve many challenges related to freshwater because its availability is a big, multifaceted challenge.

## Wave Power: An Energy Opportunity

Desalination is an energy-intensive process, in which, typically, energy is used for a variety of purposes, which could include driving fluid through a membrane, providing heat for a distillation or evaporation process, and/or hybrid configurations. The high energy costs (in many cases electricity costs) of these

systems have economic implications for their owners/operators because fuel costs can be variable and leave operators with little predictability of the operational costs to run these systems. Additionally, unlike capital expenditures (i.e., buying the equipment), operational costs cannot be amortized over the life of the project. The ability to bypass these energy costs—either by producing off-grid, decentralized electricity to directly power the system or by eliminating the need for electricity through direct pressurization—could be critical for development, driving significant cost savings and reducing the risk or sensitivity of technologies to dynamic energy prices. Companies and technology developers in the marine energy space believe wave-powered desalination may help address these issues.

NREL has researched and modeled wave-powered concepts that directly pressurize reverse-osmosis (RO) seawater desalination systems. NREL's simulation results suggest that a wave-pressurized RO application could be more cost competitive when producing water than a wave energy system producing electricity, given current cost estimates.<sup>1</sup> This finding signals a near-term market opportunity for wave energy, requiring smaller cost reductions before the technology is commercially competitive with grid-power applications.

The United States has one of the most compelling and varied wave resources along its coastline, where integrating wave energy and seawater desalination could have specific advantages:

- **Wave energy can produce clean water without any electricity.** Many desalination processes, such as RO, traditionally require a reliable, grid-connected power supply to provide continuous energy input (e.g., pressure across a membrane). However, with many wave energy converter designs operating as oscillatory pumps, they can be used to directly pressurize an RO system, potentially eliminating the need to purchase electricity.
- **Wave-powered desalination is more than just an economic challenge, it's also a technical challenge.** The capture of energy from waves and the application of water treatment technologies are both valuable areas of innovation. A marine-energy-powered system might have inherent system attributes and capabilities that go beyond existing requirements or incumbent technologies. Technical innovations are still needed to achieve a level of economic competitiveness.
- **Desalination without electricity consumption is a compelling technological challenge with potential benefits beyond drinking water.** Many of the advances from this competition could be integrated into other applications for marine energy technologies. For example, directly pressurizing a system might be an attribute of an aquaculture or marine algae farm, or it could be applied to direct seawater adsorption systems. The efforts undertaken in the prize might have broad applications across many new opportunities for marine renewable energy.
- **Wave-powered desalination could shift costs from variable to fixed.** Either by directly supplying electricity via wave energy or by eliminating the need for electricity through pressurizing, the variable costs of grid-scale or diesel-based systems could be eliminated, which would allow operators to better control and predict operational costs.

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<sup>1</sup> Yu, Yi-Hsiang, and Dale Jenne. 2017. "Analysis of a Wave-Powered, Reverse-Osmosis System and Its Economic Availability in the United States." 36th Annual International Conference on Ocean, Offshore and Arctic Engineering, Trondheim, Norway. June 25–30. <https://www.nrel.gov/docs/fy17osti/67973.pdf>.

## Stage I: CONCEPT—Closed

On Nov. 14, 2019, DOE announced the winners of the CONCEPT Stage. The winners of the first stage can be found [HERE](#).

## Stage II: DESIGN—Closed

On June 8, 2020, DOE announced the winners of the DESIGN Stage. The winners of the second stage can be found [HERE](#).

## Stage III: ADAPT—Closed

On Feb. 9, 2021, DOE announced the winners of the ADAPT Stage. The winners of this stage can be found [HERE](#).

## Stage IV: CREATE—Closed

On Sept. 9, 2021, DOE announced the winners of the CREATE Stage. The winners of this stage can be found [HERE](#).

## Stage V: DRINK Stage—Open; Rules and Requirements

### DRINK Stage Prizes

Prize Pool Up to \$1,000,000

- One Grand Prize, \$500,000 Winner
- Four Performance Prizes
  - Most Water: \$125,000
  - Simplest Assembly, Deployment, and Operation: \$125,000
  - Cleanest Water: \$125,000
  - Lowest Weight: \$125,000.

### Introduction to the DRINK Stage

The Waves to Water Prize is a five-stage contest seeking to accelerate the development of modular, flexible, and easily transportable systems using wave power to desalinate ocean water, providing clean

water in areas of the world facing disaster-relief and recovery scenarios or providing water to remote, high-cost, and water-scarce coastal and/or island locations with little infrastructure support. The purpose of the DRINK Stage is to demonstrate a fully functional wave-powered desalination device.

The DRINK Stage is the final contest of the Waves to Water Prize, culminating in an open-water, 5-day test. In the event of weather, or other conditions, that prevent safe operation, installation, or retrieval of devices the open-water test time frame may be reduced. Winners of the CREATE Stage will have up to 180 days to build and ship their systems to compete in the DRINK Stage, which will be held at Jennette's Pier in Nags Head, North Carolina. The competition aims to demonstrate practical, working solutions for wave-powered desalination and to have teams compete in efficiency, logistics, and system integration metrics. All competing teams will have to meet defined requirements to ensure they have appropriately planned for issues of safety, deployment, commissioning, and other key processes prior to the April 2022 deployment.

Winners at this stage will be determined based on the final scoring metrics outlined in the Prize section. Once the minimum thresholds have been met, there will be one Grand Prize that will be determined by both water salinity and water production over the test period. There will be additional prizes for cleanest water, most water produced, lightest container delivered to the test facility, quickest assembly procedure, and greatest commercialization potential.

Details on the test site setup, including standard mooring systems, allowed interventions, and other key details on the DRINK Stage, are provided in Appendix 2 of this document.

Requirements for this stage will include:

- **Competitor Workshop.** On Oct. 4, 2021, the Waves to Water Prize administration team will host a hybrid<sup>2</sup> competitor workshop to familiarize the competitors with the site setup and safety information, provide any required training in advance of the DRINK Stage, open-water competition, as well as provide an introduction of required materials needed in advance of the interview panel to be held January 2022. At least one member of every competing team must attend this workshop.
- **Final Design Submission and Interview Panel.** All competitors will be required to submit their final design submission document package on or before Jan. 12, 2022. The Waves to Water Prize administration team will hold virtual interviews with DRINK Stage competitors following the submission of these documents. All finalists will be required to present, explain, and answer questions pertaining to the functioning system and key operating principles. This will be done in a virtual format January 20–21, 2022. DOE expects that competitors will address any final guidance provided by the reviewers and that the final device will reflect these changes.<sup>3</sup>

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<sup>2</sup> Competitors are able to attend the workshop in person, though the Waves to Water Prize will not support any travel expenses. All travel costs will need to be incurred by the competitor.

<sup>3</sup> Reviewers expect that the device design presented in January 2022 will not have changed from the designs submitted at the end of CREATE Stage and that any proposed changes will have to be approved in a go/no-go manner during the January 20–21, 2022, interviews.

- **DRINK Stage, In-Water Competition Participation.** As a competitor in the DRINK Stage, it is expected that devices will arrive at the CSI no later than March 18, 2022, competitors will travel to Nags Head, North Carolina, and assemble their devices by March 29, 2022, and devices will be sited at Jennette’s Pier and ready for the in-water competition by April 1, 2022. Details regarding travel expectations will be provided during the October 4, 2021, workshop.

The following rules are for competitors in the DRINK Stage. “You” and “your” refer to competitors in this stage. Each team selected to participate in the DRINK Stage is limited to one submission per team, and the interview panel, to be held January 20–21, 2022, will only review the final technology designs submitted during the CREATE Stage.

## How To Enter

Only winners of the CREATE Stage will be invited to compete in the DRINK Stage. Competitors' existing registration in HeroX is sufficient.

## Important Dates<sup>4</sup>



**Sept. 9, 2021:** Opening of DRINK Stage

**Oct. 4, 2021<sup>5</sup>:** October 2021 Competitor Workshop

**Jan. 12, 2022:** Competitors submit final design submission.

**Jan. 20–21, 2022:** Competitors participate in the final team interview and go/no-go determination by Prize Administrator

**March 18, 2022:** Competitor systems arrive at CSI.

**March 19–28, 2022:** Competitor assembly period<sup>6</sup>

**March 29, 2022:** Competitors complete systems assembly at CSI.

**April 1, 2022:** Competitor systems are assembled and deploy-ready at Jennette’s Pier.

**April 2022:** DRINK Stage in-water test at Jennette’s Pier for up to 5 days<sup>7</sup> during a period of an acceptable weather window as determined by staff at Jennette’s Pier and CSI.

**April 2022:** Close of DRINK Stage

**April 2022:** Expected Winner Notification

<sup>4</sup> All dates noted in the Important Dates section are subject to change.

<sup>5</sup> Any competitor who wishes to attend the October 2021 workshop in person will be responsible for all travel costs and expenses. The Waves to Water Prize will not support travel or reimburse costs to attend this event.

<sup>6</sup> Competitors are allowed two 10-hour working days to assemble their systems within the full competitor assembly period.

<sup>7</sup> The device deployment timeline can be shortened to accommodate available weather windows and at the discretion of WPTO, NREL, and CSI.

