European Hyperloop Week 2022
RULES AND REGULATIONS

Version 2.1
November 16 2021

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November 15 2021, the EHW Committee

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:

DELFT HYPERLOOP	**Delft Hyperloop -** Technische Universiteit Delft, Netherlands
HYPED HYPERLOOP EDINBURGH	**HYPED** - The University of Edinburgh, Scotland
	Hyperloop UPV - Universitat Politècnica de València, Spain
swissloop	**Swissloop** - Eidgenössische Technische Hochschule Zürich, Switzerland

2. General Information

2.1. Purpose of the Document

This document outlines the technical aspect of the European Hyperloop Week 2022, also referred to as *EHW 2022* or *Event*.

2.2. Terminology

- For the sake of simplicity, any systems, demonstrators, or models capable of being exhibited, presented, or operated at the Event are referred to as *Systems*. Where necessary, the term *Subsystem* can also be used if, for example, a subordinate reference shall be made clear. In Chapter 9, the term *Demonstrator* is used equivalently.
- Every team, company, start-up, foundation etc. that wishes to apply for the Event is referred to as an *Applicant*.
- Every applicant that is admitted to the Event is referred to as an *Exhibitor*.

2.3. Eligibility

No restrictions are set with regard to who may apply to participate in the Event. Furthermore, no exceptions are made for any applicant, therefore each applicant must follow the application process and fulfil the technical requirements in order to be allowed to participate.

Additionally, there are no restrictions concerning which systems, demonstrators or models are allowed to be registered, as long as they stand in context with the Hyperloop concept. Some examples thereof might include:

- Demonstrators of subsystems, either conceptual or operational.
- Fully integrated systems, in real size or to scale, either conceptual or operational.
- Infrastructural concepts or demonstrators.
- Design concepts, either virtual or physical.
- Simulations, visualisations etc.

However, the EHW Committee reserves the right to decide who is admitted to the event and which systems are allowed to be brought along with the exhibitors to the Event.

2.4. Liability & Safety

LS.1 Every exhibitor must sign the **European Hyperloop Week 2022 Terms and Conditions of Participation** (hereinafter "EHW Terms & Conditions") which regulates the administrative modalities and the framework of the EHW 2022. The applicants will receive the Terms & Conditions separately via the established communication channels.

LS.2 Every exhibitor is required to take 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 a valid liability insurance that covers both personal injury and property damage at any Event venues.

LS.5 Safety is of utmost priority at any time and every exhibitor must endeavour to guarantee that.

LS.6 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.

2.5. COVID-19 Situation

This version of the EHW 2022 Rules & Regulations was created with a view to organizing the event with presence in the Netherlands. As it is not possible at the time of publication of the Rules and Requirements to assess the situation in July 2022, any new measures related to COVID-19 will be released in a future amendment. The EHW Committee is certainly aware of the situation and is monitoring it closely in order to be able to react accordingly.

2.6. Intellectual Property of Submitted Documentations

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. 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. Thus, the documentation submitted remains the intellectual property of the respective applicant. This intellectual property regime is also set out in the **EHW Terms & Conditions**.

2.7. Privacy

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. Schedule of EHW 2022

Based on current planning, the European Hyperloop Week is scheduled for 18th-24th July 2022. The event will last for one week and will be completely dedicated to Hyperloop, Hyperloop related technologies and Hyperloop research.

The main constituents of the event will be:

- **Presentations:**

  Exhibitors will present their Hyperloop related research, prototypes and/or technology. To do so, an exhibitor must apply for one of the application categories described in Chapter **4** and follow the appropriate application process as per either Chapter **5**, **6** or **7.**

- **Conferences:**

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

- **Design Competition:**

  There will be a Design Competition among the exhibitors who present a system during the event. However, this will be independent from the General Showcasing and Demonstrating and not all exhibitors will be able to take part in the Design Competition. There will be a limit to the number of participants in each of the awards of the Design Competition. Systems that stand out through innovation, feasibility, technical evaluation and public appeal have the chance to win one of seven EHW awards. Details on the Design Competition can be found in Chapter **8**.

It is important to point out the distinction between **Presentations** and **Design Competition** since it is a relevant update with respect to past editions of the EHW. The EHW 2022 will incorporate an option to showcase outside the Design Competition to encourage the knowledge transfer between all participants, without the need to qualify for one of the limited positions in the Design Competition.

The above-mentioned constituents will take place simultaneously throughout the week. The week itself will be arranged thematically such that presentations and conference elements dealing with similar systems or similar technologies will be held on the same day.

The weekdays will provide the opportunity to present subsystems and smaller systems which do not need large infrastructure to be operated. The spotlight during these days should be on the showcase and networking among participants, with individual presentations to the Technical Jury happening in the background for those exhibitors taking part in the Design Competition.

Towards the end of the week, extended infrastructure will be available for use such that entire systems can be demonstrated. The infrastructure provided by the EHW Committee and its technical characteristics can be found in Chapter **9**.

The conclusion of the EHW 2022 will be a public exhibition and will be the time when the EHW Design Competition awards will be presented.

More details on the event schedule will be included in future versions of the *EHW 2022 Rules & Regulations*. 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.

4. Application Categories

Technical and safety regulations for the EHW 2022 are specified according to each of three application categories. These are:

- **Showcase.**
- **Demonstration.**
- **Research Submission.**

They present three different levels of mandatory safety precautions which must be followed. In terms of Showcase and Demonstration of a system, it is possible to apply for an award in both categories. Although the demonstration of a system has the potential to gain slightly more points, it is possible to gain an award by only showcasing a system. Further details on the awarding system can be found in Chapter **8**.

Furthermore, it is not mandatory to register for an award if an exhibitor is solely interested in showcasing or demonstrating a system or submitting research outside the Design Competition. On the contrary, it is not possible to register a certain system for an award if this very system is neither showcased nor demonstrated.

In addition, a system which involves any kind of energy or energy storage such as but not limited to:

- **chemical,**
- **electromagnetic,**
- **kinetic,**
- **potential,**
- **thermal**

may only be brought on site of the EHW 2022 if an application of the respective system for Demonstration was submitted to and accepted by the EHW Committee. In any other cases, a system must not contain the named energy carriers, else the applicant would need to seek special approval from the EHW Committee.

