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2024

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# Rules & Regulations

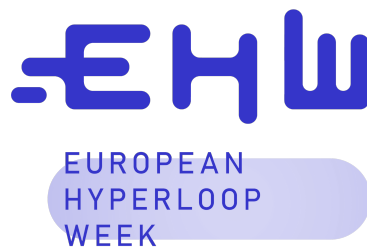
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Version 4.3

European Hyperloop Week

Tech Committee

February 16, 2024



## Changelog

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### R&R Version 4.3 ( February 15th ):

- Reformatted to LaTeX document
  - Modified rule DM.46 to make a distinction between manual disconnection of battery packs in series and in parallel.
  - Modified rule DM.47. The location of the pre-charge system is not important. Defined 'high capacitance load'.
  - Modified rule DM.50 to clarify the location of the required LEDs.
  - Added regulations for I-beam and custom tracks.
  - **IMPORTANT:** Added new Summary pages document
- 

### R&R Version 4.2 ( October 31st ):

- Developed new Scrutineering format
  - Added regulations for multiple custom tracks
  - Removed specification for sticker
  - Demonstrations on custom tracks must be visible at all times
  - Added presentations and expert talks on the Code of conduct
  - Added vacuum test on Scrutineering section.
  - Changed Innovative subsystems awards to Promising subsystems awards.
  - Removed safety factor for commercial pneumatic systems.
- 

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February 16, 2024, the EHW Committee

## Foreword

Dear Participants,

On behalf of the EHW team, we are excited to extend a warm welcome to all the teams applying to join us for the EHW week in 2024. We know that many of you are returning competitors, and some of you are joining us for the first time, so we would like to highlight the changes we have made to ensure a fair and engaging competition. Understanding these changes is crucial to your success, and we encourage you to pay close attention to them.

During the past editions, we have recognized that most of the awards are condensed around the teams that have been participating for multiple years in hyperloop competitions. In order to increase competitiveness and fairness across teams we have made a number of changes to the competition structure.

A separation has been made for the demonstrating teams: complete system and subsystem demonstrations. Teams that apply for the complete system award are not eligible for subsystem awards and vice versa. A more detailed description of each category can be found in [Applications](#). The complete system category is a challenging category, where teams must bring a system that incorporates all subsystems into an integrated prototype. We would like to say that meeting safety standards and passing scrutineering is a hard task that, in our eyes, is not achievable within a year's scope. For this, we would like to encourage teams to participate in the subsystem awards, focusing on specific subsystems of the hyperloop system, and with a multiyear view, slowly build up to a complete system.

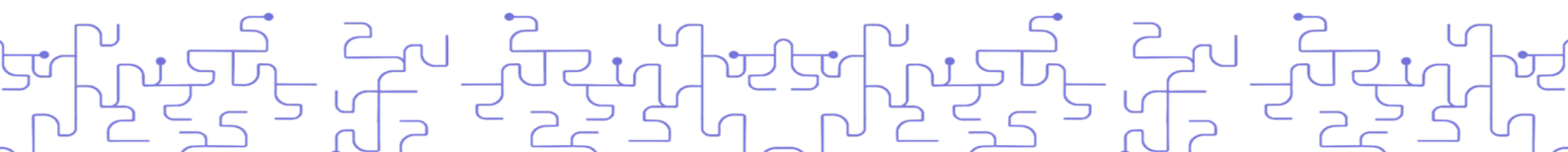
In order to have a more engaging competition, this year we want to encourage teams to demonstrate the work they have done throughout the year. For this reason, the showcase submissions have been eliminated. In order for a team (who brings a complete system or subsystem) to apply for an award, they must demonstrate their prototype. To also reduce the effort of teams before the competition, the TSD has been restructured into the SPD (Safety Procedures Documentation) and POD (Proof of Demonstration). More on this on the Application Process for Demonstration. Further changes have been made to the structure of presentations and scrutineering, among others.

We understand that these are substantial changes to the way the competition has been structured in the past. This year, the EHW team would like to be more involved with the teams throughout the year to guide you through the process of application. In this way, there will be a feedback session between the teams, the jury, and the EHW technical team after key deadlines (ITD, FDD, SPD, and POD) to discuss the proposals and give advice to teams on how to ensure a successful demonstration.

Best of regards and good luck!

The EHW Technical Team

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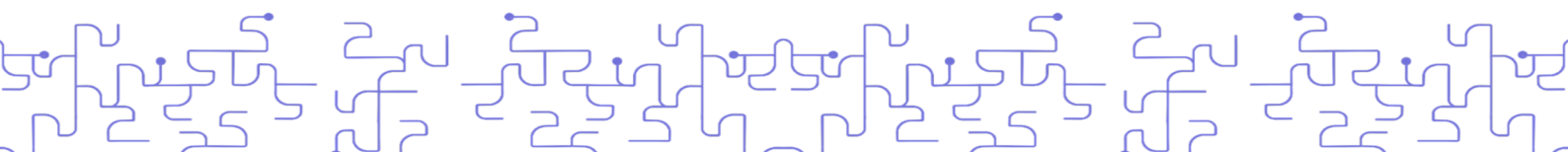


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# 1 Introduction

“The European Union must reduce the emissions of the transport sector by 60% by 2050”

“Transport services represent an industry worth 664 billion euros and employ 11 million people on just one continent” – European Commission

Under this premise, four European Hyperloop teams came together to create an event that will drive the development of the Hyperloop in Europe and around the world. It aims to be an event that brings the Hyperloop community together and that focuses on the scientific exchange between all those working on the concept of the Hyperloop. On one hand, the successful transition from the concept of Hyperloop to an actually feasible system calls for all forces to work together towards a common goal, and on the other, it is essential to inspire and convince the public that this form of transport has the potential to shape the future.

The event organizing Committee is comprised of four student teams of the European Hyperloop community, namely:



Universitat Politècnica de Valencia,  
Spain



Technische Universiteit Delft,  
Netherlands



The University of Edinburgh,  
Scotland



swissloop

Eidgenössische Technische Hochschule  
Zürich, Switzerland



## 2 General Information

This document outlines all technical aspects of the European Hyperloop Week 2024, also referred to as [EHW 2024](#) or [Event](#).

### 2.1 Terminology

- TG.1 Any model exhibited, presented, or operated at the Event is referred to as a [System](#). The term [Subsystem](#) is used if a subordinate reference shall be made clear.
- TG.2 Every team applying for the Event is referred to as an [Applicant](#).
- TG.3 Every applicant admitted to the Event is referred to as an [Exhibitor](#).
- TG.4 Every system that will be demonstrated at the EHW 2024 is referred to as a [Demonstrator](#).

### 2.2 Eligibility

- EG.1 There are no limitations on registering systems, as long as they relate to the Hyperloop concept. This includes:
- Fully integrated vehicles to scale.
  - Isolated subsystems
  - Infrastructures.
  - Test benches.

### 2.3 Liability & Safety

- LS.1 Every exhibitor must sign the [European Hyperloop Week 2024 Terms & Conditions of Participation](#).
- LS.2 Every exhibitor takes full responsibility for their systems even though the EHW Committee makes the final decision if a system might be brought to the Event or operated.
- LS.3 The EHW will NOT be liable for any damages incurred or incidents that may occur.
- LS.4 Every exhibitor who actively operates a system on the site of the Event will be obliged to possess valid liability insurance that covers both personal injury and property damage at any Event venue.
- LS.5 The instructions of the EHW Committee and associated personnel must always be followed. Failure to do so might result in the exclusion from the Event.

## 2.4 Intellectual Property of Submitted Documentations

- IP.1 The EHW Committee and all associated partners guarantee to treat the submitted documentation of the applicants confidentially and not disclose or disseminate any information from it.
- IP.2 The EHW Committee and all persons involved in the application and evaluation process for the EHW Awards explicitly do not have any rights to the content of the documentation.
- IP.3 The documentation submitted remains the intellectual property of the respective applicant.

This intellectual property regime is also set out in the [EHW Terms & Conditions](#).

## 2.5 Privacy

- PR.1 The EHW Committee guarantees to treat the personal data of the applicants confidentially, not to use them for any other purpose than for conducting the Event, and not to pass them on to third parties without their consent.

## 3 Code of Conduct

### Jury Authority

- CC.1 The EHW staff and jury reserve the right to interpret or modify the competition rules at any time and in any manner that is required to ensure a safe and fair competition.
- CC.2 All team members are required to cooperate with and follow instructions from the jury and EHW staff.
- CC.3 All clarifications posted on the website or sent to the teams directly are considered part of the rules.
- CC.4 Failure of a team or team member to follow an instruction or command directed specifically to that team or team member will result in a point penalty deducted from the team's overall score.
- CC.5 Disrespectful behavior from a member of a team towards other teams, the EHW organization, or jury will result in a direct warning to the respective team. If continued, it will be a reason for disqualification.

### Unsportmanlike behavior

- CC.6 During the event, unsportsmanlike behavior will result in a point penalty deducted from the team's overall score.

### Violations of Intent

- CC.7 Any parts, devices, or software fragments designed with the intent to violate a rule, will be considered a violation. Violation of the intent of a rule will be considered a violation of the rule itself.

### Protests

- CC.8 Protests can be filed against a decision made by the EHW or jury that is contrary to a rule from the most recent version of the Rules and Regulations of the EHW and has an actual, non-trivial, and negative effect on the team.
- CC.9 All protests must be filed in writing and should list the rule or regulation that has been violated and in which way or form and presented to the appointed EHW staff member. The team cannot present any new information in the protest. In order to have a protest considered, a team must post a 3-point protest bond which will be forfeited if their protest is rejected.
- CC.10 Protests will be handled by the advisory board of the EHW.

CC.11 The decision of the advisory board regarding any protest will be in written form and is final.

## Presentations and Expert Talks

CC.12 Every team and every member of the team is responsible for networking and getting involved in activities with the sponsors of the competition. An attitude of rejection to any activity, team, or collaborative organization will be considered unsportsmanlike behavior.

## 4 Schedule of the EHW 2024

SCDL.1 Based on current planning, the European Hyperloop Week is scheduled for 15th-21st July 2024. The event will last for one week and will be completely dedicated to Hyperloop-related technologies.

SCDL.2 The main constituents of the event will be:

- **Demonstrations**

Exhibitors will demonstrate their Hyperloop technology to the public. To do so, an exhibitor must apply for one of the application categories described in [Applications](#) (see Section 5).

- **Presentations**

Any demonstration will be preceded by a technical presentation made by the demonstrating team. The corresponding jury will be present, and any participant from any team is encouraged to attend too. This serves as a way to share knowledge and do a better evaluation of their posterior demonstration. It is also an intellectual defense, where the team will prove they understand the strengths and risks of their own system.

- **Conferences**

Talks, round tables, workshops, and others will be presented by industry and academia experts.

SCDL.3 The above-mentioned constituents will take place simultaneously throughout the week. The week itself will be arranged thematically such that presentations and conferences about similar technologies will be held on the same day.

SCDL.4 The weekdays will provide the opportunity for presentations and conferences. The spotlight during these days should be on the showcase and networking among participants.

SCDL.5 Towards the end of the week, extended infrastructure will be available for team demonstration. The infrastructure provided by the EHW Committee and its technical characteristics can be found in [EHW Infrastructure & Associated Requirements](#) (see Section 10).

SCDL.6 The conclusion of the EHW 2024 will be a public exhibition and will be the time when the EHW Competition awards will be presented.

SCDL.7 Exact details on the event schedule will be sent to the participating teams at least 1 month in advance of the competition. Be aware that the presented schedule is only a rough outline and is still subject to change. Furthermore, it will be the EHW Committee who will schedule any activities of the exhibitors, which explicitly includes the system presentations.

## 5 Applications

AP.1 There are three application categories a team can apply to:

- Complete System Demonstration.
- Promising Subsystem Demonstration.
- Research Submission.