# What To Submit

The following items constitute the submissions package. Instructions on where to submit materials will be provided at a later date.

## DUE Jan. 12, 2022

### Final Design Submission<sup>8</sup>

- System Assembly Plan (not to be made public, not scored)
- Deployment, Installation, and Retrieval Plan (not to be made public, not scored)
  - Video that details the deployment, installation, and retrieval plan (not to be made public, not scored)
- Commissioning and Decommissioning Plan (not to be made public, not scored)
- Competitor Waiver (not to be made public, not scored)
- Safety Plan (not to be made public, not scored)
- Public Facing digital drawings, images, and diagrams to be specified at the October Workshop (to be made public, not scored)
- List of Tools (not to be made public, not scored).

## DUE March 18, 2022

- Device arrives at CSI by March 18, 2022.

## DUE March 29, 2022

- Device ready to be deployed at Jennette's Pier for the DRINK Stage Competition.

# Final Documentation Submission Package

By Jan. 12, 2022, competitors are required to submit the following information and documentation to be considered for the prize. The following are mandatory. Should any of the following documentation fail to be submitted, an application will be deemed ineligible. All templates will be provided to the competitors during the Oct. 4, 2021, workshop at CSI and Jennette's Pier in Nags Head, North Carolina.

### Final Design Submission Components

- **System Assembly Plan:** Any device assembly procedures and drawings that are required prior to handing off to the CSI team for installation will need to be described. All competing teams will be given two 10-hour working days to uncrate and assemble the device prior to handing it off to the CSI team for installation. Each competing team will be allowed up to four team members.
- **Deployment, Installation, and Retrieval Plan:** A plan will need to be agreed upon by each competing team and the CSI installation team to ensure a safe deployment. This will include a lift plan for any crane operations, a description of how the device will be attached to and removed from the provided anchor, any additional steps that may be required once the device has been

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<sup>8</sup> Reviewers expect that the device design presented in January 2022 will not have changed from the designs submitted at the end of CREATE Stage and that any proposed changes must be specifically identified by the competitors and approved during the January 20–21, 2022, interviews by the Prize Administration Team.

towed to its final location, as well as required steps to prepare the device for retrieval and towing back to shore.

- **Video that details the deployment, installation, and retrieval plan:** A video that details the installation and recovery plan must include the lift point and guy line attachment points, dimensions of the assembled device in the deployment plan, device center of mass specifications, and the details of assistance required from CSI and Jennette's Pier staff for assembly. There is no required minimum or maximum length for this video.
- **Commissioning and Decommissioning Plan:** Detailed instructions must explain how to commission and decommission the device once it has been attached to and removed from the supplied anchor. This will include any operations to initiate and shut off power or water production (e.g., opening valves, releasing safety switches, and so on).
- **Safety Plan:** A template will be provided to each competitor outlining various safety considerations and disclosures needed to ensure the safe operation of each competing device at Jennette's Pier during the in-water competition.
- **Competitor Waiver:** This will be required from each team as a formal disclosure that they intend to compete in the DRINK Stage competition to ensure the prize team can adequately plan for the event.
- **Public-Facing digital drawings, images, and diagrams:** Each team will be required to submit a public-facing digital drawing, image, or diagram of their systems that WPTO can use when communicating about the prize to the public. If needed, the Prize Administration Team will work with competitors to create public-facing images and graphics developed from the originally submitted files.
- **List of Tools:** All competitors will need to provide a list of basic hand tools that they will use for system assembly, disassembly, and during interventions, if any. The list provided should include two categories: 1) tools that the team will bring to the competition to support assembly, disassembly, and intervention needs; and 2) tools that the team would like the Prize Administration Team to make available for on-site use at CSI and Jennette's Pier.

## Prizes

At the end of the 5-day testing period, devices will be evaluated based on meeting the Minimum System Technical Requirements and scored against the Performance Prizes and the Grand Prize. Multiple winners will be selected, including:

- **Grand Prize:** A Grand Prize, in the amount of \$500,000, will be awarded to the competitor with the best overall score.
- **Performance Prizes:** Four separate cash prizes of up to \$125,000 for each prize.

All competitors will need to meet the following minimum requirements to be eligible for the Grand Prize or any of the Performance Prizes.

### Minimum System Technical Requirements

Water Quality	Must be able to produce water with a maximum TDS level of 1,000 mg/L over the competition period. Fluctuations in this level are acceptable as long as the combined average does not exceed 1,000 mg/L.
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Produced Volume	At least 400 L of water are produced during the in-water testing period. If, for any reason, the in-water testing is less than 5 days, the required produced volume metric will be reduced accordingly.
Shipping Weight	Systems cannot exceed 650 kilograms (kg).
48-Hour Setup	Teams must demonstrate that their systems can be set up within two 10-hour windows.
Battery Storage Capabilities	Batteries are not a requirement of the system; however, no more than 0.5 kilowatt-hours of battery capacity can be included. Once these batteries are discharged, the batteries must ONLY be powered by wave energy. <sup>9</sup>
Other Energy Sources	All energy for desalinating water must come from wave energy. No other renewable sources will be allowed for the primary function of desalination (e.g., tidal, solar, wind). However, other energy sources can be used for ancillary purposes, such as system monitoring and system control.

Water quality, produced volume, and shipping weight will be determined, as described in the next sections for the Grand Prize and the Performance Prizes, as well as in Appendix 2.

## Grand Prize Scoring

The Grand Prize will be awarded based primarily on a wave-powered desalination metric that has been developed by the Prize Administration Team and on the Commercialization Potential of the system.

Scoring Item	Weight	Maximum Possible Points
Wave-Powered Desalination Metric Score	70%	Competing teams' scores will be normalized to the highest scoring team's score based on the following equation: $70\left(\frac{\text{Team Score}}{\text{Highest Team Score}}\right)$
Commercialization Score	30%	30 possible points, based on 5 scored statements
Possible Grand Prize Points	100%	$70\left(\frac{\text{Team Score}}{\text{Highest Team Score}}\right)+\text{Commercialization Score}$

<sup>9</sup> Remote controlled devices used for controlling operations and communication on the device will not count toward the 0.5-kilowatt-hour total allowable battery usage.

## Wave-Powered Desalination Metric

The wave-powered desalination metric will take into account both the amount and quality of water produced. This metric is designed to demonstrate a device's efficiency of energy conversion, efficiency of water desalination and the integration of these two critical functions. The energy use of a desalination system can be thought of as the product of the amount of water produced over a given period of time (i.e., flow rate) and the driving pressure, or the force required to drive the system. Measuring the water production at the end of the prize serves part of this need; however, it is not enough to inform energy utilization. Given that RO is the current state of the art, we have chosen to use TDS as a proxy for driving pressure (see Figure 1). For a single-pass RO system with a given recovery rate, and appropriate pretreatment, one can approximate driving pressure by measuring TDS. Of course, some assumptions have to be made, but if a known set of membranes are used (e.g., constant surface area and constant permeability coefficient), then the driving pressure will correlate to the produced water TDS. Leveraging DuPont's Water Application Value Engine software, the following relationship between pressure and TDS can be produced for a single-pass system.

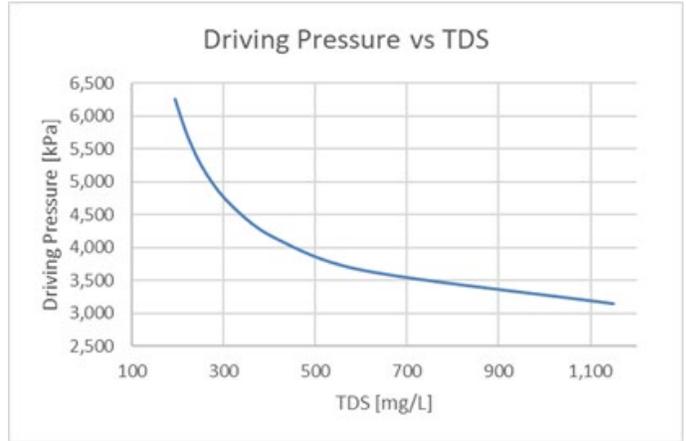


Figure 1. Driving pressure vs. total dissolved solids (TDS). *Graph from NREL*

Curve-fitting this data can be used to approximate what driving pressure is needed for a given TDS output, assuming a single-pass RO system with a 10% system recovery. Using this empirical relationship between TDS and driving pressure, along with the volume produced, serves as a proxy for the amount of energy utilized by the wave-powered desalination system. At the end of the 5-day competition, the total quantity of water delivered to the collection vessel (Figure 2) will be measured and the average salinity will be recorded. To measure water volume, water will be drained from the collection vessel and measured using a positive-displacement flow meter to directly measure flow as it is drained. After a known quantity is drained from the container and collected in a secondary container, a TDS measurement will be taken at that time. This enables the prize team to measure the volume as needed throughout the contest. At a minimum, the Prize Administration Team will measure water at least twice per day, but if a team's device is producing significantly more water than the collection vessel can hold, additional measurements will be made. At the end of the DRINK Stage, the total water volume will be summed up and the TDS measurement will be weighted so that the TDS measurement reflects the average salinity of all the water produced over the course of the competition. These two values will be input into the following equation:

$$Score = \frac{2,800 + \frac{6,500,000,000}{1 + \frac{TDS^{1.26}}{0.002}}}{1,300,000} \times Volume$$

where:

- TDS is the average TDS (i.e., salinity proxy) over the competition period in mg/L
- Volume is the total water produced over the competition period in L.