4.1. Showcase

The basic application category for the EHW 2022 is Showcase. It solely involves the presentation of a physical or virtual model of a system without operating it in any way. This reduces the necessary safety requirements to a minimum and, consequently, simplifies the application process. The minimum required content of a Showcase application must be met. The application process for Showcase is described in Chapter **5**.

4.2. Demonstration

The application category Demonstration allows the physical operation of a certain system at the EHW 2022. Consequently, the necessary degree of safety precaution involved in the application process is higher than for Showcase. The minimum required content of a Demonstration application must be met. The applicant must prove that the system they want to apply for Demonstration is safe to operate. One of the core requirements to be allowed to demonstrate a system at the EHW 2022 is the previous testing of the respective system in the exact same configuration as the proposed demonstration. All systems of Demonstration applications must be thoroughly tested and evidenced.

Demonstrations shall fall in one of the three following categories:

- **Pod-run demonstrations:**
  - Can be performed on the EHW 2022 Test Track, or on an alternative sub-track, provided by the participant, suitable for the prototype pod.
  - In the nominal case, this category of demonstration consists of a prototype pod that is launched down the track to accelerate and brake autonomously.

- **Proof-of-Concept demonstrations**:
  Complete pod but demonstrating the functionality of individual subsystems:
  - Can be performed on the EHW 2022 Test Track, or on an alternative sub-track, provided by the participant, suitable for the prototype pod.
  - In the nominal case, this category demonstrates specific functionalities of individual subsystems that are integrated within a prototype pod.
  - Subsystem functionalities could include:
    - the navigation algorithm,
    - stationary levitation,
    - the control system, and
    - the braking system.

- **Subsystem demonstrations**:
  - This category demonstrates functionalities of individual subsystems. It is not mandatory for the subsystem to be part of a prototype pod.
  - This could be, but not limited to, in the form of subsystem demonstration rigs, or alike.

If any of the infrastructure provided by the EHW shall be used, the requirements associated with each infrastructure must be met. Details concerning the available infrastructure are to be found in Chapter **9**.

An exhibitor may use their own equipment/infrastructure for a demonstration (e.g., a custom test bench). However, any equipment/infrastructure from an exhibitor must be considered and described in the documentation, shall follow the same safety standards as the systems themselves, and will require a certification by the EHW Committee. Details on the application process for Demonstration are provided in Chapter **6**.

4.3. Research Submission

Research Submission is a new application category for EHW 2022 relating to the Full-Scale Awards and no other aspect of the Design Competition. The submission should consist of a single PDF document detailing the research the applicant has conducted. 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 Showcase or Demonstration, depending on the activity the applicant aims to conduct at EHW 2022. The application process for Research Submission is described in Chapter **7**.

Note that 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. 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.

4.4. Basics of the Application Process

Concerning the application process the subsequent points must be followed:

AP.1 General

AP.1.1 Virtual participation in the Design Competition is not permitted.

AP.1.2 Every system requires its own explicit application. This means that one applicant might register some systems for Demonstration and some for Showcase.

AP.1.3 It is not necessary to register one system for both Showcase and Demonstration. An application for Demonstration implicitly includes an application for Showcase of the respective system as well.

AP.1.4 Depending on the category for which the system is to be registered, the respective application guidelines must be followed. It is not necessary to follow the application guidelines for Demonstration if that system shall only be showcased.

AP.1.5 The general concept for each system which an applicant wants to register shall be fixed in the first documentation: either ITS (Intent to Showcase) or ITD (Intent to Demonstrate). This means, adaptations of the respective system between ITS/ITD and the second documentation FSD/FDD are allowed to such extent that the basic concept is not changed. Applications that are concluded to be inconsistent with the previous documentation by the EHW Committee will be rejected.

AP.1.6 A priority order must be added to applications from each applicant. First and foremost, applications will be reviewed and accepted based on the required minimum content and quality. In the case of many applications that successfully meet and exceed these criteria, the priority order will be used to limit the number of applications to the Design Competition. Feedback will be provided after the ITS/ITD (first documentation stage) for all applications, whether accepted or rejected. The Full-Scale Awards should not be part of this priority order, as Research Submission applications will be considered separately.

AP.2 Documentation

AP.2.1 Each application must have a completed *EHW Design Competition Application Cover Page* submitted with the first documentation (ITS/ITD/ITSR), which clearly identifies which application category and, for which awards/award category each system or work of research is to be registered. Applications lacking this information will be automatically rejected without exceptions. Use the cover page appended to this document.

AP.2.2 If the applicant wants to apply to the EHW 2022 Design Competition with multiple systems and/or works of research, they must submit individual applications for each system and work of research. Each application must be independent of each other, and it must include all relevant information in its documentation. Referencing other joint submissions is permitted to avoid repetition. The mandatory content, as specified for the various documentations (see Chapters **5**, **6** and **7**), must be included in each application.

AP.2.3 If the applicant wants to apply to the EHW 2022 Design Competition with a single system for multiple awards, the applicant must submit separate applications, each focused on the respective functionality. If the distinction between applications cannot be made, the EHW Committee reserves the right to reject the application(s).

AP.2.4 If the demonstration of a certain system requires the active operation of other systems, such systems must be addressed in every documentation. All documentation must be approved by the EHW Committee and be in accordance with the Rules & Requirements for Demonstration (Section **6.2**).

AP.2.5 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. However, if it improves the understanding of the entire system, it is strongly recommended to do so anyway, but must be included in a concise, focused manner.

AP.2.6 On the basis of the various submitted documents, the EHW Committee will generally not give any feedback on further improvements that would allow admission. Additionally, a request for feedback will be ignored.

AP.2.7 However, if there is feedback from the EHW Committee, the applicant is obliged to implement/follow that feedback to ensure a successful application.

AP.2.8 The documentation timeline as presented in Section **4.5** must be followed. Failure to do so may result in the exclusion from the EHW 2022.

AP.2.9 All documentation shall be established as a *Formulated Engineering Documentation*, meaning that they are developed, written documents and consequently are not in presentation or slides format. The EHW Committee may reject applications that are inadequately written.

AP.2.10 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.3 Registration for Awards

AP.3.1 The relevant award for each application must be defined in the first documentation. However, registering for an award is not mandatory, and if the award is not stated this application will be processed as a showcase, demonstration or research submission outside the Design Competition.

AP.3.2 Every system or work of research that is to compete for an award must first be registered and accepted for either showcase, research submission, or demonstration.