AP.2 **System and subsystem applications are mutually exclusive.** Individual subsystems that compose a complete system will not apply to the individual subsystems award. This allows teams that cannot build a complete system to focus on one to three subsystems, bringing promising technologies and actually applying to the subsystem awards.

AP.3 If the team applying to subsystem application still decides to build a complete system they will not be required to provide any additional documentation and can only bring it for showcase purposes.

AP.4 **A team can not apply to more than 3 subsystems.**

The Research Submission is a parallel category anyone can apply for.

### 5.1 Complete System Demonstration

CSD.1 This is the most ambitious and challenging category. The applicant will be required to bring a fully functional hyperloop system with their systems previously tested and integrated.

CSD.2 The minimum subsystems required for a complete system are:

- Levitation
- Propulsion
- Mechanical
- Electrical
- Sense & Control

CSD.3 Custom track will be evaluated positively as part of the system but it is not mandatory for the complete system application.

CSD.4 They will be required to write extensive documentation of the complete system throughout the year, expecting an overall very high quality and clear direction of the proposal.

CSD.5 In case the system proposal is not accomplished at any point in the year, the EHW reserves the right to move the application to the subsystem category and limit the team to demonstrate the subsystems considered most feasible and promising for the competition. This is nevertheless not guaranteed and a team should not expect a category change in case their system proposal fails but a complete rejection from the demonstration.

CSD.6 After a successful demonstration, the team will be considered finalists and will be nominated for the Complete System Award. It will also be nominated to any of the Sponsor Awards.

## 5.2 Promising Subsystem Demonstration

- PSD.1 This application category encourages demonstrations of promising concepts applicable to a complete system. It does not require a complete hyperloop system, and it will demand a reduced amount of documentation, mainly applicable to the demonstrated subsystem. This reduces the overall workload and deadlines and gives the team more time to focus on a finished product.
- PSD.2 In order to facilitate scrutineering efforts, it is advised for teams that apply to this category to use off-the-shelf/commercial components for the systems outside the demonstrated subsystem.
- PSD.3 A team applying to this category must satisfy all rules surrounding the subsystem application. As an example, if a team applies for a Promising Levitation subsystem award, most likely the team will still make use of electrical, software, and mechanical interfaces. This means these interfaces must be following the rules dictated in [subsection 6.1](#).
- PSD.4 After a successful demonstration, the team will be nominated to the corresponding subsystem award and if applicable, to any Sponsor Award related to the demonstration.

## 5.3 Research Submission

- RS.1 Research Submission is an application category for EHW 2024 relating to the Full-Scale Awards.
- RS.2 The submission should consist of a single PDF document detailing the research the applicant has conducted.
- RS.3 If the applicant chooses to present a relevant prototype to this research, then documentation for this prototype needs to be submitted as well. This should be done following the guidelines of a Demonstration or Showcase, depending on the activity the applicant aims to conduct at EHW 2024. The application process for Research Submission is described in [Research Submission](#) (see Section 7).
- RS.4 The Research Submission should be self-sufficient, meaning that the applicant should not need to present any material (prototypes, pieces of software, videos, etc.) for the submission to be coherent and complete.
- RS.5 All details of relevant additional material (e.g., design and functionality of a prototype or piece of software) should be included in the Research Submission itself.

## 5.4 Basics of the Application Process

Concerning the application process the applicant must adhere to the following points.

## General

- AP.5 Virtual participation is not permitted.
- AP.6 The general concept for each application shall be fixed in the first documentation. System adaptations within the year are allowed as long as the core concept remains unchanged.
- AP.7 If there is feedback from the EHW Committee, the applicant is obliged to implement/follow that feedback to ensure a successful application.
- AP.8 A request to postpone a deadline can be made using the official communication channels. The EHW encourages to never account for extra time, although an exception can be made for a major cause or to ensure the safety of the team during the development process. The proposal review will be private and individual. The EHW reserves the right to deny these proposals without any justification.

## Documentation

- AP.9 If the demonstration of a certain system requires the active operation of other systems, such systems must be addressed in every documentation.
- AP.10 Systems or parts of a system that are not intended for demonstration or showcase as part of an application should not be included in the documentation unless they are important to the functioning of the systems being demonstrated (e.g. a control system). In that case, they should be included concisely.
- AP.11 The documentation timeline as presented in [Application Timeline](#) (see Section 5.5) must be followed. Failure to do so may result in the exclusion from the EHW 2024.
- AP.12 All documentation shall be established as [Formulated Engineering Documentation](#), meaning that they are developed, written documents and consequently are not in presentation or slide format. The EHW Committee may reject applications that are inadequately written.
- AP.13 All the represented data (i.e. Figures) must be own-referenced or the external reference must be explicitly stated. All graphs must have legible axis titles and legends (preferably with the same font type and size as the text) and with a common format throughout the document.
- AP.14 All documents and deliverables the applicant provides to the EHW should be written in English.
- AP.15 The relevant award/s for each application must be defined in the first documentation.

## 5.5 Application Timeline

Please note that each date mentioned below which is not specified in detail, will be announced at a later date.



### 5.5.1 Application Timeline for Demonstration

The application process for Demonstration Applications consists of several stages. The applicant will receive the final acceptance or rejection of their application after the final stage. Throughout the year, the deadlines presented in [Table 1](#) must be met to be considered for [Complete System](#) or [Promising Subsystem](#) Awards and Sponsor Awards.

Due Date	Action	Who
15th December 2023 23:59 CET	Submission of <a href="#">Intent to Demonstrate</a>	Applicant
January 2024	Applicant receives - Feedback session with the jury. - Notification if successfully qualified, changed to subsystem demonstration or rejected.	EHW Committee
17th March 2024 23:59 CET	Submission of <a href="#">Final Demonstration Documentation</a>	Applicant
May 2024	Applicant receives: - Feedback session with the jury. - Notification if successfully qualified, changed to subsystem demonstration, or rejected.	EHW Committee
31st May 2024 23:59 CET	Submission of <a href="#">Safety Procedures Documentation</a>	Applicant
7th June 2024	Applicant receives - Feedback session with the jury. - Notification if successfully qualified, changed to subsystem demonstration, or rejected.	EHW Committee
Late June 2024	Submission of <a href="#">Posters</a>	Applicant
30th June 2024 23:59 CET	Submission of <a href="#">Proof of Demonstration</a>	Applicant
7th June 2024	Applicant receives - Feedback session with the jury. - Notification if successfully qualified, changed to subsystem demonstration, or rejected.	EHW Committee
Before EHW 2024	Further information concerning the event week will be provided to the exhibitor	EHW Committee
15-21 July 2024	<a href="#">European Hyperloop Week</a>	

**Table 1:** Application timeline for Demonstration

### 5.5.2 Application Timeline for Research Submission

The application process for Research Submission consists of two stages. The applicant will receive the final acceptance or rejection of their application after the first stage. The second stage of the application process consists of submitting the work of the research itself.

If the applicant chooses to present a prototype along with their Research Submission, then the application process for Showcase or Demonstration needs to be followed separately for said prototype. The deadlines presented in [Table 2](#) must be met to be considered for [Full-Scale Awards](#) and Sponsor Awards.

Due Date	Action	Who
15th December 2023 23:59 CET	Submission of <a href="#">Intent to Submit Research</a>	Applicant
January 2024	Applicant receives - Feedback session with the jury. - Notification if successfully qualified or rejected	EHW Committee
9th June 2024 23:59 CET	Submission of <a href="#">Final Research Submission</a>	Applicant
Late June 2024	Submission of <a href="#">Posters</a>	Applicant
Before EHW 2024	Further information concerning the event week will be provided to the exhibitor	EHW Committee
15-21 July 2024	<a href="#">European Hyperloop Week</a>	

**Table 2:** Application timeline for Research Submission

## 6 Demonstrations Application

Every applicant shall read the following subchapters carefully and check if they can meet the requirements, with special emphasis on all the safety precautions. If the applicant fails to fulfill one point for a certain system, then the system will not be permitted for a demonstration.

### 6.1 Rules & Regulations for Demonstrations

These guidelines apply regardless of a full system or an isolated subsystem demonstration.

#### General

- DM.1 The applicant must specify the intended demonstrations and the operation procedures.
- DM.2 Detailed technical documentation and proof of testing/functionality of the respective systems must be provided [prior to the Event](#).
- DM.3 If one subsystem necessary to conduct a demonstration is considered as unsafe, the demonstration will be prohibited.
- DM.4 It is NOT only the EHW Committee that checks the safety of a system, but instead, it is the exhibitor who needs to prove to the EHW Committee the system's safety in order to be allowed for a demonstration.

#### Technical Documentation

- DM.5 The handling of high-power systems, especially for electromagnetic braking and propulsion systems, should be worked out in detail and tested properly.
- DM.6 Electromagnetic systems potentially involve a great amount of thermal and electric energy. The affected teams shall focus especially on the processing and handling of the energy involved. They need to document and test such systems extremely precisely.

#### Proof of functionality (Testing)

- DM.7 Demonstrations are NOT to be used as tests. This means that demonstrations may only be conducted in the exact same configuration of the system with the same set of parameters as it was tested before.
- DM.8 Any deliberate manipulation or wrong presentation of testing results, testing methods, or equivalent will lead to the immediate ban from the Event.
- DM.9 All critical system setpoints utilized during the proof of functionality, must be documented (e.g., pressure, current, voltage, etc.).

- DM.10 Industrial components do not need to be tested individually if they are operated within their authorized range and if they are not manipulated to alter their functionality in any way.
- DM.11 The system must be tested in the complete configuration with all components attached, just as it is intended to be operated in the demonstration.
- DM.12 Low voltage systems are considered to be under 50 V of peak voltage at full state of charge. Demonstrators above said voltage are required special safety measures, such as the definition of safe/clear zones during the operation, the explicit statement of which individuals are allowed and trained to handle the demonstrator during its operation, and the use of PPE:
- DM.12.1 Safety glasses with side shields.
  - DM.12.2 Suitable footwear (safety/steel-toed boots, rated dielectric footwear).
  - DM.12.3 Insulating gloves (rated, used along with leather/cloth linings for shock protection).
  - DM.12.4 Insulated tools.
- DM.13 Participants working with either their pod or track must wear proper safety equipment at all times. Participants are responsible to bring their own equipment.

## Design and Demonstration specifications

### System Outline

- DM.14 A detailed concept sketch of the demonstration setup and operation of the system must be proposed in the [ITD](#) developed in the [FDD](#), and detailed in the [SPD](#).

### Mechanical

- DM.15 The structural design guidelines must be given and developed briefly in the [ITD](#), detailed in the [FDD](#), and proved in the [POD](#).
- DM.16 The safety factor of all the structural elements in the worst-case scenario must be [higher than 2](#).
- DM.17 Any pneumatic or pressurized fluid circuit must be drawn with accompanying specifications, and all the vessels and enclosures must be marked with a certification nameplate, with all the certified maximum allowable pressure (MAWP) ratings being provided.
- DM.18 The operating conditions of team-made pressurized systems must meet the certified ratings with a [safety factor higher than 2](#).
- DM.19 The operating conditions of commercial pressurized systems must meet the certified ratings specified in the datasheet.

DM.20 Rotational systems must be balanced to avoid inertial asymmetry. This process must be explicitly stated and justified.

DM.21 Bearings and wheel contact surfaces must be developed to withstand the rotational speeds, as well as frictional head loads and deformations. The worst-case scenarios considered in the simulations and design criteria must be explicitly stated in the documentation.

## Braking System

DM.22 If the demonstrated (sub)system has a propulsion subsystem, the prototype should have an emergency braking system on the vehicle.

DM.23 In the neutral, not powered state the emergency braking system should be applying the required braking force for an emergency stop at maximum speed. This means that in case of a power or pressure loss, the system is still able to brake.

