SpaceX Hyperloop Pod Competition

June 2015

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1 INTRODUCTION AND SCHEDULE

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 is moving forward with a competition to design and build a half-scale Hyperloop pod. In parallel with the competition, SpaceX will be constructing a sub-scale test track (inner diameter between 4 and 5 feet; length approximately 1 mile) adjacent to its Hawthorne, California headquarters. On competition weekend, entrants will operate their pods within this test track. The competition schedule is shown in the table below.

This document serves as a top-level overview of the contest. Full details will be available in August 2015.

Note: This competition is a SpaceX event. *SpaceX has no affiliation with any commercial Hyperloop companies, including, but not limited to, those frequently referenced by the media.*

ID	Date	Name
A	6/2015	Summary document issued (this document)
B	8/15/2015	Detailed rules, criteria, and tube specifications released by SpaceX
C	9/15/2015	Deadline for entrants to submit their Intent to Compete
D	10/15/2015	Deadline for entrants to submit Preliminary Design Briefing
E	12/15/2015	Entrants submit Final Design Package
F	1/9/2016	In-person design weekend with all entrants. Texas A&M University, College Station, Texas.
G	6/2016	Competition weekend. All pods compete at the SpaceX Hyperloop Test Track in Hawthorne, California. Exact date TBA.

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2 COMPETITION BASICS

Design Weekend

- The goal of the design weekend is for entrants to submit their pod designs, which, after receiving feedback and vetting from SpaceX officials, will then be constructed for the competition weekend.
- Entities that are not interested in building a pod may still present designs for a pod, an individual subsystem, or an individual safety feature. As an example of an individual subsystem submission, a team could choose to optimize the pod's aerodynamics or to design the pod's low-speed system. The purpose of this submission would be to receive design feedback and to participate in a fun educational event.
- Entrants will present before an evaluation panel, which will be composed mainly of SpaceX engineers, Tesla Motors engineers, and university professors.
- Companies will be able to use design weekend as a platform for selecting teams to sponsor, meaning that those companies would then contribute funds, at their discretion, toward the construction of a team's competition pod.

Competition Weekend

- The criteria and rules for the competition weekend will be more rigorous than those used during design weekend, and they will be released in August 2015 as part of Event B.
- In addition to hosting the competition, SpaceX will likely build a pod for demonstration purposes only. This team will not be eligible to win.
- At SpaceX's discretion, teams will be allowed to test their pods through the test track before competition weekend.
- SpaceX, at its sole discretion, may allow or disallow entrants from accessing the test track.

No human will ride in any pod or other transport device used on the test track during this competition.

3 EVENT B: RELEASE OF COMPETITION RULES

SpaceX will publicly release a package which includes:

1. Requirements for Preliminary Design Briefing contents
2. Requirements for Final Design Package contents
3. Full Design Weekend logistics
4. Full Competition Weekend rules
5. Full criteria and performance metrics for Competition Weekend judging
6. Complete tube specifications
7. Competition Entry Agreement to be signed by all entrants
8. Intellectual Property Policy

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4 EVENT C: INTENT TO COMPETE

The Intent to Compete is an online form which can be found at www.spacex.com/hyperloop. The online form includes:

- University/entity name and a contact name and email
- Intent to either build a pod for competition weekend or to only present a design (pod, subsystem or safety feature) at the design weekend
- Acknowledgement that entrant is aware that, in order to enter the competition, he or she will have to sign a subsequently released Entrant Agreement.

The online form must be submitted by 5:00pm PDT on September 15, 2015. Within two weeks of submission, a follow-up email will be sent to each entrant requesting additional information.

5 EVENT D: PRELIMINARY DESIGN BRIEFING

Full details will be provided in August 2015 (Event B). *The Preliminary Design Briefing only applies to student teams*. This Preliminary Design Briefing package will consist of a PowerPoint slide deck of no more than 30 slides, which will likely include:

1. Top-level design description for pod
2. Top-level safety features description
3. List of any desired modifications to baseline tube definition (per Event B specification)
4. Updated list of team members (and their university majors, if applicable)

In order for SpaceX to evaluate the package, the entrant must have submitted a signed Entrant Entry Agreement (per Event C). The purpose of this briefing is for SpaceX to preliminarily vet the design and ensure that the entrant is headed in an appropriate direction.

6 EVENT E: FINAL DESIGN PACKAGE

Full details will be provided in August 2015 (Event B). For all entrants, this package should include a top-level design package, a description of the pod's safety features, and a top-level pod failure analysis. For student teams, this package will also likely require additional data, including:

1. Low-level design package
2. Answers to additional technical questions – examples are given in Section 8
3. Pod production schedule, bill of materials, and cost breakdown
4. Updated list of team members (and their university majors, if applicable)

7 EVENT F: DESIGN WEEKEND

An in-person design weekend will be held on January 9, 2016 at Texas A&M University, College Station, Texas, for all entrants. Full details will be provided in August 2015 (Event B).

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8 EVENT G: COMPETITION WEEKEND

All pods compete at the SpaceX Hyperloop Test Track in June 2016. Criteria for judging the winning pod and other details will be provided in August 2015 (Event B).

9 EXAMPLE DESIGN PACKAGE TECHNICAL QUESTIONS

Full requirements for the Final Design Package (Event E) will be released in August 2015. This will include answering several technical questions. Representative questions are:

1. What safety mechanisms are in place to mitigate a complete loss of pod power?
2. What safety mechanisms are necessary to mitigate a tube breach? The results should be quantified with regards to breach size, leak rate, tube pressures, and pod speed.
3. How should the ground operators communicate with the pod, especially in the case of an emergency (emergency stop command)?
4. Which sensors, if any, should be incorporated into the tube to aid navigation? How should the pod maintain accurate navigation knowledge within the tube?
5. What is the recommended pod outer mold line (OML)? Based on this OML, what is the drag on the pod as a function of speed and tube pressure?
6. If an air bearing system is used, how much surface area is needed for the footpad design?
    a. Specify driving pressure and flow rate needed at those required air bearing areas.
    b. Compare the flow rates required with practically available commercial units.
    c. Specify total force applied in both vertical and horizontal directions.
7. What sizing and spacing of linear motors would be required to maintain a given speed?
8. What is the steady-state temperature of the capsule as a function of speed and tube pressure?
9. What is the heat flux into the capsule as a function of speed and tube pressure?

Any questions or comments should be submitted to hyperloop@spacex.com

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