Measurements of TDS and volume will be rounded to the nearest integer value (e.g., 192.3 mg/L will be rounded to 192 mg/L) and the final scores will be rounded to the first decimal place (e.g., 1.05 will be rounded to 1.1). The right-hand side of the equation has been divided by 1,300,000 to normalize the scores so that the minimum score possible, given the prize thresholds (volume of 400 L, and TDS of 1,000 mg/L), will be 1. Increasing production and/or decreasing salinity will result in a higher score. A visual representation of the wave-powered desalination metric scoring is provided in Figure 3 (with a TDS range of 150–1,000 mg/L and produced volume between 400–3,000 L).



Figure 2. Sample collection vessel that may be used during the DRINK Stage competition. *Photo from Coastal Studies Institute*

There is no limit to the maximum score that can be achieved. The ranges provided earlier are only intended to provide insight into how the individual metrics will be evaluated.

There will be no on-device measurement of wave conditions; no analysis will be conducted to control for wave conditions experienced by each device. The purpose of this prize is to compete in a variety of wave conditions.

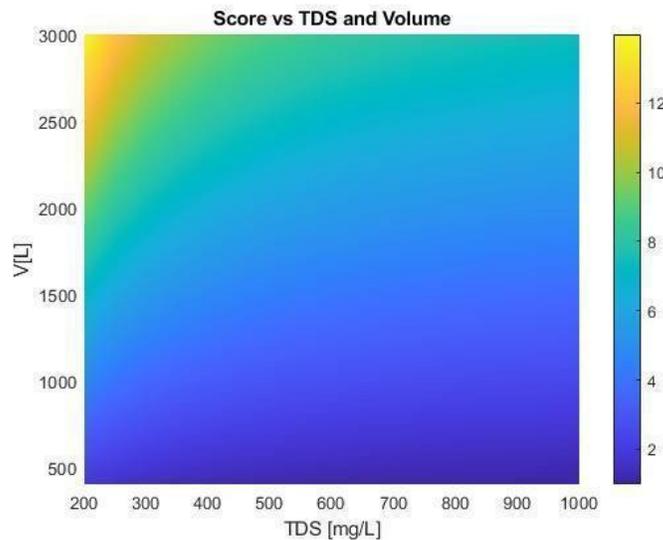


Figure 3. This graph shows the score ratings for potential volume and total dissolved solid concentration (TDS) combinations. *Graph from NREL*

## Commercialization Score

The commercialization potential will be assessed by an expert panel of reviewers to determine which device, in their expertise and judgment, is the most commercially viable. There will be a total of five statements that each reviewer will score. Four statements will be scored on a 1–6 scale and one statement will be scored as only a 1 or 6, for a total possible score of 30. These statements are intended to be broad in scope and will enable the reviewers to leverage their specific expertise in technology commercialization. The 1–6 scale is shown as follows.

1	2	3	4	5	6
Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

Statements That Will Be Scored on a 1–6 Scale
This technology has aspects that are appealing for a variety of end users.
This competing team has the breadth of experience and expertise required to commercialize their technology or has a credible plan to engage such expertise.
The developed wave-powered desalination device is well-suited for mass production and distribution processes.
This technology gives the reviewer confidence that it will be robust and low maintenance if deployed for an extended period (greater than 1 month) in a nearshore, ocean environment.

Statement That Will Receive Only a 1 Or a 6 Score
This technology, as deployed in the DRINK Stage competition, indicates that it is a commercially viable solution. Reviewers will base their decision on all DRINK Stage materials submitted by competing teams, their observed device performance during the DRINK Stage competition, and the competitor-reviewer interviews held throughout the deployment period of the DRINK competition.

## Performance Prize Scoring

There will be other prizes awarded to the competitors from a total prize pool of \$500,000. **To be eligible for any of the prize categories all the minimum thresholds, described in the Minimum System Technical**

**Requirements table in the Prizes section, must be met.** The four Performance Prizes are as described in the following table.

Performance Prizes	Description
Cleanest Water \$125,000	Awarded to the team that produces the cleanest water, measured as the lowest TDS in mg/L.
Lowest Weight \$125,000	Awarded to the team that has the lightest container delivered to the test site. Packed containers will be weighed by the CSI team.
Most Water \$125,000	Awarded to the team that produces the most water in liters.
Simplest Assembly, Deployment, and Operation \$125,000	Awarded to the team that has the fastest and simplest assembly deployment, and operation and least interventions throughout the competition.

## Assessment of Performance Prizes

### Cleanest Water

This prize will be assessed by measuring the electrical conductivity or specific conductance of desalinated water at the collection vessels to be stationed at Jennette’s Pier. The Prize Administrative team will develop a systematic sampling strategy (e.g., tanks will be sampled when they are drained). Each time a competitor’s tank is drained, a TDS sample will be taken and then applied to the amount of water that is drained from the tank. All TDS measurements will be weighted to their corresponding volume and a final TDS score will be established at the end of the competition period. The team that has the lowest TDS will be deemed the winner unless other teams are within 50 mg/L of the lowest TDS. If this occurs, all teams within 50 mg/L of the lowest TDS score will split the prize equally.

### Lowest Weight

This prize will be determined by weighing packed containers by the CSI team. The team that has the lowest weight in kg will be deemed the winner unless other teams are within 10 kg of the lowest weight. If this occurs, all teams within 10 kg of the lowest weight will split the prize equally.

### Most Water

This prize will be awarded to the team who produces the most water in liters. The water collection vessel will resemble that as shown in Figure 2. The drain valve will be plumbed with redundant water meters, and when the vessel is drained, the volume will be recorded. The collection tank will be mixed with a paddle mixer attachment on electric drill prior to draining, and samples can be taken from the water stream or tank itself. This will continue as many times as necessary during the contest to calculate the total volume produced.

## Simplest Assembly, Deployment, and Operation

The Simplest Assembly, Deployment, and Operation Prize will consider the time in minutes to assemble devices, the time in minutes needed for interventions or maintenance of the device, and the ease of deployment, as assessed qualitatively by the deployment team at CSI. The prize will be awarded based on the following scoring process.

Scoring Item	Weight	Scoring
Time Score Time to Assembly + Total Intervention Time Utilized (in minutes) Score	66%	Teams' scores will be normalized to the lowest-scoring team's time. The score will be calculated using the following equation: $66 \left( \frac{\text{Team's Time}}{\text{Lowest Team's Time}} \right) \text{ in minutes}$
Ease of Deployment and Retrieval Score	34%	24 possible points using the following equation: $34 \left( \frac{\text{Ease of Deployment and Retrieval Score}}{24} \right)$
Simplest Assembly, Deployment, and Operation Prize Points	100%	$66 \left( \frac{\text{Team Score}}{\text{Highest Team Score}} \right) + 34 \left( \frac{\text{Ease of Deployment and Retrieval Score}}{24} \right)$

### ***Time to Assembly + Total Intervention Time Utilized (in minutes)***

This metric will be determined by duration of the assembly of a device and timing any interventions after the device has been installed. Assembly time will begin when the team opens their shipping container and will end once each device for transport to Jennette's Pier for deployment. A maximum number of four members will be allowed on-site to assemble a device. Once a device is in the water and the competition begins, the intervention of each team will also be tracked and evaluated as part of this metric. There will be two 90-minute, daily intervention windows to assess equipment on the pier and intervene to adjust equipment operating on the pier, including the changing of RO filters and membranes. In the event of a needed intervention to their in-water device, a team may be allowed access on a case-by-case basis, depending on a safety review, weather and visibility assessment, and dive team availability. (See Appendix 2 for further details.) In this instance, any time that the team uses to repair, or assess, their device will be counted and added to the assembly time. This time will be measured from the time the team has access to their device until the time they indicate they are done with the work. The final metric will be the total time to assemble (in minutes) + total intervention time (in minutes).

### ***Ease of Deployment and Retrieval Score***

The ease of deployment and retrieval will be assessed by the team at CSI to determine which device, in their expertise and judgment, had the most straightforward deployment and retrieval plan and execution. There will be four scored statements. Each reviewer will score three statements on a 1–6 scale and one statement that the reviewer will score as 1 or 6. These statements are intended to be broad in scope and

will enable the reviewers to leverage their specific expertise surrounding technology deployment and retrieval. The 1–6 scale is shown as follows.

1	2	3	4	5	6
Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

The scoring will be used to calculate the ease of deployment and retrieval score. The following table explains the manner in which the ease of deployment and retrieval scores for each submission will be calculated.

Item	Number of Scored Statements	Total Possible Points
Ease of Deployment and Retrieval Reviewer Assessment	4	24

Statements That Will Be Scored on a 1–6 Scale
This technology has a well-documented and easy-to-follow deployment and retrieval plan developed for the DRINK Stage competition.
When following the deployment and retrieval plan, this technology was deployed and retrieved smoothly and safely.
This technology is adaptable to different locations and conditions and gives the reviewer confidence that it can be easily and safely deployed and retrieved with commonly available equipment in a wide variety of conditions.