4.5. Application Timeline

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

4.5.1. Application Timeline for Showcase

The application process for Showcase consists of three stages. However, the applicant will receive the final acceptance or rejection for their application after the first stage. The second stage is primarily used for operational reasons for the Event and to register the respective system for an award. The last stage is simply the submission of the required Transport, Lifting and Safety Procedures.

Due Date	**Action**	**Who**
10 December 2021 23:59 CET	Submission of ***Intent to Showcase***	Applicant
Early 2022	Applicant receives the acceptance or rejection for the applied Showcase	EHW Committee
11 March 2022 23:59 CET	Submission of ***Final Showcase Documentation***	Applicant
10 June 2022 23:59 CET	Submission of ***Safety Instruction***	Applicant
Late June 2022	Submission of ***Posters***	Applicant
Before EHW 2022	Further information concerning the event week provided to the exhibitor	EHW Committee
18-24 July 2022	European Hyperloop Week	

Table 4.1: Application timeline for Showcase

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4.5.2. Application Timeline for Demonstration

The application process for Demonstration is a three-stage process as well. Since an application for Demonstration is simultaneously also an application for Showcase, the applicant will get a final acceptance or rejection for Showcase already after the first stage.

In order to qualify for Demonstration, the applicant must pass all three stages successfully. However, the successful pass of all three stages is not a final guarantee that a demonstration will be permitted, since the EHW Committee has the right to prohibit a demonstration at any point of time.

If a demonstration were to be denied by the EHW Committee at any point after the successful completion of the first stage, the applicant may still showcase their system as successfully passing the first stage implies acceptance for Showcase. Should this occur, the applicant may be required to submit a *Final Showcase Documentation* (second stage of Showcase qualification) even if the corresponding deadline has already passed.

Due Date	**Action**	**Who**
10 December 2021 23:59 CET	Submission of ***Intent to Demonstrate***	Applicant
Early 2022	Applicant receives: ● Acceptance or rejection for Showcase ● Notification if successfully qualified for the next step in the Application for Demonstration	EHW Committee
11 March 2022 23:59 CET	Submission of ***Final Demonstration Documentation***	Applicant
Spring 2022	Applicant receives notification if successfully qualified for the next step in the Application for Demonstration	EHW Committee
10 June 2022 23:59 CET	Submission of ***Testing and Safety Documentation***	Applicant
Late June 2022	Submission of ***Posters***	Applicant
Before EHW 2022	● Applicant receives notification if successfully qualified for Demonstration ● Further information concerning the event week will be provided to the exhibitor	EHW Committee
18-24 July 2022	European Hyperloop Week	

Table 4.2: Application timeline for Demonstration

4.5.3. Application Timeline for Research Submission

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

Due Date	**Action**	**Who**
10 December 2021 23:59 CET	Submission of ***Intent to Submit Research***	Applicant
Early 2022	Applicant receives the acceptance or rejection for the applied Research Submission	EHW Committee
11 June 2022 23:59 CET	Submission of ***Final Research Submission***	Applicant
Late June 2022	Submission of ***Posters***	Applicant
Before EHW 2022	Further information concerning the event week provided to the exhibitor	EHW Committee
18-24 July 2022	European Hyperloop Week	

Table 4.3: Application timeline for Research Submission

5. Showcase Application

As stated in Chapter **4.1** the application of a system for Showcase shall be considered if the applicant intends to solely present the system at the EHW 2022 without operating it.

5.1. Rules & Requirements for Showcase

In order to receive the permission for a showcase at the EHW 2022, the applicant must follow the following rules:

SC.1 The system is powerless.

SC.2 No kind of potential, kinetic, chemical or electromagnetic energy stored in, on, within or around the system (thus especially no batteries within the system). This includes that no kind of the mentioned energy storages are allowed on the site of the EHW 2022.

SC.3 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.

SC.4 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.

SC.5 The requirements for Transport, Storage and Lifting as specified in Section **9.3** must be followed.

5.2. Application Process for Showcase

In order to get the approval for a Showcase at the EHW 2022, the applicants shall document the respective systems by submitting the three required documents in PDF form by the indicated deadlines. Failure to do so will result in an unsuccessful application. For details on the submission itself refer to Chapter **10.2**.

5.2.1. Intent to Showcase (ITS)

This document is used as a first application for the EHW 2022. It shall contain the types of showcases that the exhibitor intends to do and further provide a brief overview of the status and upcoming steps of the respective system. The applicant is reminded to complete **AP.2.1** at this documentation stage.

ITS.1. **Due:** 10 December 2021, 23:59 CET.

ITS.2. **Document format:** Formulated engineering documentation (see **AP.2.9**). Preferably using bullet points, tables, and descriptive images.

ITS.3. **Document scope:** Generally, no limitation; maximum of 10 pages per system, excluding citations, index or a cover page.

ITS.4. **Minimum content:**

ITS.4.1. General:

ITS.4.1.1. Description of the applicant and updated list of team members.

ITS.4.1.2. Details on the development environment and the research objectives.

ITS.4.1.3. Determination of one representative who will be in correspondence with the EHW Committee.

ITS.4.1.4. The Design Competition Award for which this application is registered.

ITS.4.2. System:

ITS.4.2.1. Technical description of the system to be showcased:

ITS.4.2.1.1. Desired functionality, and principal physics of its functionality.

ITS.4.2.1.2. Constraints (mass, dimensions and budget).

ITS.4.2.1.3. Initial concepts and Free Body Diagram.

ITS.4.2.2. Size, components, appearance of the system (CADs, if available at this stage).

ITS.4.2.3. Integration of the system into a subordinate structure/system (if applicable).

ITS.4.2.4. Key elements and features of the system.

ITS.4.2.5. Description of how the system will be showcased (physical prototype, virtual models, etc.).

ITS.4.3. Safety:

ITS.4.3.1. Precautions taken in order to comply with the Rules & Requirements for Showcase.

ITS.4.4. Other:

ITS.4.4.1. Clear outline of content that will be presented in the FSD.

5.2.2. Final Showcase Documentation (FSD)

With this document, the applicants shall give further exact details of the system they want to showcase at the EHW 2022. Content-wise, it is similar to the Intent to Showcase and shall provide additional insight into the development of the respective systems. Although the final acceptance or rejection of the application for showcase already happens after the ITS, the FSD is of the same importance and failure to submit the FSD will result in an unsuccessful application.

