



BUILD CONTEST

Technical and Preliminary Design
Review Q&A Responses

Ocean Observing Prize Administration
Team

March 14, 2022

Safety

- Because each vehicle is unique, the prize administration will not require a universal kill switch design, kill switch location, lift point load rating, or lift plan. However, these are critical design decisions for facilitating the practical, safe recovery of a vehicle in off-nominal situations.
 - Teams should think through worst case deployment, kill, recovery scenarios and explain how support staff could activate the kill switch and rig up lifting straps to recover a vehicle in the midst of wave action, from a boat or as a diver in the water.
- Safety Data Sheets for any chemicals that will be brought into MASK need to be submitted to OceanObserving@nrel.gov - this includes oil contained in vehicle, lubricants for connectors, solvents, etc.

Carderock Safety Approvals

- Can we still change batteries, battery configuration, add supercapacitors, add lasers after the TDR?
 - Yes, subject to approval by the OOP technical team and Carderock safety. The cutoff date for submitting design changes involving safety approvals for batteries, lasers, and supercapacitors is April 15. These components must go through a lengthy approval process before entering the MASK Basin.
- Can capacitors be used as energy storage devices?
 - Yes, as long as total energy stored (sum of battery and capacitor nameplate capacities) is under that allowed by the rules of the competition. Note, the capacities of small capacitors that are built-in components of electronics do not need to be summed for this requirement. Supercapacitors must be disclosed and approved by the OOP technical team.

Kill Switch

- Please note that no divers will be available at the BUILD test event - ease of access to the kill switch by a diver is good design practice, and divers may be available during the SPLASH competition.
- When the vehicle is in the tank, are there any people around it?
 - [This question is answered in the FAQ.](#)
- Does there need to be more than one kill switch if it is only accessible at one end of the vehicle and not the other?
 - No, the kill switch does not need to be accessible from all locations around the vehicle as long as it is easily accessible around part of the vehicle.
 - The kill switch should be well located and easily accessible by a diver or boat operator such that risk of pinch points or other bodily harm is minimized, and ease of successfully actuating the kill switch in an emergency is maximized.
- Is a visual indicator of kill switch status necessary?
 - Yes. In the safety plan, teams should explain how to visually check if a kill switch has been successfully activated or deactivated. One example of this is LED indicator lights that change color or power off when the kill switch is actuated, then change color or power on again when the kill switch is disengaged. Another example for an emergency stop style button is to explain the button will remain depressed when engaged.
- Is it acceptable for vehicle parts to twitch when the kill switch is disengaged?
 - Yes, if risks are adequately documented. In the safety plan, teams should include procedural safeties for disengaging the kill switch and repowering the system. For example, if there is any chance of an actuated part moving upon kill switch disengage

and system repower, the safety plan should detail these risks and include instructions to keep clear.

- The vehicle kill switch should kill power to all propulsion on the vehicle and should not rely on software.
- Teams are encouraged to submit their kill switch design to OceanObserving@nrel.gov for approval if there is any doubt about whether the design is acceptable.