Statement That Will Receive Only a 1 Or a 6 Score
This technology, as deployed in the DRINK Stage competition, indicates that it is an easily and safely deployed and retrieved wave-powered desalination system. Reviewers will base their decision on all DRINK Stage materials submitted by competing teams as well as their experience deploying and retrieving the device for the DRINK competition.

## How We Determine Winners

The Prize Administrator screens all completed submissions and, in consultation with DOE and CSI, will determine the readiness of each DRINK Stage competitor to deliver and deploy their device safely at Jennette’s Pier.

The Prize Administrator will consider the following components when determining prize winners for the five available prizes.

- **DRINK Deployment Device Performance:** Competitors will be evaluated against the scoring rubric in each prize category, as described in the prize section above.
- **Reviewer-Competitor Interview:** Competitors will be required to sign up for an interview with the panel of reviewers during the DRINK Stage, in-water competition at Jennette's Pier. Competitors will be invited to present, explain, and answer a set of questions developed by each participating reviewer pertaining to the functioning system and key operating principles. The interviews will be held prior to the announcement of winners and will serve to help clarify questions the reviewers may have.
- **Final Determination:** The director of WPTO is the judge of the competition and will make the final determination. Final determination of winners by the judge will take the competitor's scores, any interview findings, and the reviewers' feedback into account.
- **Announcement:** After the DRINK Stage contest closes, the Prize Administrator will publicly announce winners and request the necessary information to distribute cash prizes.

## Additional Terms and Conditions

See Appendix 1 for additional requirements. COMPETITORS THAT DO NOT COMPLY WITH THE ADDITIONAL REQUIREMENTS IN APPENDIX 1 MAY BE DISQUALIFIED.

# Appendix 1: Additional Terms and Conditions

## Universal Contest Requirements

Your submissions are subject to following terms and conditions:

- You must post the final content of your submission or upload the submission form online at <https://www.herox.com/WavestoWater> before the relevant contest closes. Other submission formats may be identified at a later date. Any other form of submission outside of the designated pathways will not be accepted. Late submissions will not be accepted.
- By clicking Submit in HeroX, the competitor is acknowledging that their technology will be deployed in a public setting and their publicly facing digital drawings, images, and diagrams will be made public.
- You must include all the required submission elements. The prize administrator may disqualify your submission after an initial screening if you fail to provide all required submission elements. Competitors may be given an opportunity to rectify submission errors due to technical challenges or to fix non-substantive mistakes or errors in their submission packages.
- Your submission must be in English and in a format readable by Microsoft Word or a PDF viewer. Handwritten submissions will not be accepted.
- Submissions and competitors will be disqualified if any engagement with the Waves to Water Prize—included but not limited to the submission, the HeroX forum, or emails to the prize administrator—contains any matter that, in the sole discretion of the U.S. Department of Energy (DOE) or the National Renewable Energy Laboratory (NREL), is indecent, obscene, defamatory, libelous, lacking in professionalism, or demonstrates a lack of respect for people or life on this planet.
- If you click “Accept” on the HeroX platform and register for any of the contests described in this document, you are agreeing to be bound by these rules in addition to the existing HeroX Terms of Use for all purposes relating to these contests. You should print and keep a copy of these rules. These provisions apply only to the contests described here and no other contests on the HeroX platform or anywhere else.

## Verification for Payments

The prize administrator will verify the identity and role of all competitors before distributing any prizes. Receiving a prize payment is contingent upon fulfilling all requirements contained herein. The prize administrator will notify winning competitors using provided email contact information for the individual or entity that was responsible for the submission. Each competitor will be required to sign and return to the

prize administrator, within 30 days of the date on the notice, a completed NREL Request for ACH Banking Information form and a completed W-9 form (<https://www.irs.gov/pub/irs-pdf/fw9.pdf>). At the sole discretion of the prize administrator, a winning competitor will be disqualified from the competition and receive no prize funds if: (i) the person/entity does not respond to notifications; (ii) the person/entity fails to sign and return the required documentation within the required time period; (iii) the notification is returned as undeliverable; (iv) the submission or person/entity is disqualified for any other reason as specified in this document.

In the event of a dispute as to any registration, the authorized account holder of the email address used to register will be deemed to be the competitor. The “authorized account holder” is the natural person or legal entity assigned an email address by an internet access provider, online service provider, or other organization responsible for assigning email addresses for the domain associated with the submitted address. All competitors may be required to show proof of being the authorized account holder.

## Team and Single-Entity Awards

The Prize Administrator will award a single dollar amount to the designated primary submitter, whether consisting of a single or multiple entities. The primary submitter is solely responsible for allocating any prize funds among its member competitors or teammates as they deem appropriate. The Prize Administrator will not arbitrate, intervene, advise on, or resolve any matters or disputes between team members or competitors.

## Submission Rights

By making a submission and consenting to the rules of the contest, a competitor is granting to DOE, the prize administrator, and any other third parties supporting DOE in the contest a license to display publicly and use the parts of the submission that are designated as “public” for government purposes. This license includes posting or linking to the public portions of the submission on the prize administrator or HeroX applications, including the contest website, DOE websites, and partner websites, and the inclusion of the submission in any other media worldwide. The submission may be viewed by DOE, the Prize Administrator, and the judges and reviewers for the purposes of the contests, including but not limited to screening and evaluation purposes. The Prize Administrator and any third parties acting on their behalf will also have the right to publicize competitors’ names and, as applicable, the names of competitors’ team members and organization, which participated in the submission on the contest website indefinitely.

By entering, the competitor represents and warrants that:

1. A competitor’s entire submission is an original work by the competitor and the competitor has not included third-party content (such as writing, text, graphics, artwork, logos, photographs, likeness of any third party, musical recordings, clips of videos, television programs or motion pictures) in or in connection with the submission, unless (i) otherwise requested by the prize administrator and/or disclosed by the competitor in the submission, and (ii) the competitor has either obtained the rights to use such third-party content or the content of the submission is considered in the public domain without any limitations on use.

2. Unless otherwise disclosed in the submission, the use thereof by the Prize Administrator, or the exercise by the Prize Administrator of any of the rights granted by the competitor under these rules, does not and will not infringe or violate any rights of any third party or entity, including, without limitation, patent, copyright, trademark, trade secret, defamation, privacy, publicity, false light, misappropriation, intentional or negligent infliction of emotional distress, confidentiality, or any contractual or other rights.
3. All persons who were engaged by the competitor to work on the submission or who appear in the submission in any manner have:
  - a. Given the competitor their express written consent to submit the submission for exhibition and other exploitation in any manner and in any and all media, whether now existing or hereafter discovered, throughout the world
  - b. Provided written permission to include their name, image, or pictures in or with the submission (or, if a minor who is not competitor's child, the competitor must have the permission of the minor's parent or legal guardian) and the competitor may be asked by the prize administrator to provide permission in writing
  - c. Not been and are not currently under any union or guild agreement that results in any ongoing obligations resulting from the use, exhibition, or other exploitation of the submission.

## Copyright

Each competitor represents and warrants that the competitor is the sole author and copyright owner of the submission; that the submission is an original work of the competitor or that the competitor has acquired sufficient rights to use and to authorize others, including DOE, to use the submission, as specified throughout the rules; that the submission does not infringe upon any copyright or any other third-party rights of which the competitor is aware; and that the submission is free of malware.

## Contest Subject to Applicable Law

All contests are subject to all applicable federal laws and regulations. Participation constitutes each participant's full and unconditional agreement to these Official Contest Rules and administrative decisions, which are final and binding in all matters related to the contest. This notice is not an obligation of funds.

## Resolution of Disputes

The U.S. Department of Energy is solely responsible for administrative decisions, which are final and binding in all matters related to the contest.

Neither the U.S. Department of Energy nor the prize administrator will arbitrate, intervene, advise on, or resolve any matters between team members or among competitors.

## Publicity

The winners of these prizes (collectively, "winners") will be featured on the DOE and NREL websites.

Except where prohibited, participation in the contest constitutes each winner's consent to DOE's and its agents' use of each winner's name, likeness, photograph, voice, opinions, and/or hometown and state information for promotional purposes through any form of media worldwide, without further permission, payment, or consideration.

## Liability

Upon registration, all participants agree to assume any and all risks of injury or loss in connection with or in any way arising from participation in this contest. Upon registration, except in the case of willful misconduct, all participants agree to and, thereby, do waive and release any and all claims or causes of action against the federal government and its officers, employees, and agents for any and all injury and damage of any nature whatsoever (whether existing or thereafter arising, whether direct, indirect, or consequential, and whether foreseeable or not), arising from their participation in the contest, whether the claim or cause of action arises under contract or tort.

In accordance with the delegation of authority to run this contest delegated to the director of the Water Power Technologies Office, the director has determined that no liability insurance naming DOE as an insured will be required of competitors to compete in this competition per 15 USC 3719(i)(2). Competitors should assess the risks associated with their proposed activities and adequately insure themselves against possible losses.

## Records Retention and Freedom of Information Act

All materials submitted to DOE as part of a submission become DOE records and are subject to the Freedom of Information Act. The following applies only to portions of the submission not designated as public information in the instructions for submission. If a submission includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, DOE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source. Submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose.

The submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

**“Notice of Restriction on Disclosure and Use of Data:**

Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes. [End of Notice]”

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows:

“Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure.”

In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets.

Competitors will be notified of any Freedom of Information Act requests for their submissions in accordance with 29 C.F.R. § 70.26. Competitors may then have the opportunity to review materials and work with a FOIA representative prior to the release of materials.

## Privacy

If you choose to provide HeroX with personal information by registering or completing the submission package through the contest website, you understand that such information will be transmitted to DOE and may be kept in a system of records. Such information will be used only to respond to you in matters regarding your submission and/or the contest unless you choose to receive updates or notifications about other contests or programs from DOE on an opt-in basis. DOE and NREL are not collecting any information for commercial marketing.

## General Conditions

DOE reserves the right to cancel, suspend, and/or modify the contest, or any part of it, at any time. If any fraud, technical failures, or any other factor beyond DOE's reasonable control impairs the integrity or proper functioning of the contests, as determined by DOE in its sole discretion, DOE may cancel the contest.

DOE reserves the right to only select competitors that are likely to achieve the goals of the program. If, in DOE's determination, no competitors are likely to achieve the goals of the program, DOE will select no competitors to be awarded a prize.

## Program Policy Factors

While the scores of the expert reviewers will be carefully considered, it is the role of the prize judge to maximize the impact of contest funds. Some factors outside the control of competitors and beyond the independent expert reviewer scope of review may need to be considered to accomplish this goal. The following is a list of such factors. In addition to the reviewers' scores, the below program policy factors may be considered in determining winners:

- Whether the use of additional DOE funds and provided resources are nonduplicative and compatible with the stated goals of this program and the DOE mission generally
- The degree to which the submission exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other competitors
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers
- The degree to which the submission is likely to lead to increased employment and manufacturing in the United States or provide other economic benefit to U.S. taxpayers
- The degree to which the submission will accelerate transformational technological, financial, or workforce advances in areas that industry by itself is not likely to undertake because of technical or financial uncertainty
- The degree to which the submission supports complementary DOE funded efforts or projects, which, when taken together, will best achieve the goals and objectives of DOE
- The degree to which the submission expands DOE's funding to new competitors and recipients who have not been supported by DOE in the past
- The degree to which the submission enables new and expanding market segments
- Whether the project promotes increased coordination with nongovernmental entities for the demonstration of technologies and research applications to facilitate technology transfer.

## National Environmental Policy Act Compliance

DOE's administration of the American-Made Challenges: Waves to Water Prize is subject to National Environmental Policy Act (NEPA) (42 USC 4321, et seq.). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website, at <http://nepa.energy.gov/>.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all participants in the DRINK Stage will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their participation in the prize competition. Participants may be asked to provide DOE with information on fabrication and testing of their device such that DOE can conduct a meaningful evaluation of the potential environmental impacts.

## RETURN OF FUNDS

As a condition of receiving a prize, competitors agree that if the prize was made based on fraudulent or inaccurate information provided by the competitor to DOE, DOE has the right to demand that any prize funds or the value of other non-cash prizes be returned to the government.

**ALL DECISIONS BY DOE ARE FINAL AND BINDING IN ALL MATTERS RELATED TO THE CONTEST.**

# Appendix 2: Jennette’s Pier Test Site and DRINK Stage Details

## Shipping Container Specifications

In the DRINK Stage, competitors will be required to fit their entire system within a standardized container. The container that has been selected is a standard, commercial, off-the-shelf container that is approximately 45 by 48 by 42 inches (e.g., DuraGreen DGR454842). The internal dimensions that all system components must fit inside are approximately 41 by 44 by 35 inches. The contest seeks technologies that can fit into a predefined container to standardize the shipping constraints that face many disaster-response and -recovery scenarios. Specifically, the Waves to Water Prize is targeting locations that may have damaged infrastructure and therefore may have limited access to on-road transportation. For this reason, the container that has been selected is sized so that any light-duty pickup truck will be able to transport a single unit to its final location. The U.S. Department of Energy (DOE) Water Power Technologies Office will supply the final contestants with one container to ensure that every competitor at the final DRINK Stage has the same shipping constraints.

## Site Testing Conditions and Setup

All solutions competing in the DRINK Stage will be evaluated at Jennette’s Pier in Nags Head, North Carolina, an open-water test site with the following site characteristics. Please note some of the data, such as water depth, are given as expected planning ranges, but actual site conditions might vary depending on shifting bathymetry, local weather conditions, and each device’s deployment needs<sup>10</sup>. The Waves to Water Prize Administration Team will plan to identify locations that meet the following criteria. These locations will have a:

- Typical significant wave height range between 0.5 meters (m) and 2.0 m
- Typical wave period range between 5 and 15 seconds
- Water depth between 2 and 5 m
- Deployment location less than 1 kilometer from shore.

It is anticipated that the test site configuration will look like the following schematic shown in Figure 4. The deployment area adjacent to the pier extends east and west from the subtidal zone, seaward of the typical surf zone, and from approximately 50 m (164 feet [ft]) to 100 m (328 ft) from the pier to the north and south.

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<sup>10</sup> A bathymetry survey will be taken and provided to the competing teams in advance of the open-water competition.

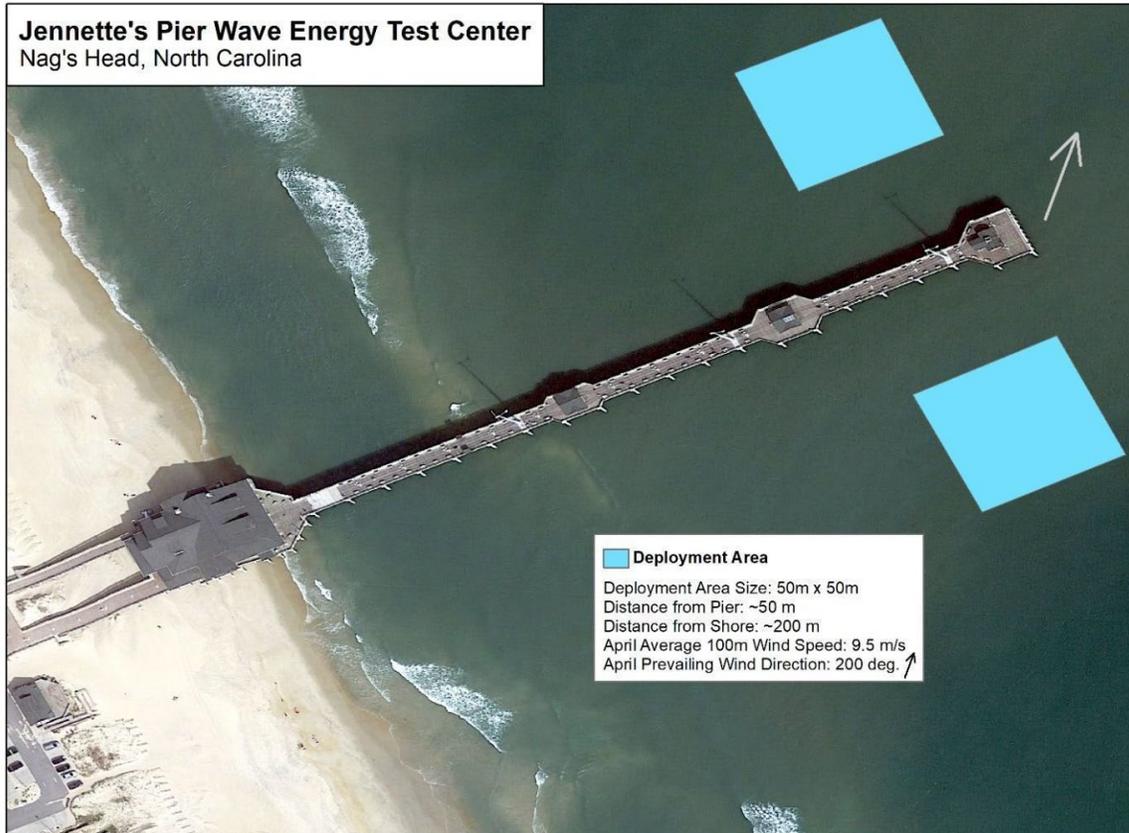


Figure 4. This schematic of Jennette's Pier shows the deployment areas for the Waves to Water Prize DRINK Stage. *Photo by Coastal Studies Institute*

The pier deck is 96 inches wide at the narrowest point. The minimum height restriction encountered between the staging area and deployment area is 2.87 m (9.42 ft).

The pier deck is approximately 7.9 m (26 ft) from the water surface. The water depth in the testing area ranges from approximately 2 to 5 m (6.5–16.4 ft). However, this range cannot be strictly guaranteed, and there might be further variance across the test site. Prior to the DRINK Stage deployment, the Coastal Studies Institute (CSI) will survey the bathymetry of the testing site. After, the Prize Administrative Team will plan to identify deployment sites with a 2-m to 5-m water depth range for each device. Competitors will work for a set period of hours with the team at CSI in advance of the DRINK Stage to finalize—at a minimum—their mooring configuration, National Environmental Policy Act compliance, and deployment strategy.