The EHW Committee reserves the right to reject an application if the FSD does not meet expectations or if it differs greatly from the ITS.

Most importantly, the applicant shall state in the FSD which award the system shall be registered for, in the case that the application is withdrawn, but the Award for which this application was registered for in the ITS cannot be changed.

FSD.1. **Due:** 11 March 2022, 23:59 CET.

FSD.2. **Document format:** Formulated engineering documentation (see **AP.2.9**).

FSD.3. **Addendums:** Applicants have until 15 April 2022, 23:59 CET, to send in an addendum to their FSD. Only minor, inevitable changes related to force majeure limitations will be accepted. Said limitations must be explicitly stated in the addendum.

FSD.4. **Minimum content:**

FSD.4.1. General:

FSD.4.1.1. Description of the applicant and updated list of team members, advisors and industry partners.

FSD.4.1.2. Details on the development environment and the research objectives.

FSD.4.1.3. Definition of budget, funding and method of manufacturing (in-house, outsourced, or combination).

FSD.4.1.4. The Design Competition Award for which this application is registered for, in the case that the application is withdrawn, but the Award for which this application was registered for in the ITS cannot be changed.

FSD.4.2. System:

FSD.4.2.1. Technical description of the system to be showcased:

FSD.4.2.1.1. Detailed explanation of theory and principal physics of desired functionality.

FSD.4.2.1.2. Description of design process taken.

FSD.4.2.1.3. Free Body Diagrams to define load cases for simulations (if applicable).

FSD.4.2.1.4. Evidence of simulations validating the theory, and detailed analysis of results (if applicable).

FSD.4.2.2. Size, components, appearance of the system:

FSD.4.2.2.1. 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.

FSD.4.2.3. Integration of the system into a subordinate structure/system (if applicable).

FSD.4.2.4. Detailed plan of the showcase, specifying the needed equipment and infrastructure (both expected to be provided by the EHW and brought by the team):

FSD.4.2.4.1. Parts list (including dimensions and mass), in tabular format. Please identify which parts are made in-house or outsourced from an external supplier.

FSD.4.2.4.2. Images, or CAD renders, of the showcase setup including all parts of the system that will be brought to the EHW 2022.

FSD.4.3. Safety:

FSD.4.3.1. Technical description of the system to ensure compliance with the Rules & Requirements for Showcase (see Section **5.1**).

FSD.4.3.2. Preliminary risk assessment for Showcase, including transport and lifting procedures.

FSD.4.3.3. Requirements for transport, storage and lifting as defined in Section **9.3**, especially TS.4.

5.2.3. Safety Instruction (SI)

In order to comply with the requirements for transport, storage and lifting as specified in Section **9.3** the applicant must establish procedures for those actions. These procedures shall be submitted in the last stage of the application process for Showcase. Furthermore, if the system utilises a transport cart to be transported, this must be tested according to **TS.2** in Section **9.3.** Evidence of this test shall be included in the Safety Instruction as well.

SI.1. **Due:** 10 June 2022, 23:59 CET.

SI.2. **Minimum content:**

SI.2.1. Required Procedures:

SI.2.1.1. Revised and further detailed risk assessment for Showcase.

SI.2.1.2. Transport procedure.

SI.2.1.3. Lifting procedure.

SI.2.2. Safety Requirements:

SI.2.2.1. Test evidence of the transport cart for the system according to **TS.2** (if applicable).

SI.2.2.2. Requirements for transport, storage and lifting as defined in Section **9.3.**

SI.2.3. Detailed plan of the showcase:

SI.2.3.1. List, in tabular format, of which parts are needed in each venue on each day of EHW 2022. Reference the list of parts submitted in the FSD, since no changes are allowed. The week schedule will be released prior to this submission.

5.2.4. Posters

All successful applicants must bring to EHW a poster with a minimum content and format requirement. One poster shall be made per showcase submission. More information and the poster template will be provided by the EHW Committee closer to the event dates in further versions of the EHW 2022 Rules & Regulations. All exhibitors must follow the minimum content requirements outlined below, or bring their own medium for showcasing which must be previously approved by the EHW Committee prior to the event

SP.1. **Due:** Late June 2022.

SP.2. **Minimum content:** The poster should summarise and reflect information included in the FSD.

SP.3. **Required format:**

SP.3.1. Minimum size A2.

SP.3.2. PDF, SVG, AI or EPS format.

SP.3.3. 300 dpi (dots per inch) or fully vectorized.

SP.3.4. CMYK colour mode.

SP.3.5. Bleed and registration marks for correct guillotining must be included in the final delivery.

6. Demonstration Application

As stated in Chapter **4.2** the application for Demonstration shall be considered if the applicant intends to operate a system at the EHW 2022.

Every applicant who wishes to register a system for demonstration at the Event shall read the following subchapters carefully and check if they can meet the requirements, with special emphasis to all the safety precautions. If the applicant fails to fulfil even one point for a certain system, then the particular system will not be permitted for a demonstration. If a demonstration application is rejected but the requirements for showcasing are fulfilled, the applicant may still showcase their system.

6.1. Safety Considerations

It must be understood that the operation of any system requires a significant amount of understanding of the respective system. Safety must be guaranteed at all times and the EHW Committee will only allow a demonstration if it is convinced of the system's safety. Thus, the applicant is expected to put in significantly more effort into the application process, the documentation and the testing of a system compared to showcasing.

Most importantly, no demonstration will be permitted if the systems involved in the demonstration have not been tested prior to the EHW 2022 by the applicants themselves. Furthermore, the conducted test results and methodology must be provided to the EHW Committee prior to the event. This means that there will NOT be the possibility to test the systems on site but just to demonstrate what has already been tested. Additionally, there will NOT be the opportunity to prove a system's functionality on site and be allowed for a demonstration at the last minute. Thus, if a certain system has not been approved for a potential demonstration prior to the Event, it cannot qualify to do so during the Event.

6.2. Rules & Requirements for Demonstration

In order to receive the permission for a demonstration at the Event, the applicant must follow the following rules:

DM.1 **General:**

DM.1.1 The applicant must specify the subsystem(s) intended for demonstration and the manner in which they are to be operated. If an entire system is to be demonstrated, specifications for the operation of the entire system must be provided.