DM.24 The emergency braking mechanism should be automatically activated when the power or a control signal to the braking activation actuator is interrupted.

DM.25 The safety margin to the end of the track must be at least the worst-case scenario emergency distance at the maximum speed of the pod.

DM.26 The emergency braking mechanism should be automatically activated when the pressure of a hydraulic or a pneumatic braking system drops beneath the minimum required pressure for keeping the brakes retracted.

DM.27 The braking forces should be in a symmetrical manner so that the net braking force is zero in all directions except opposite the direction of travel.

DM.28 All braking power calculations and specifications must ensure a safe stop within the worst-case emergency braking distance in case of any failure of the system or any integrated subsystem.

DM.29 If the braking system is electromagnetic, the handling of generated/recuperated electrical energy must be precisely tested and documented.

DM.30 The handling of generated/recuperated energy must be precisely tested and documented.

DM.31 All risks of damaging the EHW infrastructure, if used, must be discussed and completely mitigated. Any damage to the EHW infrastructure during the demonstration will result in the exclusion of the Exhibitor from the Event, with no eligibility for any of the awards.

## Power supplies and batteries under 50V

DM.32 If applicable, specifications of batteries must be given. Otherwise, specifications of power supplies must be given with the required grid inputs.

- DM.33 Maximum-rated voltage is taken into account for battery systems. A 48V nominal voltage battery will be considered a high voltage system, as the maximum voltage will be 50.4V for LiPo batteries.
- DM.34 A battery pack is defined as a single enclosed collection of batteries together with its safety electronics.
- DM.35 The positive and negative terminals of the batteries must be clearly identified, and a physical mechanism to avoid wrongly plugging in cables in these must be implemented.
- DM.36 For each pack, a battery management system must be installed, featuring:
- overcharging avoidance
  - mechanism to stop discharging past safe voltage levels
  - battery isolation in over-temperature conditions
  - balancing of all cells (active or passive).
- DM.37 The following battery pack parameters must be reported to the operator:
- state of charge,
  - pack voltage,
  - pack current,
  - cell temperature of at least 25% of all cells inside the pack.
  - minimum and maximum cell voltages.
  - voltage of every cell connected in series.

## Power supplies and batteries above 50V

All rules from 'Power supplies and batteries under 50V' apply to the batteries above 50V in addition to the following rules specifically for batteries above 50V.

For ease of demonstration, a standardized battery will be proposed to teams in a later document. Teams are free to implement their own battery pack but a failure in any of the requirements will result in a rejected demonstration.

- DM.38 All conductors on electronics above 50V must be concealed.
- DM.39 A Manual Isolation Disconnect (MID) (or Manual Service Disconnect) must be installed, featuring:
- placement in the high current line,
  - independence of low voltage electronics,
  - operation without any tools,
  - accessibility if the pod/subsystem is stuck,
  - accessibility without removing any other parts of the pod/subsystem,
  - positive locking mechanism preventing disconnection through external forces,

- no conducting surfaces other than the electrical connection.

DM.40 For each pack, at least two independent, normally open relays must be installed, featuring:

- opening of both the high and low poles of the battery pack,
- completely isolating the pack when open (i.e. no electric potential outside the pack),
- adequate rating for the expected power.

DM.41 For each pack, at least one fuse with a lower rating than the maximum break current of the relay must be installed.

DM.42 In case of two or more packs in parallel, a Manual Relay Disconnect must be installed in addition to the MID on every pack, cutting low voltage power or signal lines to all isolation relays in all drivetrain packs. This can be in the form of a switch, button, or similar. In case of two or more packs in series, the mandatory MID on every pack is sufficient.

## Electrical

DM.43 If a high capacitance load such as an inverter is connected to the battery pack, a proper pre-charge circuit must be present on the demonstrator and utilized.

DM.44 Each HV electrical subsystem must feature a separate Insulation Monitoring Device, monitoring high-to-chassis and low-to-chassis insulation.

DM.45 All the cables must be rated for the maximum system voltage.

DM.46 The cables and conductors must be:

- visually distinguishable for low and high sides,
- physically segregated from low-voltage cables (excluding interlock circuit connections) by at least 25 mm,
- colored orange when carrying voltages above 120V,
- must satisfy electrical breakdown clearance dictated by the Paschen Curve, i.e., any exposed conductors must be separated by at least twice the minimum arcing distance, accounting for maximum mechanical flex and vibrations.

DM.47 Visual indications (e.g., LEDs) must be placed on the demonstrator, signaling

- presence of high voltage outside the battery (i.e., relays closed),
- proper insulation.

Said visual indications shall be visible without removing any mechanical components. Visual indications signaling the presence of voltage at pack connectors shall not be controlled through software, power shall come directly via hardware and/or circuitry connected to the system.



## Magnetics

- DM.48 Permanent magnets require careful operation. Teams using them shall implement a detailed description of a system for demounting and/or covering the magnets.
- DM.49 The magnetic flux density cannot exceed 1 mT anywhere on the surface of the cover or storage box of any permanent magnet.
- DM.50 The magnetic flux density cannot exceed 0.5 mT at a distance of one meter or more from the pod's outer perimeter.
- DM.51 If a team intends to demonstrate a rotating permanent magnet disk for either levitation or propulsion, the following must be presented:
- (a) Simulations proving the concept.
  - (b) Mechanical simulations of the assembly and expected loads.
  - (c) Thermal simulations of energy transferred between magnets and track, particularly looking at the temperature components reach.
  - (d) The rotating part of the system must be balanced with the motor.
  - (e) The system must be checked by an external company for balancing after their transport to the EHW location.
  - (f) Analysis of failure of 1 or more components.
  - (g) Design of a mechanism to guarantee stabilization in the direction of movement.

## Software

- DM.52 If applicable, the speed of the Demonstrator must be monitored during the demonstration.
- DM.53 The emergency braking must be accessible by the person monitoring the speed.
- DM.54 A Stop Command must be implemented, such that the Demonstrator/Subsystem can be commanded to come to a safe stop. For pods, this doesn't have to be the same physical mechanism as for standard braking.
- DM.55 Demonstrator health should be quickly assessed by an external viewer.
- DM.56 Logging of all the data on the requirements is compulsory.
- DM.57 For ease of demonstration, a standardized data logging toolchain will be proposed to teams in a later document. Teams are free to implement their own toolchain but a failure to do so will result in a rejected demonstration.
- DM.58 A state machine diagram listing all software states and their interconnecting transitions must be developed briefly in the [ITD](#), detailed in the [FDD](#), and proved in the [POD](#).
- DM.59 It should not be possible in any state for the emergency brakes and propulsion system to be powered at the same time.
- DM.60 For any case when a value goes out of the required range, a safety procedure should be available and described in the [FDD](#).



## Graphical User Interface (GUI)

- DM.61 A GUI must be implemented to visualize in real-time all the data requested on the requirements.
- DM.62 A diagram of the system architecture and implementation of the Graphical user interface should be included in the [FDD](#) and shown in the [POD](#).
- DM.63 A correct error detection and notification mechanism should be implemented. Any error on the system should be visualized on the Graphical user Interface including cause and timestamp.
- DM.64 Latency of the orders sent to the prototype must be less than 100 milliseconds to ensure correct response.
- DM.65 Data should be refreshed on the monitoring application with a minimum frequency of 2 Hz.
- DM.66 In the [FDD](#) the scenarios should be given clearly for powering up the pod, accelerating the pod, decelerating the pod, the emergency braking of the pod, and powering the pod down.
- DM.67 After the [POD](#), the team will have to justify any change they want to make to the software, always oriented to improving the safety of the system and not adding any new functionality. The EHW reserves the right to have the participant set the software back to the POD version.
- DM.68 A team has to ask explicit permission from the EHW to change software during the EHW.

## Communications

- DM.69 The Applicant must include mechanisms that bring the Demonstrator to a safe state in case of loss of communication.
- DM.70 The Applicant can NOT use frequency ranges shown in [Table 3](#).

Number	Frequencies	Number	Frequencies
A	1'400 - 1'427 MHz	L	100 - 102 GHz,
B	2'690 - 2'700 MHz	M	109.5 - 111.8 GHz,
C	10.68 - 10.7GHz	N	114.25 - 116 GHz
D	15.35 - 15.4 GHz	O	148.5 - 151.5 GHz
E	23.6 - 24 GHz	P	164 - 167 GHz
F	31.3 - 31.5 GHz	Q	182 - 185 GHz
G	31.5 - 31.8 GHz	R	190 - 191.8 GHz
F	48.94 - 49.04 GHz	S	200 - 209 GHz

I	50.2 - 50.4 GHz	T	226 - 231.5 GHz
J	52.6 - 54.25 GHz	U	250 - 252 GHz
K	86 - 92 GHz		

**Table 3:** Forbidden frequencies for communication in Switzerland (Federal Department of the Environment Transport, Energy, and Communication DETEC 2023)

DM.71 Connections are restricted to the IP address of the EHW internal networks, and further details will be given after the acceptance of the Applicant as an Exhibitor.

### Custom Track

DM.72 The custom track is limited to a maximum length of 50 meters.

DM.73 The custom track should be provided with sufficient electrical grounding, to prevent harm or injury to people.

DM.74 If the track contains electrical components, no hazardous components shall be exposed like exposed terminals.

DM.75 The custom track should be fitted with a physical stop at the end of the track that is able to withstand the impact of the pod hitting it at maximum speed.

DM.76 The track shall be able to withstand strong weather conditions (wind, rain, etc.).

DM.77 The custom track is not able to move during a run, due to forces exerted on it. This should be done by properly attaching it to the ground by anchoring it or demonstrating its stability with a worst-case scenario simulation.

DM.78 The design of the custom track should be analyzed to withstand an external temperature difference of  $\pm 20^{\circ}\text{C}$  without impacting the structural integrity or affecting the alignment in such a way that it impacts the motion of the pod.

DM.79 With prior approval of the EHW Committee, it is possible to drill into the ground.

DM.80 A safety perimeter must be defined around the track.

DM.81 An assembly point must be defined where people will go if there is any emergency.

DM.82 If a tent is placed around the track, a path must be kept clear at all times to ensure that all persons are able to get out of the tent safely in case of an emergency.

DM.83 If the custom track includes a tube-like structure, this should satisfy the following requirements to ensure safety:

- The track shall not be made of flammable materials.
- An extinguish plan should be added in the SPD.
- The track shall be transported and handled with roll-over prevention structures such as wedges.

- The track should be able to adapt to the terrain given by the university
- Each team takes responsibility for the machinery used for the track assembly and handling.

## Conduction of Demonstrations

- DM.84 Prior to a demonstration, the EHW Committee (and associated personnel) is allowed to inspect the system. If the inspection reveals any issues, the demonstration can be denied. More information on the scrutineering procedure on [Scrutineering](#).
- DM.85 The operation of any system during a demonstration must be performed according to a set of procedures, which need to be established by the exhibitor and approved by the EHW Committee prior to the Event.
- DM.86 The demonstrations can take place at the university campus or at the test track, and depending on the type of demonstration, time frames for the demonstrations will be assigned by the EHW Committee.

## Transportation, Storage, and Lifting

- DM.87 The requirements for Transportation, Storage, and Lifting as defined in [Transport, Storage, and Lifting](#) (Section 10.3) must be met.

## Liability

- DM.88 Every exhibitor is obliged to possess valid liability insurance that covers both personal injury and property damage at all the EHW 2024 venues.
- DM.89 The exhibitor needs to sign the [EHW Terms & Conditions](#). This contains among other things that the exhibitor takes full responsibility for the operation of all systems.

### 6.1.1 Guidelines for System Demonstration

As stated in [Applications](#) (see Section 5), this application should only be considered if the applicant team has the technological, economical, and human resources to safely produce a complete vehicle in the time frame of the competition.