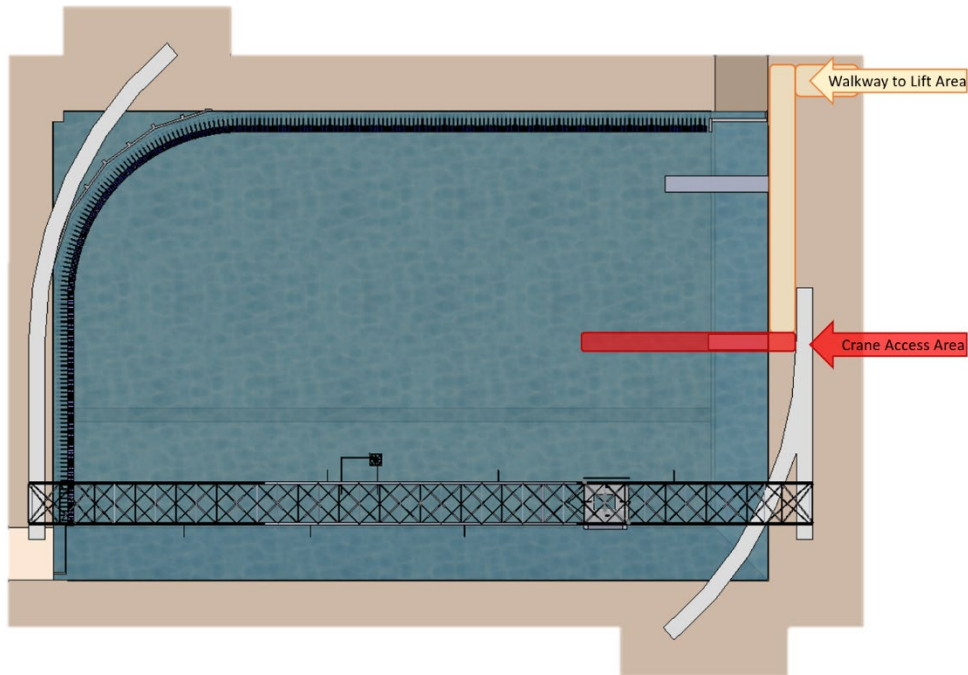
Safety Plan

- What information do we need to include in the safety plan?
 - The safety plan is meant to be a practical, operational document providing Carderock staff who are unfamiliar with your vehicle operations with clear guidance on how to deploy, recover, and respond to off-nominal operations of your vehicle in a way that keeps both staff and your vehicle safe. Your safety plan and lift plan should work in conjunction with each other. The hazard tables submitted are helpful, but do not include enough detail for Carderock staff to safely launch and recover your vehicles.
 - Please update your safety plans with steps and procedural safeties including, but not limited to, each of the situations listed below. For hazards at a specific location on the vehicle, please include photos or drawings to illustrate the hazard locations.
 - **Power up** - if there is any risk of actuated parts moving at power up, include instructions to keep clear and clearly indicate which parts of the vehicle could present a hazard
 - **Lift/launch** - you may reference your lift plan here, just be sure to include any specific safety precautions that may not be included in your lift plan (e.g., identify cut hazards, pinch hazards). Include any procedural steps not included in your lift plan.
 - **Recovery** - you may reference your lift plan here, but will need to include specific procedural language detailing how you envision an operator getting hands on a boat pole on your vehicle from a boat and maintaining control of the vehicle while slings are positioned and the crane is attached prior to hoisting.
 - **Tethered Recharge** - if your team intends to use the optional tether during the recharge tank test, include details about how and where to attach the tether, and any hazards to be aware of.
 - **Off-nominal Vehicle Operations/Worst Case Scenario Recovery** - think about all the possible failure modes for your vehicle. For any failure modes that could pose a hazard during operations or recovery, include details about the state of the vehicle in each scenario and provide ways that operators unfamiliar with your vehicle could regain control of the vehicle and perform a safe recovery. Some worst case scenario examples:
 - Vehicle floods
 - Vehicle sinks (will **NOT** have divers to assist in recovery)
 - Vehicle capsizes
 - Vehicle is unresponsive, dead-in-the-water
 - Runaway vehicle - propulsion on and vehicle unresponsive
 - Moving actuated parts stuck open in non-recovery configuration
- More information on the safety plan, including a template can be found [in Section 3.6.8 and Appendix J of the Official Rules Document](#).

Lifting, Launch & Recovery

- We don't want to add a lift point because it will add drag. Is a lift point required?