DM.1.2 In order to be approved for the desired demonstrations within this category, detailed technical documentation and proof of testing/functionality of the respective systems must be provided prior to the Event, according to the timeline prescribed in the previous Sections. Any testing between this deadline and the Event will be ignored. The technical documentations are the sole measure for admitting an exhibitor to demonstrate, and the EHW Committee will not retrospectively provide feedback on further improvements that would allow admission.

DM.1.3 In general, it is to be understood that it is NOT the EHW Committee that checks the safety of a system, but instead, it is the exhibitor who needs to prove to the EHW Committee of the system's safety in order to be allowed for a demonstration. Hence, no exact guidelines on what the documentation must contain are provided. The EHW Committee will consequently decide upon what the exhibitor is allowed to demonstrate and when to do so.

DM.1.4 Every application for Demonstration is simultaneously also an application for Showcase. In case an application for demonstration of a system is denied, showcasing will still be permitted provided that the conditions for the Showcase category are fulfilled.

DM.2 **Technical Documentations:**

DM.2.1 If the demonstration of a certain system/subsystem requires the active operation of other subsystems, they must be accounted for as well in every documentation and be described in the same depth. If one subsystem among multiple necessary to conduct a demonstration is considered as unsafe, the demonstration will be prohibited.

DM.2.2 The handling of high power systems, especially for electromagnetic braking and propulsion systems, should be worked out in detail and tested properly.

DM.2.3 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 and thoroughly.

DM.2.4 Permanent magnets require careful operation. Teams using them shall implement a detailed description of a system for demounting and/or covering the magnets.

DM.3 Proof of functionality (Testing)

DM.3.1 Demonstrations are explicitly not to be used as tests. Every intended demonstration must be tested by the exhibitor prior to the event in order to be allowed to conduct it. 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.3.2 If the participant wants to perform a longer pod run demonstration in the EHW 2022 event due to having a shorter test track at home, (meaning a change in the *exact same configuration of the system* tested at its home facilities), proof of the safety of the system at the expected conditions will have to be provided along the submitted documents.

The expected maximum speed in the longer track will have to be provided, and all other systems will have to be tested to ensure they are fully functioning at this higher speed. Numerical calculations and simulations will not be accepted as a means of “testing”, and static tests at nominal power will have to be carried out to check all parts are safe for as long as the pod run will last. Information such as simulations, dynamic prediction of the velocity profile, power consumption, tests of the systems at the predicted maximum speed, thermal management of the onboard systems and other key aspects will have to be provided in a detailed manner in order to prove the safety of the prototype.

DM.3.3 The testing results, together with the testing methodology must be described in the Testing and Safety Documentation (see Section **6.3.3**). Any deliberate manipulation or wrong presentation of testing results, testing methods or equivalent will lead to the immediate ban from the Event.

DM.3.4 All critical subsystems, as well as system setpoints utilised during the proof of functionality, must be documented (e.g., pressure, current, voltage etc.).

DM.3.5 Industrial components do not need to be tested individually if they are operated within their authorised range and if they are not manipulated to alter its functionality in any way.

DM.3.6 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.3.7 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 6061-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.

DM.3.8 Low voltage systems are considered to be under 50 V. 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.3.8.1. Safety glasses with side shields.

DM.3.8.2. Suitable footwear (safety/steel-toed boots, rated dielectric footwear).

DM.3.8.3. Insulating gloves (rated, used along with leather/cloth linings for shock protection).

DM.3.8.4. Insulated tools.

DM.3.9 At all times when participants are working with either their pod or track, proper safety equipment must be worn. (e.g., High visibility jacket, steel-toed boots, safety glasses and safety helmet). Participants are responsible to bring their own equipment.

DM.4 **Design and Demonstration specifications:**

DM.4.1 System outline:

DM.4.1.1. Prototypes considered in the Complete Pod category (see Chapter **8.3**) should range between 1 and 5 meters length. Similarly, all the demonstrators intended to be operated during the Event must have a maximum characteristic length of 5 meters.

DM.4.1.2. A detailed concept sketch of the demonstration set up and operation of the system during the demonstration must be proposed in the Intent to Demonstrate, developed in the Final Demonstration Documentation and detailed in the Testing and Safety Documentation.

DM.4.2 Mechanical:

DM.4.2.1. The structural design guidelines must be given and developed in a brief manner in the Intent to Demonstrate, detailed in the Final Demonstration Documentation and proved in the Testing and Safety Documentation.

DM.4.2.2. The safety factor of all the structural elements in the worst-case scenario must be **higher than 2.**

DM.4.2.3. If applicable, any pneumatic or pressurised 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.4.2.4. If applicable, the operating conditions of the pressurized systems must meet the certified ratings with a **safety factor higher than 2.**

DM.4.2.5. Rotational systems must be balanced to avoid inertial asymmetry. This process must be explicitly stated and justified.

DM.4.2.6. 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.

DM.4.3 Braking system (if applicable):

DM.4.3.1. The braking system must be redundant.

DM.4.3.2. The safety margin to the end of the track must be at least the worst-case scenario braking distance.

DM.4.3.3. All braking power calculations and specifications must ensure a safe stop within the worst-case braking distance in case of any failure of the system or any integrated subsystem.

DM.4.3.4. If the braking system is electromagnetic, the handling of generated/recuperated electrical energy must be precisely tested and documented.

DM.4.3.5. The handling of generated/recuperated energy must be precisely tested and documented.

DM.4.3.6. 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 to any of the awards.

DM.4.4 Electrical (batteries):

DM.4.4.1. If applicable, battery specifications must be given.

DM.4.4.2. The battery management system fault must be tolerant to avoid overcharging.

DM.4.4.3. The battery management system must isolate the battery in over-temperature conditions.

DM.4.4.4. The positive and negative terminals of the batteries must be prevented from being connected (shorted).

DM.4.4.5. If the battery pack voltage is above 50V, a Manual Isolation Disconnect must be installed, isolating at least one pole of the pack without opening a contactor or relay.

DM.4.4.6. If the battery pack voltage is above 50V, the following parameters must be reported to the operator:

DM.4.4.6.1. State of charge.

DM.4.4.6.2. Pack voltage and current.

DM.4.4.6.3. Cell temperature of at least 25% of all cells inside the pack.

DM.4.4.6.4. Minimum, and maximum cell voltages.

DM.4.4.7. All conductors on electronics above 50V must be concealed.