#### General

- VD.1 If the participant wants to perform a longer pod run demonstration in the EHW 2024 event due to having a shorter test track at home, proof of the safety of the system at the expected conditions will have to be provided along with the submitted documents.
- VD.2 For pod demonstrations on the test track, the first points of contact need to be properly defined. Also, they need to be of significantly softer material (only material softer than 6082 T6 Aluminium) than the test track. It has to be proven by all teams that any parts that will (potentially) be in contact with the test track will not harm it.

VD.3 Vehicles should range between 1 and 5 meters in length.

## 6.2 Application Process for Demonstrations

In order to get the approval for a Demonstration at the Event, the applicants shall demonstrate their understanding of subsystems with the following documents to be submitted in PDF format by the indicated deadlines. Failure to do so might result in the exclusion of the Event.

For ease of submission, a template for each of the submission documents will be released well prior to the submission deadline. These templates contain information on what each section should contain. For details on the submission itself refer to [Applications](#) (see Section 5).

### 6.2.1 Intent to Demonstrate (ITD)

This document is used as a first application for the Event. It shall provide an overview of the current status and upcoming steps of the respective system. Most importantly, the applicant must explain how the respective system will be tested prior to the Event. The applicant is reminded to complete [Application Process](#) (see Section 5.4) at this documentation stage.

ITD.1 **Due:** 15th December 2023, 23:59 CET via [this form](#). (EHW 2023c).

ITD.2 **Document format:** [Formulated Engineering Documentation](#) (see AP.11). Preferably using bullet points, tables, and descriptive images.

ITD.3 Every **ITD** starts with the cover page filled in. (EHW 2023a) (EHW 2023d)

ITD.4 **Document scope:** Maximum of 3 pages per subsystem, excluding citations, index, or a cover page.

#### Minimum content

##### **General**

ITD.5 Description of the applicant and list of updated team members.

ITD.6 Details on the development environment and the research objectives.

ITD.7 Determination of one representative who will be in correspondence with the EHW Committee.

ITD.8 The category which this application is registered for. In the case of subsystems, specify which one will be demonstrated.

##### **System**

ITD.9 Technical description of the system to be demonstrated:

- Desired functionality and principal physics of its functionality. Do not explain basic physics (such as the Laws of Newton).
- Constraints (mass, dimensional, and budget).
- Initial concepts and Free Body Diagrams.

ITD.10 Size, components, appearance of the system (CADs, if available at this stage).

ITD.11 Integration of the system into a subordinate structure/system (if applicable).

ITD.12 Key elements and features of the system.

### Safety

ITD.13 Precautions are taken in order to comply with the Rules & Requirements for Demonstration.

ITD.14 What are the key elements of the system? Which features incorporate the highest safety risks?

ITD.15 How will the respective subsystems be tested prior to the Event?

## 6.2.2 Final Demonstration Documentation (FDD)

With this document, the applicants shall give further exact details of the system they want to demonstrate at the Event. It is intended as technical documentation and the applicant shall demonstrate that the corresponding system is designed and engineered safely and that he is able to test and operate the system safely. Furthermore, the testing of systems shall be described in detail.

FDD.1 **Due:** 17th March 2024, 23:59 CET.

FDD.2 **Document format:** [Formulated Engineering Documentation](#) (see AP.11).

FDD.3 **Document scope:** Maximum of 60 pages per subsystem and 100 pages for the general system introduction, demonstrations, funding plan, and others. Excluding citations, index, or a cover page. If custom infrastructure is brought, it will count as a subsystem by itself as detailed on the FDD Guidelines. This is just an absolute maximum and most proposals should have an optimal length of 20 - 30 pages per subsystem.

FDD.4 In the case of a subsystem application [FDD](#), each subsystem demonstrated must be documented as normal. Subsystems that do not apply for an award can be referenced in another section but will not give an extra length for the corresponding team.

FDD.5 **Larger documents will not be reviewed, and will require an immediate correction upon the team is notified.**

FDD.6 **Addendums:** Applicants have until 15th April 2024, 23:59 CET, to send in an addendum to their [FDD](#). Only minor, inevitable changes related to force majeure limitations will be accepted. Said limitations must be explicitly stated in the addendum.

### Minimum content

#### General

FDD.7 Description of the applicant and list of team members.

FDD.8 Details on the development environment and the research objectives.

FDD.9 Definition of budget, funding, and method of manufacturing (in-house, outsourced, or combination) for each subsystem.

FDD.10 The category for which this application is registered. It cannot be changed from the category in the [ITD](#).

### System

FDD.11 Detailed explanation of theory and principle physics of desired functionality. Do not explain basic physics unless required by the jury in a feedback document.

FDD.12 Description of design process taken.

FDD.13 Free Body Diagrams to define load cases for simulations.

FDD.14 Evidence of simulations validating the theory, and detailed analysis of results.

FDD.15 Detailed description of the dimensioning process.

FDD.16 Description of the manufacturing processes.

FDD.17 Size, components, appearance of the system.

FDD.18 Evidence of CAD models; Technical drawings of the complete system may be used to illustrate dimensions, but they should not be included for individual components of the system.

FDD.19 Integration of the system into a subordinate structure/system (if applicable).

FDD.20 Detailed plan of the demonstration, specifying the needed equipment and infrastructure (either own infrastructure or provided by EHW Committee).

FDD.21 Parts list (including dimensions and mass), in tabular format. Please identify which parts are made in-house or outsourced from an external supplier.

FDD.22 Images or CAD renders of the demonstration setup including all parts of the system that will be brought to the Event.

FDD.23 Section specifying a complete list of needed equipment and infrastructure (either own infrastructure or provided by EHW Committee):

FDD.24 If the applicant intends to use their own infrastructure (e.g. test bench), its safety must be proven as well.

### Safety

FDD.25 Technical description of the system to ensure compliance with the [Rules & Requirements for Demonstration](#) (see Section 6.1).

FDD.26 Preliminary risk assessment for Demonstration, including transport and lifting procedures.

FDD.27 Detailed FMEA and description of risk mitigation measures.

FDD.28 Summary of all energy storage types and components present in system(s).

FDD.29 Requirements for Transport, Storage, and Lifting as defined in Section 9.3, especially TS.4.

FDD.30 Transport and Lift Plan of the system

FDD.31 Procedures for safe storage of systems including potential energy.

### Testing

FDD.32 Outline of manufacturing and testing procedures to be included in the [Safety Procedures Documentation](#).

FDD.33 Provide a preliminary testing plan including methodology and expected results.

## 6.2.3 Summary Pages

This document shall be delivered with the FDD. It will be used for the jury to get a quick overview of the system and for publication on social media and the event. It can be adapted from the ITD, polishing it with the requested feedback and adapting it to not include any confidential information.

SPG.1 [Due](#): 31st March 2024, 23:59 CET.

SPG.2 [Document format](#): [Formulated Engineering Documentation](#) (see AP.11). Tables from the ITD can be replaced with figures and renders of the system.

SPG.3 [Document scope](#): Maximum of 3 pages per subsystem, excluding citations, index or a cover page.

## 6.2.4 Safety Procedures Documentation (SPD)

This document shall describe in detail which tests will be performed and how they will be conducted to demonstrate the safety of the system.

The tests must contain the aim of the tests, results, measurements, and data expected in the demonstration. This will provide a baseline based on which the EHW Committee defines the allowed set points/operating conditions of each system during the demonstration.

Furthermore, any Transport, Storage, Lifting, and Demonstration must be executed according to one or multiple predefined procedures. These procedures shall include every important step involved in the operation of the system such that wrong handling of the system is impossible. These procedures must be established by the applicant. Failure to establish such procedures might lead to a denial of a Demonstration. Additionally, if the system utilizes a transport cart to be transported, this must be tested according to TSL.2 in [Transport, Storage, and Lifting](#) (Section 10.3).



SPD.1 **Due:** 31st May 2024, 23:59 CET.

SPD.2 **Document format:** [Formulated Engineering Documentation](#) (see AP.11).

[Minimum content](#)

[General](#)

SPD.3 A cover page, concisely describing:

- What will be demonstrated - physical prototype(s) involved.
- How it will be demonstrated - infrastructure involved in the demonstration, an overview of demonstration procedure.

SPD.4 Written report of every test for the respective systems, which include, for each test:

- Aim/objectives of the test (hypothesis).
- Test description (methodology).
- Information about used testing infrastructure and setup (components, material, dimensions, instrumentation, etc.).
- Risk assessment.
- Detailed testing protocols (including entrance and exit criteria for each step in the protocol).
- Testing setpoints/conditions (e.g. load cases, pressure, voltage, speed, etc.).
- Expected results.
- Measurement data.

[Mechanical](#)

SPD.5 Attitudes dynamic test: all the attitudes used in the prototype should be tested with the maximum load they will support in a worst-case scenario at maximum speed. Ideally, this should be performed in a testing bench where both, speed and load are monitored.

SPD.6 Braking and pneumatic systems over-pressure and leak test: both pneumatic and braking systems must be subjected to an over-pressure and leaks have to be checked throughout the entire circuit.

SPD.7 Braking pads properties test: properties such as friction coefficient and hardness should be tested for safety reasons.

SPD.8 If applicable, vacuum test.

[Electrical](#)

SPD.9 Data read: First, connect all the batteries of low and high-voltage systems following the appropriate safety measures. Then prove data read of 100% of cells, 25% of temperatures, and total voltage of the system. Battery disconnection is not required.

SPD.10 Discharge current test: If not commercial, discharge the batteries at the operating peak current to prove the safety of the system.

### Sense & Control

SPD.11 With the system turned on, demonstrate control of the state machine, reading states and intentionally controlling transitions in a controlled environment. Check the data log from every applicable system (except batteries). Demonstrate that the system enters the emergency state upon disconnection.

### Levitation

SPD.12 Demonstrate static levitation of the system.

SPD.13 If applicable, demonstrate dynamic levitation of the system.

### Traction

SPD.14 Demonstrate dynamic run procedure, with or without levitation.

### Complete System

SPD.15 Demonstrate a successful procedure of the intended demonstration that will be performed during the EHW.

SPD.16 Transport & Lifting procedure (if applicable; according to [Transport, Storage, and Lifting](#) (Section 10.3)).

SPD.17 Test Track Load & Unload Procedure (if applicable).

### Other

SPD.18 Evidence of a valid liability insurance that covers both personal injury and property damage in all the venues of the Event<sup>1</sup>.

SPD.19 If the applicant brings their custom track, planning for the setting up, testing, and packing up of the custom track should be included.

## 6.2.5 Proof of Demonstration (POD)

This document shall show in detail every test procedure previously mentioned and approved in the [SPD](#).

The tests must contain results, measurements, and data in order to prove that they have been performed. Additionally, it is required to hand in video recordings of the tests in order to prove that the tests were conducted properly. It is intended as a completion or follow-up document for the [SPD](#) with the experimental results and graphical proof that the team will

<sup>1</sup>In the EHW 2024, said liability insurance must be valid in Switzerland during all times the team will be at the EHW location.

achieve the expected demonstration at the competition. This will set the maximum allowed demonstration conditions for the competition.

Any deliberate manipulation or wrong presentation of testing results, testing methods, or equivalent will lead to the immediate ban from the Event.

POD.1 **Due:** 30th June 2024, 23:59 CEST.

POD.2 **Document format:** [Formulated Engineering Documentation](#) (see AP.11).

[Minimum content](#)

POD.3 A cover page, concisely describing:

- What has been demonstrated - physical prototype(s) involved.
- How it has been demonstrated - infrastructure involved in the demonstration, an overview of demonstration procedure.