## Standard Chain Pile Anchors

At the test site, competitors will be provided with a standard chain pile anchor connection. It is anticipated that the standard anchor will be a 3-inch shackle at a top of the chain pile, approximately 24 inches from the seafloor. The anchor will have an approximate capacity of 680.4 kg (1,500 pounds). Teams should not plan to exceed this limit. If a team does exceed this limit and a water or electrical line is disconnected because of excessive anchor movement, the team will not be allowed to reconnect. Connected to the shackle, CSI will attach a section of long link chain that competitors can attach their device to, or they can connect directly to the 3-inch shackle (see Figure 5). Design failure load links are not designed in the chain pile anchor system. Competitors are responsible for designing failure loads into their connection. Additionally, any line that connects from the shackle, or long link chain, to the device is the responsibility of the competitor. The connections between the devices and the standard chain pile anchors will be made by CSI divers, and therefore, the teams will need to specify how they intend to connect to the chain pile anchor. Should a competitor seek an alternative anchor, they will have to get it approved by CSI and the National Renewable Energy Laboratory (NREL).

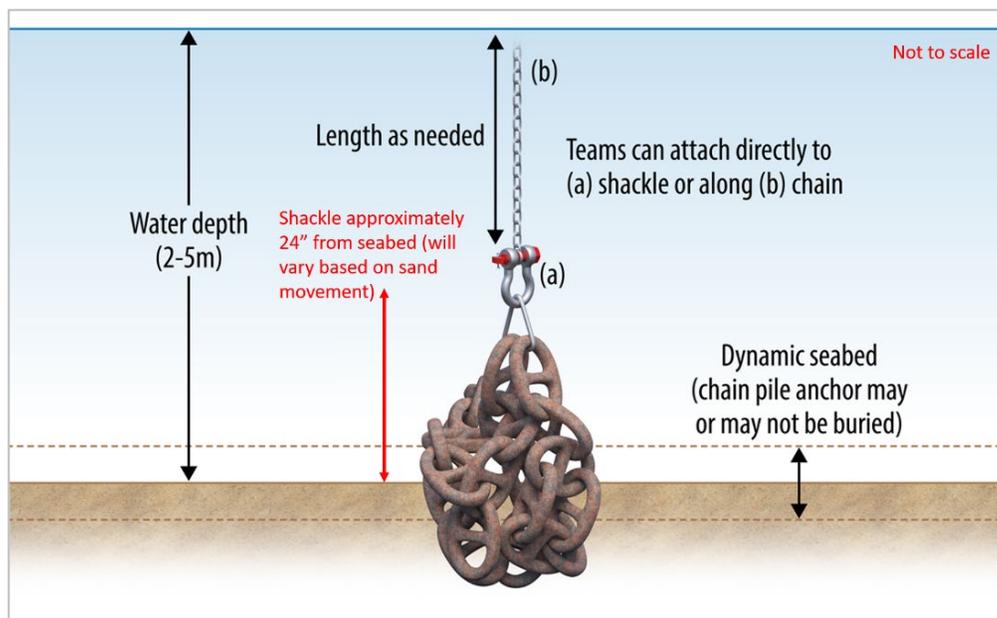


Figure 5. This schematic shows the underwater layout of the anchor that competitors will secure their in-water devices to during the Waves to Water Prize DRINK Stage. *Schematic by NREL*

## Equipment Available for Teams

At CSI, a forklift, overhead crane, and outdoor jib crane are available for weighing devices and loading them onto a trailer to be transported to Jennette's Pier. At Jennette's Pier, an electric pallet jack, a Bobcat with forks (T550), and a manual pallet jack will be available to move devices between the staging area in the pier's parking lot and onto and along the pier. There will also be a lift truck (1,814-kilogram or 4,000-pound capacity) for use in the staging area. If the Bobcat is required for mobilization, this activity will need to be performed by the CSI team because of liability and safety concerns.

A set of basic hand tools will be provided for teams for initial setup; any additional tools that the team will need for assembly will need to fit into the team's container. As part of the Jan. 12, 2022, Final Design Submission deadline, all competitors will need to provide a list of basic hand tools that they will use for system assembly, disassembly, and during interventions. The list provided should include two categories: 1) tools that the team will bring to the competition to support assembly, disassembly, and intervention needs; and 2) tools that the team would like the prize administration team to make available for on-site use at the CSI and Jennette's Pier location. Teams will be informed of the full list of tools to be provided on site prior to arrival.

## Deployment and Retrieval

In the DRINK Stage, solutions will need to address the ability to deploy quickly and easily in a disaster-response scenario where there is large uncertainty around site conditions. Competitors will have to deploy their systems in under 48 hours. Devices will be assembled at CSI and/or the Jennette's Pier parking area and deployed by a qualified team of divers and staff from CSI with a Spydercrane. Should a competitor seek to use an alternate deployment method, they will need to get it approved by CSI, WPTO, and NREL.

CSI will need the ability to unbridle and rebridle from the water, and competitors should demonstrate this capability in their rigging. The teams will also need to demonstrate that their devices will be within the height limit and within 70% of the weight capacity for the crane (single line; see the Spydercrane Specification sheet), accounting for shock load in both deployment and retrieval. This weight capacity should assume any open voids may be filled with water.

As part of the DRINK Stage, competitors will work with CSI, WPTO, and NREL to finalize the assembly plan, including how the device will be assembled on-site. Because devices will be deployed on a schedule, each device should have an inactive mode of operation. Once the devices have all been installed, there will be at least 1 hour of inactive time for the devices to ensure fairness. This 1 hour of inactive time will not count toward the 48-hour deployment window. If water is produced during the inactive period, water will be removed from the collection vessel before the contest begins.

## Water Delivery and Collection

Water will need to be either desalinated directly on Jennette's Pier or pumped to the pier in the form of desalinated water. For competitors planning to send untreated seawater to the pier, they will be responsible for outlining their plan and technical requirements for pumping seawater to the pier to feed

into their reverse-osmosis system. Competitors will need to identify a pump and work with the prize administration team to locate and secure this device relative to the pier.

Water will be collected in vessels located on the pier deck and will be periodically monitored<sup>11</sup> for total dissolved solids (TDS), pH, and turbidity. Values will be measured at least twice daily. The drums will be emptied as needed. At the beginning of the contest, competitors can choose when to begin collecting water. Teams may choose to drain their collection vessel after the contest begins, but total water produced will restart. The following standards for water quality informed the prize criteria:

- **Maximum Level TDS:** 1,000 milligrams per liter (mg/L). (The World Health Organization advises water with a TDS concentration of less than 1,000 mg/L is “usually acceptable” for palatability.)
- **Target Level TDS:** 300–600 mg/L. (This level of TDS is needed to achieve a generally acceptable taste.)

Ultimately, the prize seeks to produce drinking water at the final DRINK Stage of the competition that meets both the U.S. Environmental Protection Agency’s Secondary Standards and the mandatory limits of the National Primary Drinking Water Regulations. It is anticipated that as part of the prize, WPTO and NREL will send samples of the water competitors produced during the prize to an U.S.-Environmental-Protection-Agency-certified laboratory for analysis. However, these results will not be considered in the Grand Prize or Performance Prizes.

## Intervention During the DRINK Stage Competition

During the DRINK Stage competition, the teams will have to be conscious of device intervention in different phases throughout the event.

### Initial Setup and Delivery

Teams will ship devices to CSI (so there is someone to receive them) and set them up prior to April 1, 2022, in the CSI garage. CSI will transport the devices to Jennette’s Pier using a trailer. If competitors prefer, devices can be shipped to CSI and delivered to Jennette’s Pier’s parking lot across from the pier for assembly, but no security will be provided to monitor these devices prior to deployment.

After each teams’ shipping container arrives at CSI, teams will uncrate and assemble their systems. The systems will be transported to Jennette’s Pier and deployed by certified divers and staff from CSI with a Spydercrane. Once attached to the standard chain pile anchor, the CSI team will commission each device to compete in the competition. After the test period, results will be analyzed and a decommissioning phase will begin.

CSI inspection will need to take place before any of the teams can proceed to the installation and deployment stage of the contest. During the assembly window, teams will be able to access a basic set of

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<sup>11</sup> Sample devices that could be used for water quality measurement during the competition include: YSI EXO (<https://www.ysi.com/exo2>) with conductivity/temperature, optical DO, pH, total algae and turbidity sensors; or an Oakton TDS meter (<https://internal.coleparmer.com/i/oakton-tds-6-handheld-tds-meter-with-probe/3560420>) with NIST calibration.

hand tools for assembly. A list of the specific tools available will be provided 2 weeks following the Jan. 20–21, 2022, final design interviews. Any additional tools or equipment that will be required for assembly will need to be disclosed to the prize administration team and must fit in the specified container.

## **Preinstallation Test and Checkout**

If needed, each team will be allowed 1 hour at a specified time and under supervision of Prize Administration staff after the initial two 10-hour days to ensure all components are assembled properly (e.g., there is no binding of components, all hardware is torqued to spec, and so on) prior to being delivered to the pier.