DM.4.5 Electrical (drivetrain Battery Packs):

DM.4.5.1. A Manual Isolation Disconnect (MID) must be installed, featuring

- isolation of at least one pole of the battery pack when removed,
- placement in the high current line,
- independence of low voltage electronics,
- removability 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.4.5.2. For each pack, at least two independent, normally open relays must be installed, featuring

- opening of both high and low pole 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.4.5.3. For each pack, at least one fuse with a lower rating than the maximum switch-off current of the relay must be installed.

DM.4.5.4. For each pack, a battery management system must be installed, featuring

- balancing of all cells (active or passive),
- reporting of state of charge, pack voltage and current, cell temperature for at least 25% of all cells inside the pack,
- voltage of every cell connected in series.

DM.4.5.5. In case of at least two (2) drivetrain packs, a Manual Relay Disconnect must be installed, 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.

DM.4.5.6. If a high capacitance load is connected to the battery pack, a proper pre-charge circuit must be in place inside the pack.

DM.4.5.7. All the cables must be rated for the maximum system voltage.

DM.4.5.8. The cables:

DM.4.5.8.1. Must be visually distinguishable for low and high sides.

DM.4.5.8.2. Must be physically segregated from low-voltage cables (excluding interlock circuit connections).

DM.4.5.8.3. Must be coloured orange when carrying voltages above 120V.

DM.4.5.9. The pack 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.4.5.10. Each pack must feature a separate Insulation Monitoring Device, monitoring high-to-chassis and low-to-chassis insulation.

DM.4.5.11. Visual indications (e.g., LEDs) must be placed, signalling

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

Said visual indications shall be visible without removing any mechanical components. Visual indications signalling 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.

DM.4.6 Navigation control:

DM.4.6.1. If applicable, the speed of the Demonstrator must be monitored during the demonstration.

DM.4.6.2. The emergency braking must be accessible by the person monitoring the speed.

DM.4.6.3. 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.4.6.4. Demonstrator health should be quickly assessed by an external viewer (see **DM.4.5.11**).

DM.4.7 Software:

DM.4.7.1. A state machine diagram must be provided, listing all software states and their interconnecting transitions.

DM.4.7.2. In no state, it should be possible for the brakes and propulsion to be powered at the same time.

DM.4.8 Communications

DM.4.8.1. The Applicant must include mechanisms that bring the Demonstrator to a safe state in case of loss of communication.

DM.4.8.2. The Applicant must use frequency ranges shown in Table 6.1.

Number	Frequencies	Power	Bandwidth	Duty cycle	Remarks
B	6765 - 6795 kHz	42 dBµA/m at 10 m			
C	13,553 - 13,567 MHz	42 dBµA/m at 10 m			
D	26,957 - 27,283 MHz	10 mW e.r.p.,which is 42 dBµA/m at 10 m			
D1	26,990 - 27,000 MHz	100 mW e.r.p.	≤ 10 kHz	< 0.1%	
	27,040 - 27,050 MHz				
	27,090 - 27,100 MHz				
	27.140 - 27,150 MHz				
E	40,660 - 40,700 MHz	10 mW e.r.p.			Cannot be used for video
F1	169,4000 - 169,4750 MHz	500 mW e.r.p.	≤ 50 kHz	< 1%	
F2	169,4000 - 169,4875 MHz	10 mW e.r.p.		< 0.1%	
F3	169,4875 - 169,5875 MHz	10 mW e.r.p.		< 0.001%	
F4	169,5875 - 169,8125 MHz	10 mW e.r.p.		< 0.1%	
G	433,050 - 434,790 MHz	10 mW e.r.p.		< 10%	
G1	433,050 - 434,790 MHz	1mW e.r.p.			For bandwidth higher than 250 kHz the maximum power density is -13 dBm/10 kHz
G2	434,040 - 434,790 MHz	10mW e.r.p.	25 kHz		
H1	863,000 - 865,000 MHz	25mW e.r.p.		< 0.1%	
H2	865,000 - 868,600 MHz	25mW e.r.p.		< 1%	
H3	868,700 - 869,200 MHz	25mW e.r.p.		< 0.1%	
H4	869,400 - 869,650 MHz	500 mW e.r.p.		< 10%	
H5	869,400 - 869,650 MHz	25mW e.r.p.		< 0.1%	
H6	869,700 - 870,000 MHz	S mW e.r.p.			
H7	869,700 - 870,000 MHz	25mW e.r.p.		< 1%	
I	2400 - 2483,5 MHz	10 mW e.i.r.p.			
J	5725 - 5875 MHz	25 mW e.i.r.p.			
K	24,00 - 24,25 GHz	100 mW e.i.r.p.			
L	57 - 64 GHz	100 mW e.i.r.p.			Maximum transmitter power output of 10 dBm and a maximum e.i.r.p. spectrum power density of 13 dBm/MHz
M	61,0 - 61,5 GHz	100 mW e.i r.p.			
N	122 - 123 GHz	100 mW e.i r.p.			
O	244 - 246 GHz	100 mW e.i r.p.			

Table 6.1: Available frequencies with power, bandwidth and duty cycle for communication in the Netherlands (source: **https://wetten.overheid.nl/BWBR0036378/2016-12-28***).*

DM.4.8.3. 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.

DM.4.9 Alternative Track

DM.4.9.1. The alternative track should be provided with sufficient grounding.

DM.4.9.2. The track should be fitted with a physical stop at the end of the track, to make sure there is no possibility of the pod leaving the end of the track.

DM.4.9.3. The track is not able to move during a run, due to forces exerted on it. This should be done by properly attaching to the ground by anchoring it.

DM.4.9.4. The design of the track should be able to allow for unevenness in the floor. An estimation of this unevenness is a deviation of 25 cm at a length of 10 m. The foundation will consist of 2x2 meter Stelcon plates, 16 cm thick.

DM.4.9.5. The design of the track should be validated to withstand reasonable temperature differences.

DM.4.9.6. With prior approval of the EHW Committee, it is possible to drill into the ground.

DM.4.9.7. All track material has to be removed before the **24th of July 2022 17:00 CET.**

DM.5 **Conduction of Demonstrations:**

DM.5.1 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.

DM.5.2 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.5.3 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.

DM.6 **Transportation, Storage and Lifting:**

DM.6.1 The requirements for Transportation, Storage and Lifting as defined in Section **9.3** must be met.