POD.4 Written report of every completed test for the respective systems, which include, for each test:

- Aim/objectives of the test (hypothesis).
- Test description (methodology).
- Information about used testing infrastructure and setup (components, material, dimensions, instrumentation, etc.).
- Risk assessment.
- Detailed testing protocols (including entrance and exit criteria for each step in the protocol).
- Testing setpoints/conditions (e.g. load cases, pressure, voltage, speed, etc.).
- Expected results.
- Measurement data.
- Processed results (graphs, diagrams). All the representation of results must be own-referenced or the external reference must be explicitly stated. All graphs must have legible axis and legend titles (preferably with the same font as the text) and with a common format throughout the document.
- Conclusion.

POD.5 Video of performed tests submitted in the following format:

- Static camera position.
- Clear vision of performed test.
- At least 1080p resolution.
- [Uploaded to an online streaming service](#) (e.g. YouTube) and provides a link within the POD report.
- The [date of the video upload](#) onto the streaming service [must precede the submission deadline of the POD](#).

POD.6 Evidence of a valid liability insurance that covers both personal injury and property damage in all the venues of the Event.

POD.7 If the applicant brings their own custom track, planning for the setting up, testing, and packing up of the custom track should be included.

### 6.2.6 Posters

All successful applicants must bring to EHW a poster with a minimum content and format requirement. More information and the poster template will be provided by the EHW Committee closer to the event dates. See also [showcasing posters](#).

DP.1 **Due:** 17th June 2024, 23:59 CEST.

DP.2 **Minimum required content:** The poster should summarise and reflect information included in the [FDD](#).

**Required format:**

DP.3 Minimum size A2

DP.4 PDF, SVG, AI, or EPS format.

DP.5 300 dpi (dots per inch) or fully vectorized.

DP.6 CMYK color mode.

DP.7 Bleed and registration marks for correct guillotining must be included in the final delivery.

### 6.2.7 Technical Presentations

Presentations serve as a way for the jury to directly interact with the team proposal, as an intellectual defense that proves the team understands their proposal and as an information exchange between teams and other assistants to the competition.

DP.1 **Due:** Competition week.

DP.2 **Document format:** Graphical slides.

DP.3 **Document scope:** 30' of presentation for the complete system presentation. 15' for the subsystem presentations. This time is exclusive for the presentation and more time will be given for questions.

### 6.2.8 Scrutineering

The safety of the teams, jury, and audience is crucial. Therefore, the prototypes of the teams will be thoroughly checked before they are cleared for demonstrations with a round of scrutineering before the event. Specific details on the logistics of how to apply for the Scrutineering stages once at the EHW location will be provided 1 month before the competition.

Testing of the system inside the EHW precinct will not be allowed before the corresponding scrutineering is passed.

During the scrutineering, prototypes will be inspected by the technical jury. The technical jury will assess the manufacturing and assembly of the prototype and will check safety-related aspects. In addition to that, the resemblance of the pod with the documentation previously supplied to the EHW ([FDD](#) and [SPD](#)) will be checked.

The scrutineering will happen before or during the EHW 2024. Detailed logistical information will be given in further versions of this R&R document. Team members will need to be present during the scrutineering. The pod or demonstrator has to be present during the scrutineering to be eligible for demonstration.

### General

SCRT.1 The scrutineering is divided into the following stages:

- Mechanical check
- Magnets inspection
- Battery and Low-Voltage inspection
- Software and Sensors inspection
- Power Electronics inspection
- Vacuum test
- Demonstration test

SCRT.2 Each demonstrating system applying to the complete system award must pass all parts of technical inspection. Failure to do so will result in the team not demonstrating its system.

SCRT.3 Each demonstrating system applying to a subsystem award must pass all parts of the technical inspection that apply to them (decided by the jury). Failure to do so will result in the team not demonstrating its system.

SCRT.4 The jury reserves the right to disqualify a team or apply up to a 10-point penalty if significant changes are made to the system concerning the [FDD](#) or [SPD](#).

SCRT.5 A scrutineering sheet containing points that will be inspected will be provided to the teams prior to the competition.

SCRT.6 Teams are responsible for confirming their system and that the required equipment satisfies the Rules and Regulations before presenting it for scrutineering.

SCRT.7 Safety non-critical rule violations that do not provide a benefit to the team and that cannot be changed at the event location may result in at least 3 penalty points.

SCRT.8 Safety non-critical rule violations that provide a benefit to the team and cannot be changed at the event location may result in at least 5 penalty points.

SCRT.9 Once the system is approved for demonstration, any damage to the system that requires repair(s) will void the scrutineering. After completion of the repair(s), the system must be re-submitted for scrutineering approval.

SCRT.10 Scrutineering officers reserve the right to prohibit the use of a part that could pose a safety risk.

### Scrutineering Responsible Person (SRP)

SCRT.11 To accelerate the scrutineering process, a member of the team must be appointed Scrutineering Responsible Person for each scrutineering stage.

SCRT.12 This person must be:

- Familiar with the system, especially with the part being inspected.
- Able to show the scrutineering officers' compliance with the points included in the scrutineering sheet.

SCRT.13 A maximum of 3 members from the team are allowed to be present during each of the scrutineering stages.

SCRT.14 In the case that the scrutineering stage requires performing a procedure (e.g. mounting the batteries, driving the pod into the track, etc) the team is allowed to have more members present to perform the procedure.

SCRT.15 Every person present during the scrutineering stage must wear the appropriate PPE and wear a reflective vest.

### Pre-scrutineering

SCRT.16 The following items must be present before and during scrutineering:

- Two up to date **1st class powder** certified fire extinguishers
- High-voltage gloves
- Safety glasses
- Safety shoes
- Helmets

SCRT.17 High energy systems must not be operated after arrival at the EHW location until the respective scrutineering stages have been successfully passed.

SCRT.18 Magnets must be properly protected using non-conducting cases until the magnets inspection is passed. If feasible, the team can choose to realize the magnets inspection with their magnets mounted on the pod.

SCRT.19 Batteries (above 50 V peak) must be properly stored and not mounted on the pod or test setup. Low-voltage batteries are allowed.

SCRT.20 All pneumatic tanks must be empty.

### Mechanical Inspection

SCRT.21 Checks performed:

- Fitting of all components.
- Loose parts/bolts/screws.
- Pneumatic/Hydraulic system.
- Thermal management system
- Mechanical inspection of the track.
- Definition of assembly point and a safety perimeter.

SCRT.22 Procedures to perform:

- Filling of pneumatic system.
- Emptying of pneumatic system.

### Magnets Inspection

SCRT.23 Checks performed:

- State of permanent magnets.
- State of electromagnets.

SCRT.24 Procedures to perform:

- Mounting of magnets on the pod.
- Dismounting of magnets on the pod.

### Battery and Low Voltage Inspection

SCRT.25 Checks performed

- Low voltage installation.
- State of low and high voltage batteries.

SCRT.26 Procedures to perform:

- Loading of the pod on track.
- Pod push test along the whole distance of the track.
- Low voltage battery mounting.
- Power on.
- Power off.
- Battery dismounting.

- Emergency procedure: Battery fire (pod on track)
- Unloading of the pod on track.

#### Software and sensors inspection

##### SCRT.27 Checks performed

- GUI check
- Navigation sensors check (may require pod being on the track)
- State machine transitions

##### SCRT.28 Procedures to perform

- Pod run (up until pressing the 'run' button).

#### Power electronics inspection

##### SCRT.29 Checks performed

- Power electronics installation condition.
- Insulation monitoring device.

##### SCRT.30 Procedures to perform

- Mounting of high voltage battery onto the pod.
- Dismounting of high voltage battery.

#### Vacuum test

SCRT.31 If the demonstration does not involve a vacuum but the team wants to prove vacuum compatibility a vacuum test can be done on the EHW track or the team's custom track.

SCRT.32 Failure to pass this stage will award 0 points in the vacuum section of the respective application, independent of the [FDD](#) or any previous video shown in the POD.

SCRT.33 No custom-made batteries are allowed inside the vacuum chamber.

#### Demonstration test

SCRT.34 During this test, the team will be asked to perform what will be demonstrated during Demonstration Day.

SCRT.35 When the jury arrives at the demonstration location to perform a demonstration test, all procedures approved during the previous scrutineering stages must have been performed up until the point where low voltage is on the system.

SCRT.36 All team members involved in the test must be wearing their respective PPE and reflective vests.

SCRT.37 If the system contains high voltage batteries, the MIDs must be turned off.

#### Scrutineering approval



- SCRT.38 During the mechanical inspection, the team will be handed a sticker containing all required scrutineering stages. This sticker must be placed in a visible spot on the system or test setup.
- SCRT.39 The jury and EHW technical team will decide which scrutineering stages must be performed by each team. The team will be informed well before the competition.
- SCRT.40 To pass any scrutineering stage:
- The jury must physically review in detail the involved parts of the system
  - The procedure must be approved.
  - The procedure must be performed live in front of the jury.
  - The team should be able to answer all questions posed by the jury members.
- SCRT.41 The jury may not approve a stage and ask the team to change certain aspects of the system. In this case, the team must perform that scrutineering stage again to gain approval.
- SCRT.42 To be able to perform the demonstration test, the team must have successfully passed all scrutineering stages. This means no partial stages.

#### Post-event scrutineering

- SCRT.43 The jury reserves the right to perform another scrutineering at any point during the week to check for compliance with the rules.
- SCRT.44 After any demonstration, the system must comply with the rules.
- SCRT.45 If the inspected team presents violations of the rules, the jury reserves the right to apply a penalty of up to 10 points on each of the awards the team is applying for.
- SCRT.46 After the demonstration test has been performed, the team is not allowed to make any changes to the system that will alter the performance of the system unless strictly stated via written notice by the jury. This includes software updates.
- SCRT.47 If any changes are made to a part of the vehicle (either hardware or software) that has already been scrutineered, the applicant must pass this stage(s) again.
- SCRT.48 If unauthorized changes are made, the jury reserves the right to:
- Apply a penalty of up to 10 points if the applied changes result in a considerable improvement in the performance.
  - Disqualify the team if the changes result in a safety hazard.

## 7 Research Submission Application

As stated in [Research Submission](#) (see Section 5.3), the Research Submission consists of a self-sufficient document fully detailing the work of research the applicant has completed.

### 7.1 Rules & Requirements for Research Submission

For the Research Submission to go ahead at EHW 2024, the applicant must abide by the following rules:

- RSA.1 The research presented is the applicant's own work. Previous literature can be used, as long as the applicant adheres to scientific standards. All contributions to the research by collaboration and information exchange with third parties should be clearly indicated.
- RSA.2 The Research Submission presents novel information. The applicant is responsible for revising the novelty of the research. Previous edition reports can be found [here](#) (EHW 2023e). In case the research addresses a previously investigated topic, the applicant must clearly indicate what new aspects of the topic are addressed or to what extent the topic is approached in a new way, resulting in new information or insights.
- RSA.3 The Research Submission itself may consist of a single PDF document per topic. If the applicant would like to present supplementary material related to their Research Submission, such as an experimental set-up, then they need to follow the application process for [Demonstration](#) (see Section 6) or [Showcasing](#) (see Section 8) as required by their intended activities. The supplementary material will not contribute to the evaluation of the Research Submission or Full-Scale Presentation.

### 7.2 Application Process for Research Submission

In order to be allowed to submit and present research at EHW 2024, the applicants shall document their work in the Intent to Submit Research (ITSR) and Final Research Submission (FRS) in PDF format by the indicated deadlines. Failure to do so will result in an unsuccessful application. For details on the submission itself refer to the announcements on the social media of European Hyperloop week and webpage.

#### 7.2.1 Intent to Submit Research (ITSR)

This document is used as the first application for the EHW 2024. It shall contain information on the topic of research the applicant aims to submit, the scope of the work, and a brief overview of the methodology used.

- ITSR.1 **Due:** 15th December 2023, 23:59 CET, via [this form](#).
- ITSR.2 **Document format:** Extended abstract, use of tables and descriptive images recommended.
- ITSR.3 Every ITSR starts with this [cover page](#) (EHW 2023b) filled in.

