

2019 SpaceX Hyperloop Pod Competition Rules and Requirements

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CONTENTS

1 Introduction	2
2 General Information	3
3 Schedule	4
4 Intent to Compete.....	4
5 Preliminary Design Briefing.....	5
6 Final Design Package	6
7 Final Design Presentations	8
8 Safety Briefing.....	8
9 Reference Materials	8

1 INTRODUCTION

Competition History. On August 12, 2013, Elon Musk released a [white paper](#) on the Hyperloop, his concept of high-speed ground transport. In order to accelerate the development of a functional prototype and to encourage student innovation, SpaceX announced the Hyperloop Pod Competition in 2015 to design and build high-speed Hyperloop Pods. For this competition, student teams from around the country and world came together for a Design Weekend in January 2016 to share their Pod designs. Top teams advanced to the build phase and spent 2016 turning their designs into functional Pods. These teams then competed in the first Hyperloop Pod Competition in January 2017, where they raced their Pods on SpaceX's Hyperloop Test Track adjacent to its Hawthorne CA headquarters. Two subsequent competitions were held in August 2017 and in July 2018.

Based on the continued success of teams competing in the Hyperloop Competition, SpaceX is moving forward with a fourth competition: the 2019 Hyperloop Pod Competition.

2019 Competition Rules and Requirements. This document outlines the competition logistics and rules. The competition is open to new student teams interested in competing on the Test Track as well as to existing student teams who have already built and tested Pods to further refine their designs. There will be some updates to the competition rules as outlined in this document.

As with previous competitions, the competition will be judged solely on one criteria: maximum speed with successful deceleration (i.e. without crashing) and all Pods must be self-propelled.

The key updates to the rules for the 2019 competition are:

1. Teams must use their own communications system. SpaceX will not provide its on-Pod communications system, otherwise known as the Network Access Panel (NAP).
2. Pods must be designed and tested to propel themselves to within 100 feet of the far end of the tube before stopping. This can take the form of a single main run to that point, or a "slow crawl" after the Pod's main run has been completed.

Additional Notes. For an updated competition schedule, visit [Hyperloop.com](https://hyperloop.com). Any questions or comments about the 2019 Competition Rules and Requirements should be submitted to Hyperloop@spacex.com.

- This competition is a SpaceX event. SpaceX has no affiliation with any Hyperloop companies, including, but not limited to, those frequently referenced by the media.
- Additional competition support is provided by [The Boring Company](#).

2 GENERAL INFORMATION

Eligibility. Only student teams are eligible to enter the competition. To determine eligibility:

1. A student team is one that is composed solely of undergraduate and graduate students who are currently enrolled as of the intent to compete deadline of September 28, 2018.
2. Teams can consist of students from multiple schools. We will also accept exceptional high school entrants on a case-by-case basis.
3. The team structure is flexible, with no minimum number of team members and no maximum number (within reason).

Faculty Advisor. Each team must have a Faculty Advisor. Faculty Advisors are not allowed to:

1. Design the vehicle
2. Fabricate or assemble more than a minority of the components
3. Directly participate in creating any documentation or presentation
4. Answer questions onsite during design briefings or reviews with SpaceX or The Boring Company Volunteer Advisors

If there is any question about eligibility, please email Hyperloop@spacex.com.

Returning Teams. Teams who have built a Pod for a previous competition are eligible to compete again provided they meet the student team eligibility described above and they make tangible and clear modifications to their Pod used for the previous competition. Returning teams may also choose to build a new Pod.

Note that the intent of this rule is so that teams do not race the exact same Pod at multiple competitions.

Competition Format. Selected Pods will compete at the SpaceX Hyperloop Test Track during the final competition, scheduled to occur at the end of Competition Week. At SpaceX's discretion, teams may be allowed to test their Pods on the Test Track before the final competition. Additionally, SpaceX, at its sole discretion, may allow or disallow entrants from accessing the Test Track. No human or animal shall ride in any Pod or other transportation device used within the Test Track during this competition or during any pre-competition access.

3 SCHEDULE

The competition schedule can be found below. Events in bold indicate a deliverable from the contestants. More information about bolded events can be found below.

Due Date	Name
8/23/2018	2019 Hyperloop Pod Competition Announced
9/28/2018	Intent to Compete Form Due
Fall 2018	Preliminary Design Briefing Due
Fall 2018	SpaceX notifies teams that have advanced
Winter 2019	Final Design Package Due
Winter 2019	Final Design Presentations
Winter 2019	SpaceX notifies teams that have advanced
Spring 2019	Safety Briefing Due
Summer 2019	SpaceX Hyperloop Pod Competition Week
Summer 2019	2019 SpaceX Hyperloop Pod Competition

4 INTENT TO COMPETE

The Intent to Compete form must be filled out online at Hyperloop.com. The form must be completed in full by 11:59pm EDT on Friday, September 28, 2018.

The form requires information on your team captain, faculty advisor, and university, along with a pdf file of a signed letter from the University Engineering Dean, Assistant Dean, or equivalent in support of the contestants entering this competition.

After the submission of their Intent to Compete form, registered teams will receive a Competitor Entry Agreement form as well as the SpaceX Hyperloop Test Track Specification, which provides more specific technical specifications for the Hyperloop Test Track.