- All teams are required to have a hard lift/tag point that will allow a boat operator to maintain physical control of the vehicle during recovery via boat hook, tagline, or hands. Please be sure there is adequate clearance for a boat hook or carabiner to fit through the lift/tag point.
 - Requirement 8 listed in the [System Requirements: Physical Characteristics and Principal Dimensions table in the Official Rules Document](#) states “The assembled system must be safe and stable while lifted during deployment and recovery and have at least one hard lift point that is easily accessible, or as many as needed to ensure stable orientation while lifted. If the design uses two separate bodies, each body may be lifted separately or together.”
 - If you do not have a lift point and choose not to add one, you will receive no credit for the lift point requirement. You will need to provide clear instructions for launch and recovery in your safety plan. This solution, including procedure and hardware, would need full approval by the OOP technical team and Carderock safety before you would be allowed to participate in the test event.
- Can the lift point be removable?
 - The lift/tag point must be permanent as this will be used to gain control of your device during recovery operations.
- Can we use a soft lift point rather than a hard lift point?
 - A soft strap lift point may be acceptable for use during the BUILD test, subject to design approval of the lift plan and safety plan by the OOP technical team and Carderock safety. Because the hard lift point is a requirement, a soft lift point will be scored lower.
- Can we use dual slings or a net for recovery as an alternative to lifting the vehicle from a single hard lift point?
 - Yes. Any specialized recovery hardware or recovery methods that are more complicated than attaching a crane to a hard lift point (e.g., dual sling recoveries with or without spreader bars, recovery nets) must be specified and well detailed in the team’s safety plan and approved by the OOP technical team and Carderock safety.
- Do we need to bring our own lifting straps, shackles, spreader bar?
 - While teams should be prepared to supply their own specialized equipment, Carderock can provide most standard hoisting gear, including shackles and slings. Carderock may also have some smaller spreader bars that teams can utilize, if what they already own happens to work for your lift plan. If you plan to use Carderock’s hoisting equipment, please plan to coordinate with them ahead of time by emailing OceanObserving@nrel.gov
 - If you plan to bring your own lifting equipment, all slings, straps, shackles, and other load bearing hardware must be load rated and preferably tagged by the manufacturer. Teams should be prepared to submit any certificates that came with the lifting equipment to Carderock.
- Can you describe the crane that will be used to hoist vehicles into the test tank?
 - The MASK Basin has a center-line overhead crane with a single hook that can only reach ~1/5 of the length of the basin (highlighted in red in the image below). Your vehicle will be launched in this small area and moved either under its own power or towed by a small boat to the starting location. During recovery, your vehicle will again move either under its own power or be towed by a small boat to the crane recovery area, where the Carderock team will attach hoisting gear prior to lifting.



- Hand-carry transport and deployments are not acceptable at Carderock due to OSHA safe lifting limits and due to the height and angles that would be required to lift a vehicle into the MASK basin. OSHA and Carderock limit each person to lift a maximum of 50 lbs.
- Beach launching is not possible due to the construction of the tank - the MASK basin “beach” is blocked by the sides of the tank.

Vehicle Communication

- Is it permissible to report data back from the vehicle to the operator station on the dock during the tank test?
 - Yes, as long as no commands are sent to the vehicle during a mission.
- Is there significant noise in the 2.4GHz range inside the MASK facility such that it would interfere with RF comms between vehicle and operator station?
 - No, this shouldn't be an issue
- How important is demonstration of satellite comms?
 - Demonstration of integrated satellite communications is a requirement. If a team cannot demonstrate satellite communication with a module that is integrated into the vehicle, they will not receive points.
- How can we navigate without GPS?
 - [This question is answered in the FAQ.](#)
- Can we use remote control to satisfy the maneuvering requirements?
 - No, demonstrating vehicle maneuvering with remote control does NOT satisfy the maneuvering requirements.
 - Remote control is allowed to position the vehicle in the tank during initial deployment, reset between tests, and final recovery. The maneuvering test must be completed by the vehicle autonomously, without operator intervention.
- Is satellite blocked in Carderock?