ITSR.4 **Document scope:** Sketch the outline of your research; maximum of 5 pages per Research Submission, excluding the cover page, and optional index and citations.

### Minimum content

#### General

ITSR.5 Description of the applicant, including the development environment and an up-to-date list of team members working on the submission.

ITSR.6 Designation of one representative who will be in correspondence with the EHW Committee.

ITSR.7 The Full-Scale Award for which this application is registered.

#### Research

ITSR.8 Title of the research project.

ITSR.9 Motivation of the research project and research objectives.

ITSR.10 Scope of the research.

ITSR.11 Overview of the methodology followed (or to be followed) in conducting the research.

ITSR.12 Outline of content that will be presented in the FRS.

ITSR.13 If applicable, description of supplementary material the applicant would like to present and whether this material will be demonstrated or showcased based on the definitions of the Rules and Regulations. In the case of demonstration, a separate ITD is required following the Rules and Regulations stated in [Demonstration](#) (see Section 6).

## 7.2.2 Final Research Submission (FRS)

This document should contain all details of the research conducted by the applicant that is to be presented at EHW 2024. Content-wise, it should follow the guidelines described in this section and be self-sufficient without requiring additional material. The appendix may provide supplementary information which is relevant, but not necessary to understand the submission.

The EHW Committee reserves the right to reject an application if the FRS does not meet expectations or if it differs greatly from the [ITSR](#).

FRS.1 **Due:** 9th June 2024, 23:59 CEST.

FRS.2 **Document format:** Research paper. The submission should be a single PDF file no longer than 20.000 words (roughly 40 A4 pages), not counting the reference list and appendices.

FRS.3 **Addendums:** No addendums will be accepted for the FRS. Submissions should be in their final form at this stage.

### Minimum content

#### General

FRS.4 Title of the submission.

FRS.5 Team name and authors.

FRS.6 Description of the applicant and the development environment, with an updated list of team members, advisors, industry partners, and other contributors. Contributions of third parties may also be listed in a separate acknowledgments section.

FRS.7 The Full-Scale Award for which this application is registered in the respective [ITSR](#), in case the FRS is submitted for an award.

FRS.8 Word count (excluding front page, sources, and appendices).

FRS.9 Specification of the location where the submission will be published (ideally with a link to the website page).

#### Abstract

FRS.10 Summary of around 300 words including:

- Research question or aim\*.
- Brief overview of motivation.
- Summary of methods.
- Presentation of main results and conclusions.

#### Introduction

FRS.11 Detailed presentation of the topic of research and the motivation for it.

FRS.12 Background information on the topic that may prove useful later.

FRS.13 Aim of the research (including research question)\*.

#### Methodology

FRS.14 Detailed account of methods used. May include simulation software, mathematical models, experimental set-up, survey set-up, literature review methods, and more. The methodology should be presented in a way such that the process is repeatable.

#### Results and Discussion

FRS.15 Detailed presentation of the outcomes of the research conducted.

FRS.16 Discussion on the significance and validity of those results.

### Bibliography

FRS.17 All references used in writing the paper.

FRS.18 All sources should be openly accessible by scientific publishing platforms or a website. The EHW will not accept confidential sources.

FRS.19 If referencing a website or other frequently updated source, include the date accessed.

FRS.20 If expert interviews are used, a transcript of the interview must be presented in the appendix. In case single pieces of information are retrieved from an expert, the name of the expert, the organization, and the date of consultation suffice.

\* Research questions are required for all socio-economic submissions, but not necessarily for technical submissions.

## 7.2.3 Posters

All successful applicants must bring a poster to the EHW with minimum content and format requirements. One poster shall be made per Research Submission. More information and the poster template will be provided by the EHW Committee closer to the event dates. See also [showcasing posters](#).

RSP.1 **Due:** 17th June 2024, 23:59 CEST.

RSP.2 **Minimum required content:** The poster should summarise and reflect information included in the FRS.

### Required format

RSP.3 Minimum size A2

RSP.4 PDF, SVG, AI, or EPS format.

RSP.5 300 dpi (dots per inch) or fully vectorized.

RSP.6 CMYK color mode.

RSP.7 Bleed and registration marks for correct guillotining must be included in the final delivery.

## 7.2.4 Full-Scale Presentations

Presentations serve as a way for the jury to directly interact with the team proposal, as an intellectual defense that proves the team understands their own proposal, and as an information exchange between teams and other assistants to the competition.

FSP.1 **Due:** Competition week.

FSP.2 **Document format:** Graphical slides.

FSP.3 **Document scope:** 20-25' of presentation. This time is exclusive for the presentation and more time will be given for questions.

## 8 Showcasing

Apart from applications for the competition, a team is encouraged to showcase their work at the EHW. There are four scenarios in which teams can showcase:

- **Technical System Design:** A subsystem that is not eligible for or rejected from the demonstration competition can be showcased at the EHW. The system will not be eligible for any award.
- **Complementary System for Demonstration:** A subsystem can be showcased to complement a demonstrable subsystem, like an aeroshell where a Sense & Control system is demonstrated.
- **Research:** Any Hyperloop-related research that is not eligible for or rejected from the full-scale competition can be showcased at the EHW. The research will not be eligible for any award.
- **Supplementary Material Research:** To complement a full-scale presentation or research that is presented outside of the competition.

In any of these cases, the team can showcase their work at a dedicated stand with the corresponding posters. Teams that solely showcase will have the right to attend presentations, demonstrations, and social events at the EHW site, but will not perform any presentations themselves or apply for any of the awards.

### 8.1 Rules & Requirements for Showcase

In order to receive the permission for a showcase at the EHW 2024, the applicant must follow the following rules:

- SHW.1 In principle, each participating team has space for 3x1 meters to showcase systems, research, and posters. In case a team is in doubt about something they intend to bring to the EHW, they are strongly advised to contact the technical team.
- SHW.2 The showcased work is powerless.
- SHW.3 No kind of potential, kinetic, chemical, or electromagnetic energy stored in, on, within, or around the showcased work (thus especially no batteries within the system). This includes that no kind of the mentioned energy storage is allowed on the site of the EHW 2024.
- SHW.4 The exhibitor needs to sign the [EHW Terms & Conditions](#). Therefore, they take full responsibility for any damage, incident, or accident caused to or by an exhibitor's system.
- SHW.5 Any further low-power devices or appliances that are not part of the system and only intended for visual display or presentation purposes (i.e., LEDs, lights, monitors) must also be mentioned and highlighted in the Showcase application and can be powered on-site if approved by the EHW Committee.
- SHW.6 The requirements for [Transport, Storage, and Lifting](#) as specified in Section 10.5 must be followed.

## 8.2 Showcase Documentation (SD)

In order to get approval for a Showcase at the EHW 2024, the applicants shall document the respective system by submitting the required documents in PDF form by the indicated deadline. Failure to do so will result in an unsuccessful application. For details on the submission itself refer to [section 11](#).

SHWD.1 **Due:** 17th of June 2024, 23:59 CEST.

SHWD.2 **Document format:** [Formulated Engineering Documentation](#) (see AP.11) or extended research abstract.

### [Minimum content](#)

#### [General](#)

SHWD.3 Team name

SHWD.4 Point of contact and email

SHWD.5 Description of the applicant and updated list of team members, advisors, and industry partners.

SHWD.6 Details on the development environment and the research objectives related to the showcased material.

SHWD.7 If applicable, the award application to which the showcased material is related.

#### [System \(if applicable\)](#)

SHWD.8 Detailed explanation of theory and principle physics of desired functionality.

SHWD.9 Description of design process taken.

SHWD.10 Free Body Diagrams to define load cases for simulations (if applicable).

SHWD.11 Evidence of simulations validating the theory, and detailed analysis of results (if applicable).

SHWD.12 Dimensions, mass, and components of the system.

SHWD.13 Appearance of the system, either by clear images or CAD models. Technical drawings of the complete system may be used to illustrate dimensions, but they should not be included for individual components of the system.

SHWD.14 Integration of the system into a subordinate structure/system (if applicable).

SHWD.15 Detailed plan of the showcase, specifying the needed equipment (expected to be provided by the EHW and brought by the team).

SHWD.16 Images, or CAD renders, of the showcase setup including all parts of the system that will be brought to the EHW 2024.

#### [Research \(if applicable\)](#)

SHWD.17 Title of the research project.

SHWD.18 Motivation of the research project and research objectives.

SHWD.19 Scope of the research.

SHWD.20 Overview of the methodology followed (or to be followed) in conducting the research.

SHWD.21 Outline of content that will be presented in the FRS.

### 8.3 Showcasing Posters (SP)

All successful applicants must bring a poster to the EHW with minimum content and format requirements. One poster shall be made per Research Submission. More information and the poster template will be provided by the EHW Committee closer to the event dates. All exhibitors must follow the minimum content requirements outlined below.

SP.1 **Due:** 17th June 2024, 23:59 CEST.

SP.2 **Minimum required content:** In case the poster regards research, it should summarise and reflect information included in the FRS. In case the poster regards a technical system (proposal), it should summarise and reflect information included in the [FDD](#) or present the information that is in line with the requirements for [FDD](#) documentation.

#### Required format

SP.3 Minimum size A2

SP.4 PDF, SVG, AI, or EPS format.

SP.5 300 dpi (dots per inch) or fully vectorized.

SP.6 CMYK color mode.

SP.7 Bleed and registration marks for correct guillotining must be included in the final delivery.



## 9 Awarding System

### 9.1 Introduction

As one of the core features of the EHW 2024, the best systems demonstrated will be awarded. For the current edition of the EHW, the following awards exist:

- **Complete System Award:** for the finalist teams that manage to create a real hyperloop system and perform a dynamic run. The following awards will be given:
  - 1st place
  - 2nd place
  - 3rd place
  - Finalist

Complete systems will not apply to the Individual Subsystem Awards.

- **Subsystem Awards:** for teams that manage to create innovative technology in a respective engineering area. This will be:
  - Mechanical Subsystem Award.
  - Electrical Subsystem Award.
  - Sense & Control Subsystem Award.
  - Traction Subsystem Award.
  - Guiding Subsystem Award.
- **Full-Scale Awards:** for teams that successfully submit a hyperloop-related paper. This will be:
  - Full-Scale Award - Technical Aspects of Hyperloop Systems
  - Full-Scale Award - Socio-Economic Aspects of Hyperloop Development
- **Best Design Awards:** sponsored by partners of the Event. Applications to any award will automatically be added to the Best Design Awards. Best Design Awards may be, but are not limited to:
  - Most Scalable Design Award.
  - Best Thermal Management Award.
  - Outreach Award.
  - Vacuum Technologies Award.
  - Sustainable Legacies Award.
  - Infrastructure Award.
  - Best GUI Award.

The grading of the awards will be done by an impartial jury consisting of people with a technical, industrial, or research background.

## General Information on the Evaluation

The applicant shall notice the following points concerning how all systems will be evaluated:

- EV.1 The FDD of the respective system and the FRS form an important part of the grading of the system/submission.
- EV.2 Systems will be evaluated based on "good engineering," which includes design, engineering, scalability, cost efficiency, and product quality. It is encouraged to address in detail new ideas, promising and scalable concepts, and ground-breaking aspects of the system in detail that may appeal as close-to-market designs for ongoing hyperloop development.

This means in particular:

- EV.3 **Complete System Award:** Every aspect of the entire pod and custom track (if applicable) may be evaluated for the award. Focus is made on the integration of the different subsystems as a whole and with the track. This means that it will be highly recommended to treat all subsystems of the pod in detail, as well as the systems integration.
- EV.4 **Promising Subsystem Awards:** The documentation shall include all aspects of the respective systems included in the award.
- EV.5 **Full-Scale Awards:** For the Full-Scale Awards, teams will be evaluated on the content of their submission and on the presentation at the EHW. The submission will be evaluated on its form, writing, content, and scientific value, with a focus on the quality of the content. The content is evaluated on all the information presented in the submission, i.e. the introduction, methodology, results, and discussion. The scientific value of the submission is evaluated based on the correct use of reputable sources and the relevant knowledge that is added by the research.