## **Transport to the Crane**

After the device has been assembled and inspected by the CSI and NREL safety officers and the weather window has been determined for installation, devices may either be walked down the pier by teams (with assistance from NREL, CSI, or Jennette’s Pier staff, if needed), or CSI will provide additional equipment for mobilizing the device. Use of the Bobcat and/or a pallet jack will be performed by the CSI team because of liability and safety concerns. Once the device is at the end of the pier, the crane will need to be attached to the lift points on the device per the lift plan that will have been approved by CSI prior to the competition. The crane, operated by the CSI team, will lift the device into the water and tow it out to the final location where it will be anchored by the CSI dive team.

## **Deployment and Commissioning of the Device**

The CSI dive team will install the device and connect any anchor lines and water or electrical connections to the device. This procedure will need to be documented in the commissioning plan and approved by the CSI and NREL safety officers prior to arrival. This commissioning plan will need to include any additional steps that the divers will need to include to initiate production during the contest, such as opening or closing valves, engaging any relays or switches on the device, and defining the connections for water and/or electrical on the device that will end up on the pier. If there are technical difficulties associated with the commissioning plan, the dive team may need to communicate with the competing teams to develop a safe installation procedure during this time. However, because of safety and liability concerns, the teams will not be allowed to perform any of these activities themselves.

Any equipment that is on Jennette’s Pier, such as any desalination units, will need to be described in the commissioning plan and approved by the CSI and NREL safety officers. Any commissioning activities, such as opening or closing valves and engaging any relays or switches, that are located on the pier can be performed by the team upon approval by the CSI and NREL safety officers.

## **Post-Installation Test and Checkout**

Once the device and any equipment on the pier has been installed, each team will be allowed two 90-minute intervention windows to ensure all components are functioning as expected and that the installation was successful before the contest begins. If there are any changes that need to be made,

either on the pier or on the device, it will be at the discretion of the CSI and NREL safety officers, and a correction plan will be evaluated with that competing team.

## During the Contest

Once all devices have been commissioned, any water that has been collected during the commissioning phase and the test and checkout phase will be drained, and the contest will begin at the same time for all competitors. During the contest, each team will be allowed two 90-minute windows each day at predetermined times to assess their equipment on the pier. Competitors should plan to not have access to any equipment on the in-water device. But in the event of a needed intervention to their in-water device, access may be allowed on a case-by-case basis, depending on a safety review, weather and visibility assessment, and dive team availability. In the event of a component or system failure outside of the specified 90-minute windows, any proposed repair will need to be reviewed and authorized by the NREL and CSI teams.

Competing teams will be allowed to remotely monitor and/or control their devices. Dedicated communication lines will not be permissible. Wireless communication is permissible; however, all communication and power must be provided by the team, following the rules of the prize, and powered solely using wave energy and/or the allotted 0.5-kilowatt-hour battery limit. Remote controlled devices used for controlling operations and communication on the device will not count toward the 0.5-kilowatt-hour total allowable battery usage.

## Decommissioning and Retrieval

After the prize has concluded, the devices will be decommissioned and removed. Prior to the DRINK Stage, a decommissioning plan will need to be developed and reviewed by the CSI team to ensure safe removal of the device. Each competing team will also be required to provide a removal strategy in their lift plan to get the device back onto the pier and back to the staging area. In the staging area, competing teams will be required to disassemble and remove the device from the test location. The device does not need to fit back into the required container, but it must be removed from the contest location by each competing team. Any abandoned equipment will be disposed of at the discretion of CSI and teams will be charged an exorbitant fee for disposal.

## National Environmental Policy Act Compliance

The following is a list of environmental concerns that must be addressed prior to the final design review:

- Noise emissions from the devices' operation.
- Entanglement of and/or collision by marine organisms and diving birds.
- The presence of deployment and retrieval vessels in the water, deployment and retrieval equipment on the beach and Pier facilities, and a UAS in the air introduce the risk of striking organisms, noise emissions, and light emissions.
- Direct impact by project related equipment or materials.
- Exposure to wastes and discharges.
- Human presence disturbance.
- General disturbance.

Brine discharge, or other salt concentration issues resulting from the process of desalinating water, will need to be managed effectively depending on existing environmental regulations. The development of zero or near-zero liquid discharge technologies can be important for achieving highly efficient desalination systems. In addition, it is important that desalination systems do not introduce biological or chemical contaminants, such as unregulated or nontraditional constituents (e.g., boron). Brine management strategies that effectively address both the economic and environmental cost of brine diffusion, disposal, or other applications will be encouraged. Specific strategies that are robust across a variety of feedwater types could also be critical for some applications and should be considered. Another critical factor might be the trade-off between concentrating brine recovery and brine volume and determining an optimal level of water production to resource recovery.

Additionally, consideration will be given to system recovery, cleanup, and possible redeployment. At a minimum, technology that is deployed at the test site will have to be completely removed from the test site at the end of the testing period.

## Relevant Regional Observations

### Waves

Historical wave heights from a moored acoustic wave and current meter at the 11-m test berth at Jennette's Pier: <https://chlthredds.erdcdren.mil/thredds/catalog/frf/oceanography/waves/awac-jpier-11m/catalog.html>

Regional wave information from the U.S. Army Corps of Engineers Field Research Facility: <https://chlthredds.erdcdren.mil/thredds/catalog/frf/oceanography/waves/catalog.html>

Measurements from Waverider 243 at the 26-m isobath about 10 miles offshore from Jennette's Pier: [https://cdip.ucsd.edu/themes/?d2=p70:s:243&zoom=auto&pub\\_set=public&regions=all&tz=UTC&units=standard](https://cdip.ucsd.edu/themes/?d2=p70:s:243&zoom=auto&pub_set=public&regions=all&tz=UTC&units=standard)

Measurements from Waverider 192 at the 26-m isobath to the south of Jennette's Pier about 10 miles offshore from Pea Island: [https://cdip.ucsd.edu/themes/?d2=p70:s:192&zoom=auto&pub\\_set=public&regions=all&tz=UTC&units=standard](https://cdip.ucsd.edu/themes/?d2=p70:s:192&zoom=auto&pub_set=public&regions=all&tz=UTC&units=standard)

Measurements from a CSI spotter buoy at Jennette's Pier: [https://spotters.sofarocan.com/?spotter-filter=SPOT-0560&fbclid=IwAR1VRVR6Oo4avL4xTQUaN6HwyKX\\_f33my63vpM8T6VGN50ZcIFSlotJFaHo](https://spotters.sofarocan.com/?spotter-filter=SPOT-0560&fbclid=IwAR1VRVR6Oo4avL4xTQUaN6HwyKX_f33my63vpM8T6VGN50ZcIFSlotJFaHo)

### Currents

The most relevant, available current data may be from this acoustic wave and current profiler deployed at the U.S. Army Corps of Engineers Field Research Facility at the same depth as the test site: <https://chlthredds.erdcdren.mil/thredds/catalog/frf/oceanography/currents/awac-5m/2009/catalog.html>

Surface currents offshore from the test site in North Carolina from the National High Frequency Radar Network: <https://dods.ndbc.noaa.gov/thredds/hfradar.html>

View the surface current map in near-real time: <https://cordc.ucsd.edu/projects/mapping/maps/>

## Tides

The most accurate tidal information may be from the U.S. Army Corps of Engineers Field Research Facility tide gauge in Duck:

<https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=8652226&units=metric&bdate=20220401&edate=20220430&timezone=LST/LDT&clock=12hour&datum=MLLW&interval=hilo&action=monthlychart>

## Wind

Three years of historical observational meteorological data, including wind, from the National Oceanic and Atmospheric Administration <sup>12</sup>:

<https://americanmadechallenges.org/wavestowater/docs/JennettesMetData.xlsx>

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<sup>12</sup> Any party using these wind data must acknowledge WeatherFlow Inc. as the provider.

# Appendix 3: Safety During Assembly, Transportation, and Handling Operations at the Competition Sites

Working safely is a requirement of a successful competition. All participants in this activity have the authority and responsibility to stop work if unsafe conditions are observed or suspected and notify staff immediately. Do not act instinctively or impulsively to save hardware that may be about to undergo an imminent failure. Equipment or property can be replaced, but people cannot. The safe completion of this competition depends on all team members conducting work in accordance with these requirements and always remaining vigilant.

## Personnel Protective Equipment

At a minimum, throughout the course of this competition, workers shall be trained to use personal protective equipment (PPE), which is considered the last line of defense against an injury. This equipment shall fit properly, be comfortable, and must be readily accessible. All PPE in use shall meet the pertinent American National Standards Institute (ANSI) requirements. Guidance for selection and proper usage of PPE can be found here.

- Hard hats (ANSI Z89.1) – To reduce the potential for injury from accidental impacts, hard hats will be worn when equipment is being hoisted by a crane or heavy equipment, such as when forklifts are in operation. Hard hats will be inspected before use and baseball hats or caps are not allowed to be worn underneath, where they could interfere with the suspension.
- Safety glasses with side shields (ANSI Z87.1) are required when working with tools or when workers may be potentially exposed to flying objects, particles, or incidental splashes from chemicals that could injure the eyes.
- Hearing protection, such as ear plugs or muffs, shall be worn properly when faced with high noise tasks or environments and must have an appropriate noise reduction rating.
- Heavy-duty work gloves to protect the hands from sharp objects and abrasions. Chemical gloves that are adequately resistant to the materials in use.
- Sturdy work boots to give proper traction and protect the feet and toes. If heavy objects are being lifted that could be dropped and injure the feet or heavy equipment is in use in the immediate area, safety-toed footwear that meets the appropriate American Society for Testing and Materials standard shall be used.
- Personnel working over or near water, outside of public pier guard rails where the danger of drowning exists, shall be provided with U.S.-Coast-Guard-approved life jackets or buoyant work vests.
- Respiratory protection – Work tasks that require the use of tight-fitting respiratory protection, such as, but not limited to, spray painting, silica producing activities, composite work, resin application, composite grinding, or the use of hazardous chemicals, are forbidden at the competition site.