5 PRELIMINARY DESIGN BRIEFING

All teams will be asked to submit a Preliminary Design Briefing document consisting of a PowerPoint slide deck (in PDF format) of no more than 30 slides, along with a signed Competitor Entry Agreement (this agreement will be sent to registered teams and should be submitted as part of the Preliminary Design Briefing).

Exact deadlines and submission instructions will be provided to registered teams.

The Preliminary Design Briefing will include:

1. Description of team and updated list of all associated team members and advisors
2. Top-level design description for Pod. Teams are allowed to revise their design in subsequent submissions, so consider the Preliminary Design Briefing to be a “best initial guess.” At a minimum, this should include, where applicable:
 - Estimated Pod dimensions
 - Estimated Pod mass by subsystem
 - Estimated Pod power consumption by subsystem
 - Pod navigation mechanism
 - Pod levitation mechanism (if any)
 - Pod propulsion mechanism
 - Pod braking mechanism
 - Pod stability mechanisms (e.g. attitude and lateral motion)
3. List and description of any stored energy on the Pod (e.g. pressure vessels, batteries)
4. List of hazardous materials, if any
5. Top-level description of safety features
6. If a returning Pod, highlight the modifications and upgrades made

The purpose of this briefing is for SpaceX to “sanity check” the design and ensure the entrant is heading in a viable direction. Following the submission, there may be a down-select decision in order to properly manage the number of entrants.

6 FINAL DESIGN PACKAGE

All entrants who have successfully advanced past the Preliminary Design Briefing phase will be asked to submit a Final Design Package (consisting of no more than 80 pages/slides).

The Final Design Package must consist of:

1. Description of team and updated list of all associated team members and advisors
2. Design description for Pod. At a minimum, this should include:
 - a. Pod top-level design summary
 - b. Pod dimensions
 - c. Pod mass by subsystem
 - d. Pod payload capability
 - e. Pod materials
 - f. Pod power source and consumption
 - g. Pod state diagram
 - h. Pod navigation mechanism
 - i. Pod levitation mechanism (if any)
 - j. Pod propulsion mechanism
 - k. Pod braking mechanism
 - l. Pod stability mechanisms (e.g. attitude and lateral motion)
 - m. Pod aerodynamic coefficients
 - n. Pod magnetic parameters (if applicable)
3. Predicted Pod thermal profile
4. Predicted Pod trajectory (speed versus distance)
5. Predicted vibration environments
6. Pod structural design cases: at a minimum, this shall include initial acceleration, nominal deceleration, and a reasonably foreseeable off-nominal crash
7. Pod production schedule
8. Pod cost breakdown
9. Electronics system overview
 - a. Sensor list and location map
 - b. List of all Electronic Control Units and explanation of what each Electronic Control Unit is responsible for
 - c. Overview of how these components communicate with each other
10. Sensor list and location map
11. Comments on scalability to an operational Hyperloop with respect to:
 - a. System size (increased tube length, tube diameter, and Pod size)
 - b. Cost (both production and maintenance)
 - c. Estimated Pod mass and cost if built full-scale
 - d. Maintenance (e.g. not requiring specialized alignment tools, hot-swappable subsystems)
12. Loading and unloading plan
 - a. Full descriptions of all functional tests
 - b. Full description of Ready-to-Launch checklist/state (e.g. Loop Computer in “Launch

- Mode” and sending telemetry, Pod hovering at 0.25 inches)
 - c. Full description of Ready-to-Remove checklist/state (e.g. Wheels locked, Power Off)
 - d. Description of how Pod is moved from Staging Area to Hyperloop
 - e. Description of how Pod is moved from Hyperloop to Exit Area
13. List and description of any stored energy on the Pod (i.e. pressure vessels, batteries)
14. List of any hazardous materials, if any
15. Description of safety features including:
- a. Hardware and software inhibits on braking during the acceleration phase
 - b. Mechanisms to mitigate a complete loss of Pod power
 - c. Pod robustness to a tube breach resulting in rapid pressurization
 - d. Fault tolerance of braking, levitation, and other subsystems
 - e. Single point of failures within the Pod
 - f. Recovery plan if Pod becomes immovable within tube
 - g. Implementation of the Pod-Stop command
16. Component and system test program before the Pod arrives for the Competition
17. Vacuum Compatibility Analysis
18. If a returning Pod, highlight the modifications and upgrades made

7 FINAL DESIGN PRESENTATIONS

Based on the Final Design Packages, SpaceX and The Boring Company will select teams to present their designs via video conference to a judging panel composed of employees of SpaceX and The Boring Company. These presentations will include a Q&A session and will take place in winter 2019. More information about the video conference presentations will be released at a later date. Following this, the teams who are advancing to Competition Week will be notified.

8 SAFETY BRIEFING

Before attending Competition Week, competitors will submit a complete Safety Briefing, instructions for which will be provided in the Safety Checklist referenced below.

9 REFERENCE MATERIALS

In addition to this Rules and Requirements document, SpaceX will separately provide the below reference materials to registered teams, including:

1. **SpaceX Hyperloop Test Track Specification:** Information about SpaceX's Hyperloop test track to inform Pod design.
2. **Safety Checklist:** A list of design and safety considerations that SpaceX will use as a basis for evaluating Pods onsite during Competition Week.

Questions about these materials can be directed to Hyperloop@spacex.com.