HOVERCRAFT C

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Prior to the competition, participants will design, construct, and calibrate a self-propelled, air-levitated vehicle **to carry nickels** down a track.

A TEAM OF UP TO: 2 **APPROXIMATE TIME:** 10 minutes

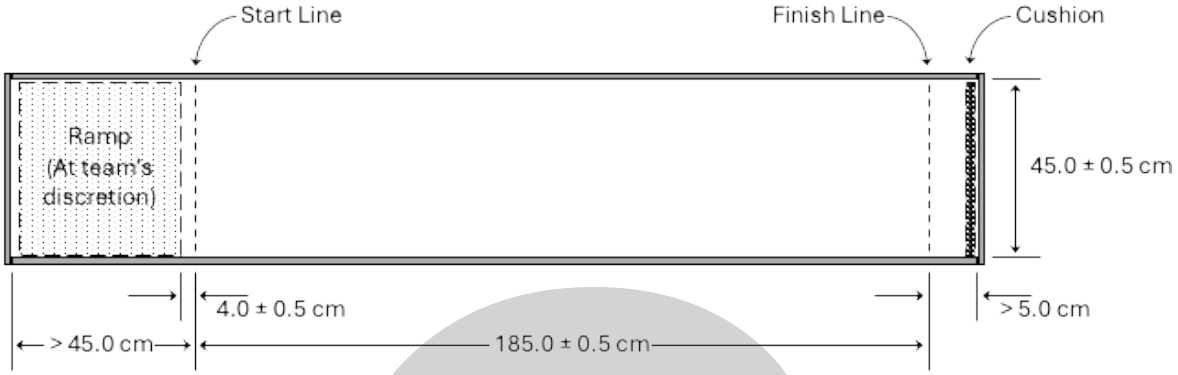
EYE PROTECTION: B **IMPOUND:** Yes **CALCULATOR:** Class III

2. **EVENT PARAMETERS:**
   a. Each team must impound only one vehicle**, any spare parts,** and any papers/notes necessary for the competition time. The vehicle must be impounded with the batteries stored separately and presented to the Event Supervisor for inspection. No additional papers/notes may be brought into the competition area after impound.
   b. Teams may bring tools and two Class III calculators. These items need not be impounded. **Tools are items that do not travel with the hovercraft on its competition runs. Tools utilizing lasers are not permitted.**
   c. Participants must wear Category B eye protection during vehicle setup and operation. Teams without proper eye protection must be immediately informed and given a chance to obtain eye protection if time allows.
   d. The Event Supervisor will provide the testing materials listed in the **ES-PROVIDED MASSES and** TRACK section**s**. Teams should not bring their own **masses,** track**,** or ramp.
3. **CONSTRUCTION PARAMETERS:**
   a. The vehicle must fit into a 40.0 cm x 40.0 cm x 40.0 cm box when levitated in the ready-to-run configuration. Vehicles must not modify or damage the track.
   b. Electrical components shall be limited to batteries, wires **(including battery holders/connectors)**, **mechanical** switches, **relays**, resistors (including potentiometers **and rheostats**), capacitors, and up to two motors (including brushless motors). Integrated circuits (other than those that are an **integrated, manufactured** part of a commercial motor) are not permitted.
      i. **Mechanical switches are switches with moving parts that connect or disconnect an electrical circuit. They may be operated manually by a person or by contact with another part of the hovercraft.**
      ii. **Components utilizing lasers are not permitted.**
   c. The vehicle must levitate on a cushion of air as it moves down the track. Participants may be asked to demonstrate levitation by pushing the vehicle slightly down. If it then rises, it is levitating. **Contact of vehicle components with the track surface or inside edge of the track's side rails is permitted. Vehicle components cannot contact the top or outside edge of the side rails.**
   d. **All thrust and lift on the vehicle must be achieved with air pressure. Non-electric sources of energy are permitted to power other vehicle functions such as a timing system.**
   e. For timing and measurement purposes, the vehicle must have a 1/4" or larger wooden dowel vertically attached within 3.0 cm of its front edge such that the top end is at least 20.0 cm above the track's surface when levitated. The dowel must be placed on the hovercraft so that it will be the first part of the vehicle to break a laser timing beam when the vehicle is traveling forward.
   f. **Safety Parameters (devices failing to meet these may not run, scored as Participation points):**
      i. All propellers/impellers, including those under the vehicle, must have shielding that prevents a 3/8" dowel from touching them.
      ii. Only commercial batteries, including rechargeables, may be used to energize each of the vehicle's motors. The label on each battery must be the manufacturer's original and easily viewable by the Event Supervisor. Lithium and lead batteries are prohibited. Multiple batteries may be connected together as long as the expected voltage across any two points does not exceed 12.0V, as calculated by their individual labels.
      iii. All motors must have an **accessible manually-operated mechanical** switch to permit safe starting and stopping. Relying on inserting batteries or twisting wires together to start is not allowed. If more than one motor is used, they may be combined on the same switch or wired on separate switches.
   g. Participants must be able to answer questions regarding the design, construction, and operation of the vehicle per the Building Policy found on www.soinc.org.