As necessary, workers shall continuously assess the hazards to determine the need for additional PPE based upon specific tasks. Additional PPE may also be required by support staff when a hazard is identified.

## Hand Tools

Hand tools must be properly maintained to keep workers from being injured while in use. Workers must familiarize themselves with the instruction manual for powered hand tools and follow the safety requirements specified. Always inspect tools prior to use to determine if they are fit for service and ensure that guards are secure; do not remove them. Ensure that electrical cords are in good condition and that ground fault circuit interrupters are in use when working outdoors or in potentially wet or damp environments. Trying to “make do” with the wrong tool, especially attempting to use a tool that is too small for the job, causes many injuries.

## Manual Material Handling: Lifting Safely To Prevent Musculoskeletal Injuries

To prevent musculoskeletal injuries, use the following techniques to lift objects safely:

- Employ sound manual lifting techniques and body mechanics.
- Use mechanical lifting aids when possible.
- Avoid single-person lifts of heavy objects. Use team lifts instead.
- Evaluate all lifts in advance to identify good hand holds.
- Plan your route and eliminate objects in your path of travel.
- Wear gloves to improve your grip on an object.

## Electrical Safety, Lockout/Tagout, System Safety

Guidelines on electrical safety, lockout/tagout, and system safety include the following:

- **System Safety Design Review:** Provide a one-line diagram and piping and instrumentation diagram for system safety design review. Provide details on the components to be used. Systems that contain hazardous chemicals/materials or are pressurized need to have flow rates, volumes and pressures, and have associated safety systems.
- **Electrical Safety:** Work on energized systems shall be limited to taking voltage and current measurements while wearing the appropriate PPE by a trained and authorized worker as determined by Coastal Studies Institute (CSI) and NREL. The electrical safe work practices and PPE requirements identified in NFPA-70E 2018 and the NREL Electrical Safety Program shall be followed. There are no exceptions to this requirement. Electrical installations shall conform to the National Electric Code. All completed electrical work shall be inspected and approved by a licensed electrician (other than the installer). Appropriately rated electrical cords and ground fault interrupter circuits shall be used to support outdoor electrical work (e.g., use of power tools) or work in wet or damp environments.

- **Arc Flash Hazards:** A 6-foot arc flash boundary shall be established for work conducted on energized systems (including voltage testing to confirm zero energy). Boundary tape or a spotter shall be deployed to keep unauthorized and unqualified workers away from the work area.
- **Multiple Energy Source Hazards:** Work on systems having the potential for multiple energy sources (e.g., pressure, tension, electrical) will employ the use of lockout/tagout (LO/TO) procedures to achieve effective isolation and zero energy. All workers within the LO/TO boundary shall have locks and tags applied at the predetermined LO/TO points and shall witness zero-energy verification. During verification of zero energy, the PPE and approach boundaries as specified in NFPA-70E 2018 shall be followed.
- **Electrical PPE:** Electrical PPE is selected based on the voltage rating and task per NFPA-70E 2018 and the NREL Electrical Safety Program.

## Crane Operations: Hoisting and Rigging Hazards

- Crane and lift operator(s) shall be experienced, qualified, and authorized. The cranes shall be thoroughly inspected by the operators prior to the lift. Any deficiency identified during the inspection shall be corrected prior to the lift.
- The work area shall be inspected prior to the lift and move to ensure that the path of travel is unobstructed and free of hazards. As necessary, objects that might interfere with the lift or path of travel shall be moved. Ground conditions must be stable in the lift area and over the path of travel.
- A lift master shall be designated and supervise and oversee all aspects of this activity. Individual assignments of responsibility shall be made to assure that the sequence of work is executed safely and that the equipment employed performs as intended (e.g., crane, rigging).
- A lift plan shall be developed, detailing the test articles specifications (e.g., dry weight, wet weight, dimensions) and how it shall be rigged, lifted, placed into the water, and finally, retrieved, shall be submitted for review and approval by competition staff. This plan will be written and approved utilizing NREL Form F1262 or an equivalent. Special design consideration shall be given to the fact that the test article will need to be connected by staff to rigging while its floating on the water.
- Lifting slings and rigging hardware shall be selected based on anticipated loads and rigging configuration (e.g., sling angles, sling hitch). Appropriate derating factors shall be applied based on sling angle and hitch configuration. Where necessary, small diameters and sharp edges shall be padded to prevent sling damage. Test lifts shall be conducted to assess the center of gravity and the adequacy of rigging for each lift. Rigging adjustments as necessary shall be made prior to the actual lift.
- A prelift safety meeting shall be conducted with all workers involved in this activity to review the scope of work, assignments, responsibilities, and communication protocols (e.g., radios, verbal commands, hand signals) and to identify the path and sequence of the lift and other necessary details to ensure a safe operation.
- Tag liners and riggers shall remain clear of loads when suspended. No one shall be permitted to stand, walk, or work beneath a suspended load or live loads that have the potential to shift unexpectedly.
- The lift master and crane operators shall remain vigilant of the wind and weather conditions. If unexpected or unpredictable behavior is observed, the lift shall be suspended. A conservative approach shall be employed.

- Persons not directly involved in this activity shall stay clear of the work area while the moves and lifts are in progress. The work team shall remain vigilant for intruders and suspend the lift/move if necessary.

## Shifting and Crushing Loads

The hoisting and rigging process shall proceed cautiously to ensure that workers are not exposed to injury. Workers shall remain clear of suspended loads and the reactive path of loads under tension. Workers shall not reach blindly or place body parts between shifting loads or objects. The lift master shall confirm that all workers are clear of the load before it is raised or moved.

## Diving Operations for Qualified Staff

### Qualifications of the Dive Team

Each dive team member shall have the experience and training necessary to perform assigned tasks in a safe manner. Dive team qualifications must be reviewed and approved by CSI. Each dive team member shall have experience or training in the following:

- The use of tools, equipment, and systems relevant to assigned tasks
- Techniques of the assigned diving mode
- Diving operations and emergency procedures
- Cardiopulmonary resuscitation and first aid.

### Assignments

Each dive team member shall be assigned tasks in accordance with the employee's experience or training, except that limited additional tasks may be assigned to an employee undergoing training, provided that these tasks are performed under the direct supervision of an experienced dive team member.

### Designated Person-In-Charge

CSI will designate a person who shall be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive team members. The designated person-in-charge shall have experience and training in the conduct of the assigned diving operation.

## Safe Chemical Usage

Chemicals for use in assembly, maintenance, or servicing of test articles must have their inherent hazards evaluated. Teams must provide details on how the materials will be handled, applied, and stored. Provide electronic copies of safety data sheets to staff for evaluation and approval. Hard copies of safety data sheets will be readily accessible by teams during the competition. Corrosive chemicals will necessitate that a shower/eyewash is readily accessible, and this must be coordinated with staff in advance.

## Ladder Safety To Prevent Falls

Standing on test equipment or other objects greater than 4 feet in height presents a fall hazard and is forbidden in this competition. Allowances are made for working from a deployed portable ladder on a sturdy level surface. Inspect the ladder before use and remove it from service if it is damaged. Workers using ladders shall always maintain three-point contact and follow the manufacturers warnings.

## Weather-Related Hazards

The competition's area of operation is prone to high winds, lightning, and other forms of severe weather. The team shall monitor site conditions and take necessary action to adequately protect workers, materials, and equipment from damage caused by high winds and other weather-related exposures. Wet surfaces can present a slip-and-fall hazard to workers, jeopardize safe equipment operation as a result of a loss of traction, and affect the stability of the crane.

## Traffic Control

The work area shall be barricaded or cordoned off (e.g., with traffic cones) as necessary to delineate the work area and restrict access by unauthorized workers. Workers shall remain vigilant to monitor access restrictions. Unauthorized workers shall not be permitted in the work area. As determined necessary, work areas shall be barricaded or otherwise cordoned off to prevent access during nonworking hours.

## Tripping/Terrain-Related Hazards

The work area must be inspected to identify tripping hazards that might be present. As necessary, these shall be protected or delineated (e.g., with cones) to enhance awareness so the hazard can be avoided. Workers shall remain focused on the task at hand and guard against being distracted when moving about the work area.

## Environmental Releases

Any spill, leak, or release of hazardous materials (e.g., oils, coolants, and chemicals) will be immediately reported to the staff. Immediate steps shall be taken to control and collect the spilled material.

## COVID-19

The pandemic has necessitated the use of a variety of safety practices and requirements across the country. The latest requirements will be determined and sent to competing teams well in advance before the competition so they can plan accordingly.

## Emergency Response

Teams will be briefed on emergency response procedures at the competition sites as well as the locations of the nearest medical facilities for non-life-threatening injuries.