## 9.2 Complete System Award

This category focuses on the demonstration of a complete functional Hyperloop prototype. A complete system will excel in the implementation of all the subsystems listed above. Although a complete system will not apply for any subsystem awards, the individual subsystems will be evaluated using the same criteria. This private score, in addition to integration criteria, will form the final result.

Teams using their custom test track can use the track for propulsion and braking. For this category, applicants present a Final Final Demonstration Documentation (FDD) for their prototype. Only one design will be graded per exhibitor. In addition to subsystem evaluation, these are the criteria that will be evaluated for the complete system:

1. **Integration Criteria:** The integration criteria evaluate the effectiveness of combining various components into a unified, functional whole, ensuring the seamless operation and performance of the Hyperloop system. This includes:
  - Integration of the subsystems between them.
  - Integration of the propulsion system with the track

- Integration of the levitation subsystem with the track
  - Use of space and distribution inside the vehicle.
  - Robustness of system
2. **Innovation Criteria:** The Innovation Criteria evaluate groundbreaking concepts and novel solutions that directly or indirectly contribute to one of the following aspects:
- Economical aspects
  - Energetic aspects
  - Logistical aspects
3. **Full-Scale Criteria:** The full-scale criteria evaluate the potential adaptability of the system to a full-scale hyperloop network (operating at higher speeds, longer distances, variable weights, etc.):
- Scalability of concept
  - Safety considerations
  - Speed and efficiency
  - Maintenance and reliability
  - Materials used
  - Energy efficiency

### 9.3 Promising Subsystem Award

- PSA.1 This category focuses on the demonstration of prototypes for a specific subsystem of a Hyperloop Pod. The design can be for a full-scale Hyperloop system or a small-scale prototype Pod. If a certain subsystem can be evaluated in different categories due to the multiple functions it has, it will be strictly evaluated in each category based on the corresponding functionality.
- PSA.2 For the subsystem awards, teams are encouraged to focus their resources on an isolated aspect of the system, aiming to develop new technology.
- PSA.3 Subsystems eligible for the Subsystem Awards shall fall under the following five categories:
- (a) **Mechanical Subsystem:** In the Mechanical Subsystem Award, all mechanical systems are evaluated, including but not limited to:
    - i. Emergency brakes
    - ii. Mechanical suspension
    - iii. Stability
    - iv. Chassis
    - v. Shell
    - vi. Custom track.
  - (b) **Electrical Subsystem:** In the Electrical Subsystem Award, all power electronics systems are evaluated, including:

- i. Power supply
  - ii. Electrical integration
  - iii. Power stage design and implementation
  - iv. Battery and battery management systems.
  - v. Onboard Chargers
  - vi. Motor drives Excluded from this category are:
  - vii. Propulsion systems
  - viii. Levitation systems
  - ix. Braking systems.
- (c) **Sense & Control Subsystem:** In this award the sensing and controlling systems for the pod and track are evaluated, including:
- i. Control system (whole, in its entirety)
  - ii. Data acquisition (sensor network)
  - iii. Signal processing
  - iv. Controllers
  - v. Communication systems
  - vi. Location systems

What is not part of the award:

- vii. i. Control systems that only control one subsystem (like a levitation system).
- (d) **Traction Subsystem**
- i. The Traction Subsystem Award is open to both propulsion and deceleration systems, including:
  - ii. Motor
  - iii. If applicable, other braking systems (which do not fall under emergency brakes).  
Examples: electromagnetic brakes, braking with the motor, etc.
  - iv. These systems may be solely mechanical, electromagnetic, or hybrid.
- (e) **Guiding Subsystem**
- i.
  - ii. The Guiding Subsystem Award is open to all suspension and stability systems including:
  - iii. Vertical Suspension Systems
  - iv. Lateral Guidance Systems
  - v. This award will also take into account the interface between the motor and the guiding subsystem. These systems may be solely mechanical, electromagnetic, or hybrid.

## 9.4 Full-Scale Awards

This category focuses on the challenges involved in the translation from Hyperloop prototypes to a real-world Hyperloop system. Exhibitors must demonstrate an understanding of the implementation of Hyperloop technologies in society, by presenting research relevant to

full-scale Hyperloop development.

For a Research Submission to be eligible for a Full-Scale Award, it must follow the rules as stated in Chapter 8. In addition, a team has to publish their submission on an open-access platform after the competition, so from the 21st of July 2024 onwards. The EHW website, your own platform (like Hyperloopconnected.org), your university repository, or another open-access platform can be used as a platform to publish open-access submissions.

Submissions eligible for the Full-Scale Awards shall fall under the following two categories:

### 1. Technical Aspects of Hyperloop Systems:

This category aims to explore technical aspects of the full-scale Hyperloop system, including both the pods and the infrastructure. The development of Hyperloop technology is very much still underway, with many technical questions remaining unanswered. EHW 2024 is an opportunity for student teams to attempt to answer some of those questions.

Any topic that falls within the category of Technical Aspects of Hyperloop Systems is an acceptable choice for submissions to this award. Full-scale Technical Aspects submissions for technical systems could include your own laboratory research.

Teams are highly encouraged to perform research on one or more of the following topics or come up with their own underexposed area of technical Hyperloop research:

- Safety systems (emergency exits, safe havens, etc.).
- Life support systems.
- Vacuum management (leakage, vacuum pumps, airlocks).
- Thermal management.
- Banking.
- Tube construction (forces, joints, lane-switch)
- Energy management and (inductive) power supply to the vehicle.
- Noise inside the pod, and/or outside the tube.

### 2. Socio-Economic Aspects of Hyperloop Development

This category of the Full-Scale Award is meant to explore the aspects of Hyperloop development that have to do with the interaction between (the development of) Hyperloop technology and society. With the technology advancing rapidly, questions arise regarding the non-technical aspects of the implementation, both of social and economic nature.

Any topic that falls within the category of Socio-Economic Aspects of Hyperloop Development is an acceptable choice for submissions to this award. Full-Scale Socio-Economic Aspects submissions could include your own surveys.

Teams are highly encouraged to perform research on one or more of the following topics or come up with their own underexposed area of socio-economic Hyperloop research:

- Sustainability of construction and operation.
- Accessibility for people with reduced mobility.
- Impact on society (acceptability/societal changes).
- Travel comfort/experience.
- Costs and ticket affordability.
- Security and emergency procedures (eg. risk and harm mitigation vs. zero failure policy).
- Alignment (underground vs. above ground, approach to cities, integration in environment).
- (Safe) operation.

The two categories define broad topics that the research questions of the submissions should fall within. The Research Submission could entail a broad or narrow subject within the respective category. However, it is strongly recommended to perform in-depth scientific research, rather than examining all aspects of a category. A submission should contribute to the expansion of knowledge concerning a full-scale Hyperloop. Knowing the Hyperloop system and its current development is therefore key for a good submission. Although a thorough literature review is also essential to not repeat existing research and to label sources correctly, solely combining existing research does not suffice. The categories have been chosen to be broad to allow applicants the freedom to explore the topics that they find most appealing and impactful.

Applicants may submit up to one application per award category. A repository with a collection of known repositories for Hyperloop research and a curated literature repository for Hyperloop research from EHW, jurors and partners is available at the [Hyperloop Paper Repository](#).

## 10 EHW Infrastructure & Associated Requirements

### 10.1 Test track

An I-Beam is installed on concrete foundations at the Switzerland Innovation Park Zurich (IPZ). The straight track is 50m long and has an access point at the beginning for loading and unloading the pods. 230V and 400V/three-phase power outlets will be provided nearby for battery charging. A forklift (Load capacity: max. 1000kg) will be provided for lifting the pod onto the I-Beam track.

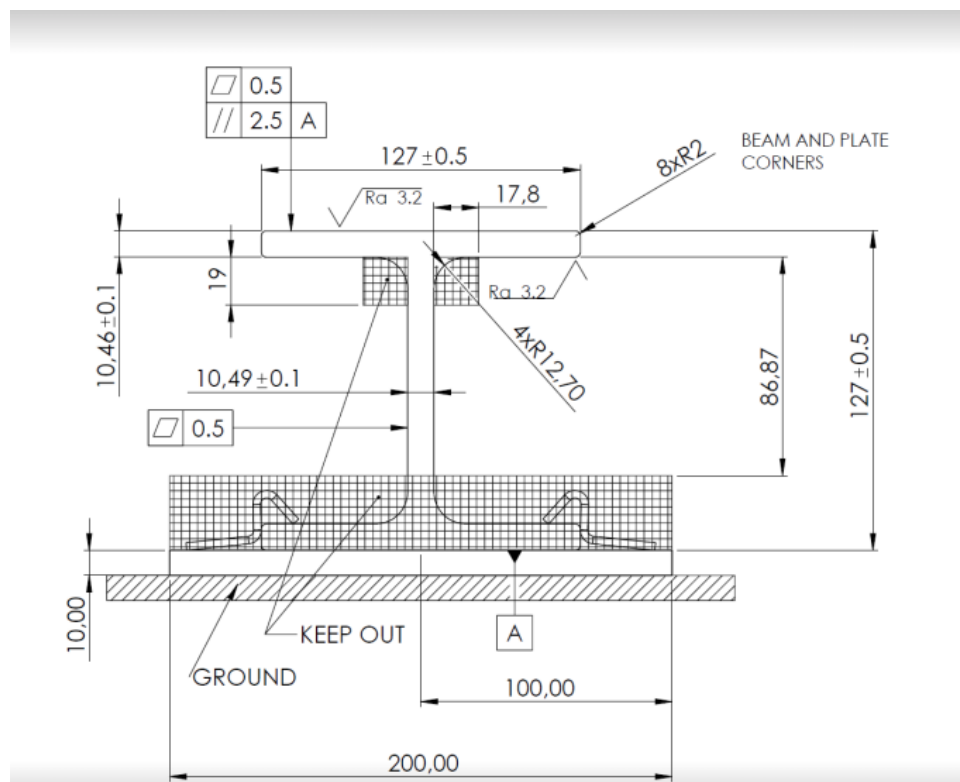


Figure 1: Cross section of I-beam (all values in mm).

#### 10.1.1 Test Track Specifications

TT.1 **Material:** 6082 T6 Aluminium.

TT.2 **Length:** 50m.

TT.3 **Tolerances:** The track consists of 6 m sections. The maximum deviation between the sections is listed below:

TT.3.1 Lateral: 2 mm.

TT.3.2 Vertical: 2 mm.

TT.3.3 Gap between segments: 3 mm.



## 10.1.2 Test Track Requirements

In summary, the following requirements must be met in order to be allowed to operate any system on the test track.

- TT.1 Under no circumstances should the keep-out zone be violated. The keep-out zones are defined in Figure 1. The bottom keep-out zones extend outward in a horizontal direction infinitely.
- TT.2 The exhibitor must prove that the demonstrated system does not harm the test track infrastructure by any means. Thus, any (possible) contact point with the track needs to be of significantly softer material (only material softer than 6082-T6 aluminum) than the test track.
- TT.3 During a demonstration, it is forbidden for people or subjects to remain within the pod loading area, the pod unloading area, and the keep-out safety zones.
- TT.4 Loading and unloading of a demonstrator must happen in the designated loading area.
- TT.5 The demonstrator shall preferably be designed such that it can propel itself to the unloading area. Demonstrators who might be stuck on the test track may only be pushed by hand to the loading or unloading area, if the exhibitor previously has conducted a procedure to power off the demonstrator, thus showing that touching the demonstrator is safe.
- TT.6 The only manipulations allowed to be performed at the demonstrator while it is on the test track are to recover a stuck demonstrator. Any other manipulations are solely permitted if the demonstrator is either at the loading or the unloading area.
- TT.7 A moving demonstrator on the test track must use at least two independent and appropriate methods to measure its location or velocity.
- TT.8 Further details on the exact procedures for a demonstration on the Test Track will be provided at a later stage.