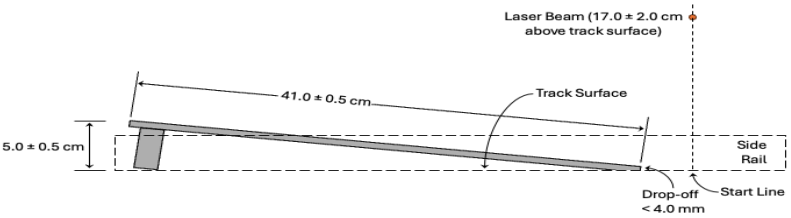


4. **THE COMPETITION:**
   a. Once participants enter the event area to compete, they must not leave or receive outside assistance, materials, or communication until they are finished competing.
   b. Event Supervisors will check the vehicle specifications before the team's testing period. Teams must be notified as soon as possible if a vehicle is out of spec. Teams may modify the vehicle to bring it into compliance during their testing period.
   c. Vehicles violating any of rule 3f or that are otherwise deemed unsafe in construction or operation by the Event Supervisor will not be allowed to run unless brought into compliance. If the team is unable to bring the vehicle into compliance with 3f, the vehicle will not run and will only receive **Participation points**.
   d. At the start of their **competition time**, each team will be given a Target Time (TT). The Target Time will be between **6**.0-**26**.0 seconds in intervals of **1.0** seconds for Regionals and 0.5 seconds for **States**/ Nationals. The TT will be the same for all teams.
   e. Teams have a **competition time** of 8 minutes to adjust and repair their vehicle and make their runs. **The team's competition time ends after two complete or two incomplete runs or the competition time limit has been reached (whichever comes first).** Practice runs are not allowed.
   f. **During their competition time, teams may dry-sweep the track, but may not wet it or apply any substance. Teams may take measurements of the track and the surface it is on, but may not request changes to the track's position or leveling.**
   g. **The vehicle may carry an ES-provided mass consisting of a combination of both loose nickels and rolls of nickels. Participants will select how much mass, if any, the vehicle carries and this amount may vary by run. Participants will not be allowed to unroll, break, or alter the packaging of the nickels nor will they be allowed to use any adhesive or tape to affix the rolls or nickels to the vehicle; any vehicle that requires such measures to carry the nickels and/or rolls will not be allowed to use masses during their competition runs.**
   h. An incomplete run occurs if a vehicle fails to move for 3 seconds before crossing the finish line or the dowel fails to cross the finish line within (2 x TT) seconds. Teams are not allowed to declare a run as incomplete. A run is complete if it is not incomplete.
   i. If the vehicle's dowel does not cross the starting line within 3 seconds of launching, it does not count as a run (either complete or incomplete). A run **will be allowed to finish and** will be counted in the scoring as long as it is started before the 8-minute period has elapsed.
   j. If any part of the vehicle, **nickel rolls, or individual nickels** fall off during a run, the team incurs **one construction** penalty **(not one per item)** for the run. **Any nickels or rolls that fall off before the Event Supervisor tells the team to turn off the vehicle at the completion of the run do not count towards the Mass Score.**
   k. If they choose, teams may utilize an Event Supervisor-provided ramp (as described in 6.f) for the launching of their vehicle. In such cases, the Event Supervisor will place the ramp in the same position for all teams. Using the ramp will impact the team's score (**7.f.v** and 7.d.iii), and the time for placing the ramp will come out of the 8-minute period. The team may change this decision for each run.
   l. To begin a run, the team will place their vehicle**, including the nickel load,** on the track fully behind the start line. **The team may start anywhere behind the start line. The Event Supervisor will provide and hold a wood block against the front of the vehicle to hold it in place.** The team then activates their vehicle's motor(s) **and removes their hands from the vehicle.**
   m. The team will give a countdown of "3, 2, 1, launch"; then the Event Supervisor will remove the wood block. Timing starts when the vehicle's dowel crosses the start line and stops when the dowel crosses the finish line. If photogates are used, the dowel must be the first part of the vehicle to break the laser beams at both the start and finish lines.
   n. **After removing their hands at the vehicle's start,** the team must not touch their vehicle **or interfere with its run in any manner** until the Event Supervisor states they may do so. If touched **or interfered with**, the run is counted as a complete run with a DS, TS, **and MS** of 0.
   o. If a run is declared incomplete, the Event Supervisor will place the starting block in front of the hovercraft at the point where the run was declared incomplete to prevent the vehicle from moving. The ES will ask the competitors to turn off their vehicle without moving it, and the ES will then record the distance from the finish line to the position of the dowel. The team's testing period time will halt while the Event Supervisor makes measurements and will resume when the measurement time is done.
   p. The Event Supervisor will review with the team the data recorded on their scoresheet.
   q. A team filing an appeal must **alert the Event Supervisor and** leave their vehicle in the **impound** area.