DM.7 **Liability:**

DM.7.1 Every exhibitor is obliged to possess a valid liability insurance that covers both personal injury and property damage at all the EHW 2022 venues.

DM.7.2 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. Thus, although the EHW Committee makes the fundamental decision for a go or no go of a demonstration, any damage, incident, or accident caused by or to an exhibitor's system is solely their responsibility.

DM.8 The EHW Committee explicitly reserves the right to impose **further restrictions** on any demonstration in whatever form (power, force, duration, speed, etc.), and is allowed to change or prohibit demonstrations at any point.

6.3. Application Process for Demonstration

In order to get the approval for a Demonstration at the Event, the applicants shall demonstrate their understanding of subsystems with the following documents that are to be submitted in PDF format by the indicated deadlines. Failure to do so might result in the exclusion of the Event. For details on the submission itself refer to Chapter **10.2**.

6.3.1. Intent to Demonstrate (ITD)

This document is used as a first application for the Event. It shall contain the types of demonstrations that the exhibitor intends to do and further 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 **AP.2.1** at this documentation stage.

ITD.1. **Due:** 10 December 2021, 23:59 CET.

ITD.2. **Document format:** Formulated engineering documentation (see **AP.2.9**). Preferably using bullet points, tables, and descriptive images.

ITD.3. **Document scope:** Generally, no limitation; maximum of 10 pages per system, excluding citations, index or a cover page.

ITD.4. **Minimum content:**

ITD.4.1. General:

ITD.4.1.1. Description of the applicant and list of updated team members.

ITD.4.1.2. Details on the development environment and the research objectives.

ITD.4.1.3. Determination of one representative who will be in correspondence with the EHW Committee.

ITD.4.1.4. The Design Competition Award which this application is registered for.

ITD.4.2. System:

ITD.4.2.1. Technical description of system to be demonstrated:

ITD.4.2.1.1. Desired functionality, and principal physics of its functionality.

ITD.4.2.1.2. Constraints (mass, dimensional and budget).

ITD.4.2.1.3. Initial concepts and Free Body Diagrams.

ITD.4.2.2. Size, components, appearance of the system (CADs, if available at this stage).

ITD.4.2.3. Integration of the system into a subordinate structure/system (if applicable).

ITD.4.2.4. Key elements and features of the system.

ITD.4.2.5. Outline of how the system will be operated during demonstration and what infrastructure will be necessary to do so (either own infrastructure or provided by EHW Committee).

ITD.4.2.6. What other systems need to run in order to operate the system?

ITD.4.3. Safety:

ITD.4.3.1. Precautions taken in order to comply with the Rules & Requirements for Demonstration.

ITD.4.3.1.1. What are the key elements of the system? Which features incorporate the highest safety risks?

ITD.4.3.1.2. How will the respective subsystems be tested prior to the Event?

ITD.4.4. Other

ITD.4.4.1.1. Outline of content to be included in the ***Final Demonstration Documentation (FDD)***.

6.3.2. Final Demonstration Documentation (FDD)

With this document, the applicants shall give further exact details of the system they want to demonstrate at the Event. Content-wise, it is similar to the Intent to Demonstrate and shall provide additional insight into the development of the respective systems. It is of special use for the organisational unit of the EHW Committee. 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:** 11 March 2022, 23:59 CET.

FDD.2. **Document format:** Formulated engineering documentation (see **AP.2.9**).

FDD.3. **Addendums:** Applicants have until 15 April 2022, 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.

FDD.4. **Minimum content:**

FDD.4.1. General:

FDD.4.1.1. Description of the applicant and list of team members.

FDD.4.1.2. Details on the development environment and the research objectives.

FDD.4.1.3. Definition of budget, funding and method of manufacturing (in-house, outsourced, or combination).

FDD.4.1.4. The Design Competition Award for which this application is registered for, in the case that the application is withdrawn, but the Award for which this application was registered for in the ITD cannot be changed.

FDD.4.2. System:

FDD.4.2.1. Technical description of the system to be demonstrated.

FDD.4.2.1.1. Detailed explanation of theory and principle physics of desired functionality.

FDD.4.2.1.2. Description of design process taken.

FDD.4.2.1.3. Free Body Diagrams to define load cases for simulations.

FDD.4.2.1.4. Evidence of simulations validating the theory, and detailed analysis of results.

FDD.4.2.1.5. Detailed description of dimensioning process.

FDD.4.2.1.6. Description of the manufacturing processes.

FDD.4.2.2. Size, components, appearance of the system:

FDD.4.2.2.1. 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.4.2.3. Integration of the system into a subordinate structure/system (if applicable).

FDD.4.2.4. Detailed plan of the demonstration, specifying the needed equipment and infrastructure (either own infrastructure or provided by EHW Committee):

FDD.4.2.4.1. Parts list (including dimensions and mass), in tabular format. Please identify which parts are made in-house or outsourced from an external supplier.

FDD.4.2.4.2. Images or CAD renders of the demonstration setup including all parts of the system that will be brought to the Event.

FDD.4.2.5. Section specifying a complete list of needed equipment and infrastructure (either own infrastructure or provided by EHW Committee):

FDD.4.2.5.1. If the applicant intends to use own infrastructure (e.g. test bench), its safety must be proven as well

FDD.4.2.6. Safety:

FDD.4.2.6.1. Technical description of the system to ensure compliance with the Rules & Requirements for Demonstration (see **6.2**).

FDD.4.2.6.2. Preliminary risk assessment for Demonstration, including transport and lifting procedures.

FDD.4.2.6.2.1. Detailed FMEA and description of risk mitigation measures.

FDD.4.2.6.2.2. Summary of all energy storage types and components present in system(s).

FDD.4.2.6.3. Requirements for Transport, Storage and Lifting as defined in Section **9.3**, especially TS.4.

FDD.4.2.6.3.1. Transport and Lift Plan of the system

FDD.4.3. Procedures for safe storage of systems including potential energy.

FDD.4.4. Testing:

FDD.4.4.1. Outline of manufacturing and testing procedures to be included in the ***Testing and Safety Documentation (TSD)***.

FDD.4.4.2. Provide a preliminary testing plan including methodology and expected results.