## 10.2 Vacuum Tube

For this year's EHW edition, the EuroTube company will offer its new DemoTube as a vacuum chamber for all teams who want to demonstrate their vacuum systems. The vacuum chamber consists of an 8-meter vessel, which is the initial section for the entire 124-meter tube that is being built by EuroTube.

In order to properly demonstrate, the vacuum vessel counts with a sealed door and a valve that isolates the vessel from the rest of the tube. Also, this section does not have any type of rail and has a wooden floor.

The Tube is located in the Switzerland Innovation Park Zurich, at Wangenstrasse 68, 8600 Dübendorf. The operations performed by the teams



## 10.2.1 Vacuum Tube specifications

VTs.1 The Tube dimensions can be seen in Figures 2 and 3.

VTs.2 **Pressure:** 1 atm to 1 mbar (the vacuum level can be adjusted to the user's needs)

VTs.3 **Elevation:** 1.7 meter over ground level

VTs.4 **Maximum payload:** 2,000 kg.

VTs.5 Other specifications such as air humidity or temperature can be seen in the [DemoTube Users Guide](#)

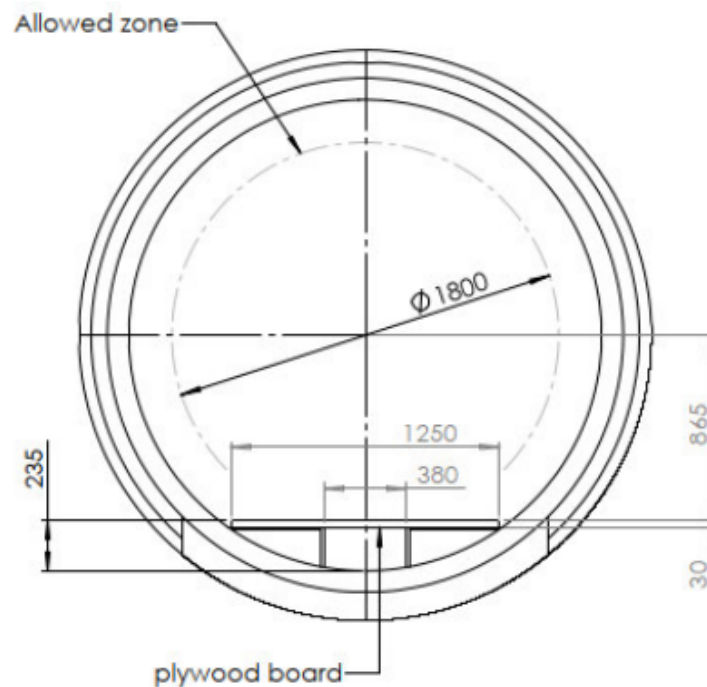


Figure 2: Cross section of the 8 m airlock at the EHW24

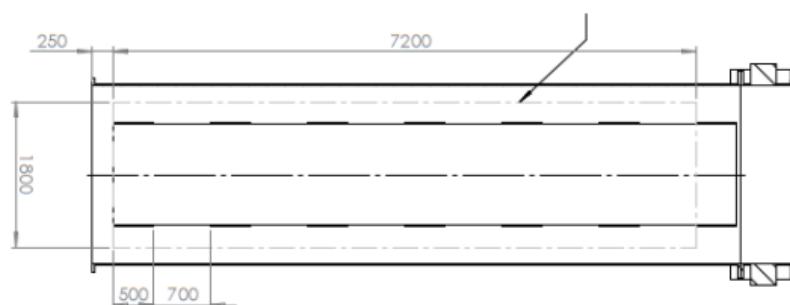


Figure 3: Top view of the airlock plus valve at the EHW24

## 10.2.2 Vacuum Tube Requirements

- VTR.1 The teams are required to design the vehicle or to modify its topology to fit the available vehicle zone(also described in Figure 1)
- VTR.2 The vehicle or its transport trolley must be able to roll in order to properly access the vessel.
- VTR.3 For further detail about the loading and unloading procedures, see the [DemoTube Users Guide](#).

## 10.3 Custom Test Tracks

For custom tracks, a space will be provided.

- CTT.1 All teams who would want to bring their own Custom Test Track to demonstrate must provide a detailed assembly and disassembly plan in the FDD. This must include a timeline, requested equipment, days and times when a forklift will be required as well as the number of people that will be working on the Custom Test Track simultaneously.
- CTT.2 Participants have one and a half weeks before the EHW event to assemble their own track. The tracks must be disassembled within three days of the end of the event.
- CTT.3 All custom tracks and assembly plans must be approved by EHW.
- CTT.4 Multiple tracks will be considered a single unit and must be documented accordingly. Their total length and width is obtained from the sum of the various tracks in addition to the safety distance between them. This length must not be superior to the maximum established length and width for a single track.
- CTT.5 For more specific information, feel free to contact the EHW committees to adjust for your specific case.

### 10.3.1 Technical Requirements for Custom Tracks

- CTT. 1 The flatness of the custom track location cannot be guaranteed, meaning a leveling system must exist. A topological survey will be provided at a later date with specifics.
- CTT. 2 All teams bringing custom tracks must provide detailed Health and Safety documentation for assembly, demonstration of the pod, and disassembly of the track. Separate H and S documentation must be provided for demonstration and assembly/disassembly (e.g. 2 RA documents).

### 10.3.2 Logistical Requirements for Custom Tracks

- LRC. 1 All components of the custom tracks (including equipment and control station) should fit within the allotted space (as requested on the application form).
- LRC. 2 Custom tracks shall arrive in as few deliveries as practical.
- LRC. 3 Demonstrations on custom tracks should be visible to the public directly or via a live stream.

- LRC. 4 All deliveries must arrive in sturdy containers that can be lifted by a forklift (maximum weight 2.5 Tonnes - symmetrical load). Other lifting mechanisms provided by the teams can be used, but must first be approved by EHW.
- LRC. 5 Demonstrations should be visible to the public at all times. For tube-like infrastructures or other non-visible infrastructures, a live stream system must be implemented.
- LRC. 6 The document outlines the scope of what will be provided, extras or favors can be asked for however the EHW has no obligation to provide them.
- LRC. 7 EHW does not provide cover for custom tracks.

## 10.4 Communications

General EHW Pod Communications Rules and Requirements:

- CM. 1 Test track communication: Under no circumstances shall the exhibitor transmit in frequency ranges shown in Table 6.1 and with power and duty cycles higher than shown in Table 6.1.
- CM. 2 While a demonstration is being performed, the rest of the exhibitors should be disconnected from the EHW network, and any transmission equipment should be turned off so it cannot interfere.
- CM. 3 The pod should be always under control, if a disconnection or other connectivity error that impedes continuous data flow and control is detected, the pod should enter in a safe state, stopping its trajectory.
- CM. 4 The pods should not have a connection to the Internet. Connections are restricted to the IP address of the EHW internal networks.
- CM. 5 Exhibitors should be equipped with at least one NAP (Network Access Point) for the correct development of all the testing.
- CM. 6 All IP addressing will be static thus DHCP or DNS Servers are not needed.

## 10.5 Transport, Storage and Lifting Requirements

- TSL. 1 Each demonstrator needs a method to move around either by hand or on a transport cart.
- TSL. 2 Any transport cart must be tested prior to EHW with its maximum payload. The conducted test shall either be covered in the SPD.
- TSL. 3 Each demonstrator shall provide the possibility of being lifted either by hand or with a forklift/small crane.
- TSL. 4 The exhibitor must prove that the lifting points of the demonstrator are dimensioned to its mass. This proof shall be included in the FDD.
- TSL. 5 If a demonstrator is hand-lifted, the allowable weight for each person is limited to 23 kg.

- TSL. 6 A demonstrator must have as many lifting points as required to ensure the previous requirement to be allowed to be hand-lifted.
- TSL. 7 If a demonstrator needs a forklift, please contact the EHW organization.
- TSL. 8 Unstable demonstrators must have a straight base for the demonstrator handling.
- TSL. 9 There is limited storage space during the EHW, so please specify the amount of storage the participant needs.
- TSL. 10 If the needed storage space is exceptionally large (not limited to only a pod and scalability stand), the space is to be discussed by the EHW. If not enough space is available, the Participant may be responsible for their storage.
- TSL. 11 Each Participant must provide a wooden box(es) in which they store their materials. The dimensions must be specified in the FDD.
- TSL. 12 Transport boxes over 150 kg should be able to be lifted by a forklift.
- TSL. 13 For external events, the EHW organization should provide cargo trucks in which each demonstrator must go inside its pertinent box. If the Participant brings an exceptionally large amount of equipment, please discuss it with the EHW organization.
- TSL. 14 The exhibitor shall contact the EHW Committee if they intend to ship their demonstrator themselves.
- TSL. 15 The EHW organization will oversee the storage of the demonstrators. More details will be included in further editions of the Rules and Regulations.

## 11 Administrative Information

- Al. 1 Each applicant shall determine one representative, who will be in correspondence with the EHW Committee. The representative will be responsible for submitting the documentation and will receive feedback and updates from the EHW Committee. If any questions arise, the correspondence between the applicant and the EHW Committee shall be conducted via the representative only.
- Al. 2 All required documentation should be uploaded as a single PDF document to the respective form which will be provided via email.
- Al. 3 All video submissions related to the SPD need to be submitted through an online streaming service as specified in Section 6.2.4.
- Al. 4 In case of any uncertainties or suggestions concerning the present version of the EHW 2024 Rules & Regulations please contact the following email address:

[technical@hyperloopweek.com](mailto:technical@hyperloopweek.com)  
subject: Rules & Regulations Query

Important: The EHW will only react to queries sent to the EHW email address, thus do not message EHW members individually. Typically the response time for queries is one week.

### 11.1 Document Version and Further Updates

- Al. 5 The EHW Committee explicitly reserves the right to alter, add or delete any regulations within this document at any time and release a new version.
- Al. 6 Any exhibitor who wants to compete in the EHW 2024 must implement any changes from this document and must comply with the latest version at the EHW 2024.
- Al. 7 Any updates from the EHW Committee's side will be sent to the representative via email.
- Al. 8 The copyright for the present document lies with the EHW 2024 Committee. It is prohibited to copy, reproduce, or distribute extracts from this document in any form.

## References

EHW (2023a). Complete System Cover Page ITD. url: <http://tinyurl.com/yckezjat> (visited on 02/15/2024).

— (2023b). Cover Page ITSr. url: <http://tinyurl.com/3ac7mn65> (visited on 11/09/2023).

— (2023c). ITD and ITSr Submission Form. url: <https://forms.gle/We1UM5P1wz3Ls8Li6> (visited on 11/09/2023).

— (2023d). Promising Subsystem Cover Page ITD. url: <http://tinyurl.com/fs5jn297> (visited on 02/15/2024).

— (2023e). Research Reports 2023. url: [https://hyperloopweek.com/research\\_reports\\_2023/](https://hyperloopweek.com/research_reports_2023/) (visited on 11/09/2023).

Federal Department of the Environment Transport, Energy, and Communication DETEC, Name1 (2023). "Swiss National Frequency Allocation Plan and Specific Assignments". In: OFCOM Switzerland. url: <https://www.fedlex.admin.ch/filestore/fedlex.data.admin.ch/eli/fgae/2022/4/de/pdf-a/fedlex-data-admin-ch-eli-fgae-2022-4-de-pdf-a.pdf>.