5. **THE ES-PROVIDED MASSES:**
   a. **The ES will provide 4 full rolls of U.S. nickels, 1 half roll of U.S. nickels, and 20 loose U.S. nickels.**
   b. **One full roll contains 40 nickels. Each roll should be unopened, wrapped in a bank paper roll wrapper, folded snugly against the nickels.**
   c. **One half roll contains 20 nickels. The one half-roll should be wrapped in a bank paper roll wrapper with the ends trimmed to minimize the excess paper, and folded snugly against the nickels.**
   d. **One full roll of U.S. nickels ≈ 200 g, each individual nickel ≈ 5 g. In combination, the ES-provided nickels can make a mass approximately between 5 g and 1 kg.**
6. **THE TRACK:**



   a. The Event Supervisor will supply a 45.0 ± 0.5 cm wide and at least 240 cm long track on a non-carpeted smooth floor or other firm smooth base surface, such as a countertop. The outside boundary of the track is composed of rails each with a height at least 30.0 mm (standard 2x4 framing studs or steel framing studs recommended). The Event Supervisor will also supply a cushioned barrier to stop vehicles and a wood block to hold the vehicle at the start line. Example setups are at www.soinc.org.
   b. Each rail must be securely affixed to the floor, base, or each other.
   c. **Event Supervisors may provide a track that has either a built-in base or utilize a table or the room's floor as a base. In either case, Event Supervisors should clean the base of the track (or the floor) at the start of the day and should provide as level a surface as possible. Small imperfections in the track's base surface, though, do not disqualify the track for tournament use; the point of a hovercraft is to traverse uneven terrain. Tournaments are encouraged to make available ahead of time information about the type of surface the tracks will have.**
   d. The length of the timed portion of the track is fixed at 185.0 ± 0.5 cm. A start line must be marked that is at least 45.0 cm from the end of the track. The finish line must be marked 185.0 ± 0.5 cm from the start line and a cushioned barrier at least 5.0 cm past it must block the channel.
   e. A photogate timing system is recommended. If used, the system will be installed at the start and finish lines with the beams at a height of 17.0 ± 2.0 cm. At least one manual timer should be used as a backup. If photogates are not being used, three timekeepers should be utilized with the median time used as the official Run Time; lasers are recommended to be placed at the start and finish lines so the timekeepers only have to watch for the flash of light as the dowel cuts through the laser beam. Time is recorded in seconds to the device precision if photogates are used, or to the tenth of a second if manual timers are used.
   f. The Event Supervisor must provide a removable ramp that competitors may use for the launching of their vehicle. The ramp should have a smooth, flat surface and must span the width of the track between the rails. The height of the ramp is 5.0 ± 0.5 cm and the length of the ramp's surface is 41.0 ± 0.5 cm. When the ramp is placed on the track, the edge where the vehicle exits the ramp must be 4.0 ± 0.5 cm behind the start line. At the bottom of the ramp, where it meets the track surface, the transition should be reasonably smooth, with a drop-off from the ramp surface to the track surface of no more than 4.0 mm. See www.soinc.org for information on how to build a ramp and track.





g. Multiple tracks may be used to facilitate teams competing in a timely manner.

7. **SCORING:**
   a. High Score wins.
   b. Final Score (FS) = Best Run Score. A scoring spreadsheet is available at www.soinc.org.
   c. Run Score = DS + TS + MS
   d. Distance Score (DS):
      i. Complete Run: Distance Score = **40**
      ii. Incomplete Run: Distance Score = **40** x (185 - (distance from the finish line in cm)) / 185
      iii. If the ramp is utilized, the Distance Score is multiplied by 0.5 for that run.
   e. Time Score (TS):
      i. Runtime = Time from the Vehicle dowel crossing the start line until the dowel crosses the finish line
      ii. Complete Run: Time Score = **40** x (1 - abs(Runtime - TT)/TT)
      iii. Incomplete Run: Time Score = 0
      iv. The smallest possible Time Score is 0.
   f. **Mass Score (MS) = (4R+ .1N) x (185 - (distance from the finish line in cm)) / 185**
      i. **R = # nickel rolls. The half-roll of nickels counts as .5 of a nickel roll (i.e. if the vehicle carries 2 complete rolls and the half roll, the # of nickel rolls is 2.5)**
      ii. **N = # loose nickels**
      iii. **The Maximum Mass Score for a Complete run is 20. The Mass Score formula prorates the Mass Score for the distance traveled in incomplete runs**
      iv. **The nickel rolls and loose nickels must stay on the vehicle for the entirety of the run to be counted.**
      v. **Mass Score for a run using the ramp = 0**
   g. **Teams unable to pass the safety parameters in 3f will receive only Participation Points.**
   h. Teams without any runs will receive a Final Score of 0, with ties broken as indicated in 7.l.. Ties are possible.
   i. The DS, TS, and **MS** for each run will be multiplied by 0.7 if the team misses impound.
   j. The DS, TS, and **MS** for a run will be multiplied by 0.8 for each CONSTRUCTION violation present during that run.
   k. The DS, TS, and **MS** for a run will be multiplied by 0.9 for each COMPETITION violation present during that run.
   l. Tie Breakers: 1st – Best TS over all runs; 2nd – Fewest # construction violations **in the team's run that has the most construction violations, or, in the case of a vehicle that does not have any runs in the competition time, the number of construction violations per 4b**; 3rd – Best **MS**, 4th - 2nd Best Run Score