- Competitors are advised that communications signals (e.g., satellite-based, cellular, RF, etc.) originating from outside the MASK Basin cannot be guaranteed or expected to be received within the facility.
- If satellite is blocked, why do we need to demonstrate satellite communication at BUILD? SATCOMs equipment and subscriptions are expensive.
 - The ability to communicate via satellite is required per the [Official Rules Document](#) of the BUILD competition. This capability will be important for open water deployments in the SPLASH competition.
 - Difficulties with cost have been noted. Stay tuned for details about support that may help with this expense.

Tethering During Recharge

- Please explain what is meant about prohibiting tethering tension as it relates to the energy harvesting portion of the prize competition.
 - Per the [Official Rules Document](#): Teams have the option to tether systems during recharge.
 - [This question is answered in the FAQ.](#)

Post Mission Analysis Data Format

- Is there a specific format requirement for data provided by the teams to meet the requirements?
 - Data will be collected for review of test IDs 18, 29, 34, 52, 59, 64, and 72-74. Timestamping is required for CTD and vehicle data. However, beyond this requirement, there is not a specific format we expect, though presenting data that are clearly labeled will help us confirm the requirements are satisfactorily met. Power performance data is collected by the DPPM and will be analyzed consistently for all competitors.

DPPM

- Is the test DPPM sent to the teams fully functional?
 - Yes, the DPPM competitors received is fully-functional, adhering to the specifications in the [Official Rules Document](#) Appendix E, though it will not log data. The 100W payload built into the DPPM is functional and will heat up when powered.
 - Remember that the face of the DPPM should be submerged in water for adequate heat dissipation when it is powered - this can be accomplished during bench testing by submerging the face of the DPPM in a bucket of water. If you must power the payload in air during bench testing, do not power it for more than a few minutes at a time.
- Are ADCPs required? Is the DPPM an ADCP?
 - The DPPM does not and will not function as an ADCP during the BUILD or SPLASH competitions.
 - Integration of an ADCP is not a requirement of the BUILD or SPLASH Competition.

- The DPPM must be accommodated per the competition rules and is intended as a proxy for a third-party sensor integration. If competitors wish to use an ADCP, this must be a separate unit, as one will not be supplied.
- If you want to learn more about ADCPs, check the manufacturer websites. Many ADCP manufacturers have a theory section published on their websites.

Grounding

- System Requirement 20 in the [System Requirements: System Requirements: Data Collection and Communications Requirements](#) table states, “All conductive chassis surfaces on the assembled system must be electrically grounded.” Do grounding straps need to be attached between each component/part of the device?
 - Per previous guidance, the intent is for all device surfaces to be equipotential, hard grounded to system ground, and the GFCI intent is only for power source to water/external current sinks. Achieving equipotential surfaces may be accomplished through grounding straps if necessary, or through conductivity between assembled parts.

Prequalifying Video

- What do you expect for the prequalifying video? Is there a specific format we should use?
 - Please reference Section 3.6.11 in the [Official Rules Document](#) for an overview of what should be included in the video. The intent of the video submission is to visually prove your team’s test readiness.
 - Video content should include:
 - Overview of the dry, assembled, integrated prototype from multiple angles - teams should point out, at a minimum, the location of the kill switch, lift point(s), propulsion system, and location of any other key vehicle parts.
 - Benchtop testing of any articulation or actuation of interest - for example, demonstrate propellers spinning, winches turning, WEC devices actuating
 - Prototype(s) actuating and/or articulating in a water tank (no waves required) - demonstrate the vehicle is ready and capable of operating in water
 - Demonstrate that the DPPM fits within the hull and is integrated into the power/data system - teams should demonstrate installation of the DPPM into the system and show that its 100W payload can be powered on.
 - The video submission does not need to be professionally edited. Separate video clips of each of the four content topics is acceptable as long as the total duration of the clips is 4-10 minutes. The order of the requested video content does not matter. Verbal narration is acceptable, as is a document containing time-stamped written explanations
 - Teams should highlight any changes to the vehicle since the TDR.

Carderock Testing

- What needs to fit within the shipping crates?
 - All equipment associated with vehicle operations must fit within the dimensions of two double pallet crates. The vehicle itself must fit, disassembled if needed, within a 1,165 mm × 2,400 mm × 1,220 mm crate. All other supporting equipment including hand tools, vehicle cart, operator computer, comms station, etc, must fit within a second crate of the same size.
- Can my equipment shipment be delivered to Carderock later than May 31st?

- No, all shipped equipment must be delivered to Carderock by May 31st. Teams are allowed to drive their own equipment on site on Day 1 of the team's scheduled test.
- Can you clarify the beam length requirement?
 - [This question is answered in the HeroX FAQ.](#)
- Can you tell us more about the lighting in the MASK facility?
 - The MASK is a dark environment illuminated by several 1000 Watt Metal Halide overhead lamps, which are about 60 ft above the water surface.
 - Recent recordings of light were recorded per a team's request and the highest reading in the MASK was 19 LUX, with the average around 10 LUX. These readings were taken with an Android phone app at three different locations along the basin just above the water surface.
 - [A resource that was published with pictures of what the lighting looks like in the MASK facility](#) has been updated to include screenshots of the LUX readings at these three locations.
- Can you tell us more about the magnitude and direction of the waves during the test?
 - [Section 3.5.2. Wave Profiles of the Official Rules Document](#) contains information about magnitude and spectral content of the generated wave field. Direction is not specified, but the MASK layout in the [MASK Basin Dimensions and Safety Procedures Section of the Official Rules Document](#) shows the location of the paddles and the wavemaker limit plot. This plot is applicable across the full 90 degree range of direction. The direction of the wave field will be chosen by the Ocean Observing Prize Team to best allow testing of the specific functions of a device.
- Are CTDs required for the BUILD test? Why?
 - Requirement 14 listed in the [System Requirements: System Requirements: Data Collection and Communications Requirements](#) table states "System must incorporate a commercially available CTD instrument that is able to sample at the rated depth of the system. The CTD does not need to be a single instrument, but the conductivity, temperature, and depth must all be captured using commercially-available sensors, powered by wave energy."
 - The ability to measure conductivity, temperature, and depth is required per the rules of the BUILD Competition for the profiling body.
 - These measurements may be taken with any commercial CTD unit or with independent sensors.
 - Sensors do not need to be scientific-grade.
 - For NOAA's hurricane monitoring mission, it is essential to have the profiling capability to record CTD data at depths throughout the water column. Other industry partners also expressed interest in collecting data at depth.
- What other profiling capabilities currently exist in industry?
 - There are many. An incomplete list includes towfish, drag sleds, fly kites, AUVs, gliders, CTDs, and ADCPs.
 - NOAA currently uses downward looking doppler for some oceanographic applications. NOAA glider fleet specifications are published and available.

Scoring

- Will teams receive results from the competition, including numerical scores and feedback?
 - Numerical scores will not be shared, but broad area feedback will be provided, including reviewer comments.

SPLASH Considerations

- Although SPLASH is a long way off, here are a few things to keep in mind during your design process:
 - A hard tow point will be required for SPLASH such that a boat operator can attach a tow line with a carabiner-type clip and tow the vehicle behind a boat
 - Communications antennas will need to be well above waterline for vehicles to have reliable surface communications
 - All vehicles will likely be required to have a bright 360° white light visible when the vehicle is at the surface. This light may strobe or remain solid - the intent is to increase visibility of partially submerged equipment in low-light conditions. Additional lighting may be required to comply with USCG regulations
 - If your design includes lasers or acoustic devices aside from ADCPs or DVLs, this should be disclosed to Ocean Observing Prize Team as early as possible, as approval will be needed for NEPA permitting

Contact Information

- For the most expedient response from Ocean Observing Prize team, please submit all questions to OceanObserving@nrel.gov. If you wish to reach out to a specific Ocean Observing Prize team member directly, please be sure to Cc the OceanObserving@nrel.gov email address in all correspondence.