6.3.3. Testing and Safety Documentation (TSD)

This document shall describe in detail which tests have been performed and how they were conducted. The tests must contain the aim of the tests, results, measurements and data in order to prove that they have been performed. Additionally, it is possible and recommended to hand in video recordings of the tests in order to prove that the tests were conducted properly. This will provide a baseline based on which the EHW Committee defines the allowed setpoints/operating conditions of each system during the demonstration. Note that **Annex B** provides some further testing guidelines.

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

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 a wrong handling of the system is impossible. These procedures must be established by the applicant and submitted with the Testing and Safety Documentation. Failure to establish such procedures might lead to a denial of a Demonstration. Additionally, if the system utilises a transport cart to be transported, this must be tested according to **TS.2** in Section **9.3**. Evidence of this test shall be included in the TSD as well.

TSD.1. **Due:** 10 June 2022, 23:59 CET.

TSD.2. **Document format:** Formulated engineering documentation (see **AP.2.9**).

TSD.3. **Minimum content:**

TSD.3.1. A cover page, concisely describing:

TSD.3.1.1. What is going to be demonstrated - physical prototype(s) involved.

TSD.3.1.2. How is it going to be demonstrated - infrastructure involved in the demonstration, overview of demonstration procedure.

TSD.3.2. Written report of every completed test for the respective systems, which include, for each test:

TSD.3.2.1. Aim/objectives of the test (hypothesis).

TSD.3.2.2. Test description (methodology).

TSD.3.2.3. Information about used testing infrastructure and setup (components, material, dimensions, instrumentation, etc.).

TSD.3.2.4. Risk assessment.

TSD.3.2.5. Detailed testing protocols (including entrance and exit criteria for each step in the protocol).

TSD.3.2.6. Testing setpoints/conditions (e.g. load cases, pressure, voltage, speed, etc.).

TSD.3.2.7. Expected results.

TSD.3.2.8. Measurement data.

TSD.3.2.9. 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.

TSD.3.2.10. Conclusion.

TSD.3.3. Video of performed tests submitted in the following format:

TSD.3.3.1. Static camera position.

TSD.3.3.2. Clear vision of performed test.

TSD.3.3.3. 1080p resolution.

TSD.3.3.4. **Uploaded to online streaming service** (e.g. YouTube) and provide **link** within the TSD report.

TSD.3.3.5. The **date of the video upload** onto the streaming service must **precede the submission deadline of the TSD.**

TSD.3.4. Detailed procedure and safety measures; the procedures should include at least:

TSD.3.4.1. Power on/off Procedure and Operation Procedure of the system.

TSD.3.4.2. Emergency Procedure.

TSD.3.4.3. Transport & Lifting procedure (if applicable; according to Section **9.3**).

TSD.3.4.4. Test Track Load & Unload Procedure (if applicable).

TSD.3.5. Evidence of a valid liability insurance that covers both personal injury and property damage in all the venues of the Event[1].

6.3.4. Posters

All successful applicants must bring to EHW a poster with a minimum content and format requirement. One poster shall be made per demonstration submission. Note that an application for Demonstration implicitly includes an application for Showcase of the respective system as well, and there is going to be a presentation of all the registered systems (see Chapter **3**). More information and the poster template will be provided by the EHW Committee closer to the event dates in further versions of the EHW 2022 Rules & Regulations. All exhibitors must follow the minimum content requirements outlined below or bring their own medium for demonstration which must be previously approved by the EHW Committee prior to the event.

DP.1. **Due:** Late June 2022.

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

DP.3. **Required format:**

DP.3.1. Minimum size A2

DP.3.2. PDF, SVG, AI or EPS format.

DP.3.3. 300 dpi (dots per inch) or fully vectorized.

DP.3.4. CMYK colour mode.

[1] In the EHW 2022, said liability insurance must be valid in the Netherlands.

DP.3.5. Bleed and registration marks for correct guillotining must be included in the final delivery.

6.3.5. 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.

During the scrutineering, prototypes will be inspected by the technical jury. The technical jury will assess the manufacturing and the 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 TSD) will be checked.

Applicants must expect, for example, the following verifications from the technical jury:

- Are wires connected properly?
- Are the batteries produced in a safe way?
- Are there any sharp edges?
- Are there significant differences between the CAD models and the manufactured parts?
- Are the manufacturing processes used coherent with the documentation provided beforehand?
- … etc.

If there are significant changes from the FDD and TSD, the prototype will not be allowed to demonstrate.

The scrutineering will happen some days before the EHW 2022. Detailed logistical information will be given in further versions of this R&R document. Team members will need to be present during the scrutineering.

7. Research Submission Application

As stated in Chapter **4.3** 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

In order for the Research Submission to go ahead at EHW 2022, the applicant must abide by the following rules:

RS.1. The research presented is the applicant's own work.

RS.2. The applicant needs to sign the **EHW Terms and Conditions.**

RS.3. The Research Submission itself may consist of a single PDF document per topic. If the applicant would like to present additional material related to their research submission, then they need to follow the application process for showcase or demonstration as required by their intended activities. These processes are detailed in Chapters **5** and **6.**

7.2. Application Process for Research Submission

In order to be allowed to submit and present research at EHW 2022, the applicants shall document their work in the two required documents 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 Chapter **10.2**.

7.2.1. Intent to Submit Research (ITSR)

This document is used as the first application for the EHW 2022. 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. The applicant is reminded to complete AP.2.1 at this documentation stage.

ITSR.1. **Due:** 10 December 2021, 23:59 CET.

ITSR.2. **Document format:** Extended abstract, use of tables and descriptive images recommended.

ITSR.3. **Document scope:** Generally, no limitation; maximum of 5 pages per research submission, excluding citations, index or a cover page.

ITSR.4. **Minimum Content**:

ITSR.4.1. General:

ITSR.4.1.1. Description of the applicant and update list of team members.
ITSR.4.1.2. Details on the development environment and the research objectives.
ITSR.4.1.3. Designation of one representative who will be in correspondence with the EHW Committee.
ITSR.4.1.4. The Design Competition (Full-Scale) Award for which this application is registered for. (if applicable)

ITSR.4.2. Research:

ITSR.4.2.1. Title of the Research Project.
ITSR.4.2.2. Motivation of the research projects.
ITSR.4.2.3. Scope of the Research.
ITSR.4.2.4. Overview of the methodology followed (or to be followed) in conducting the research.
ITSR.4.2.5. Clear outline of content that will be presented in the FRS

ITSR.4.3. Other:

ITSR.4.3.1. If applicable, description of supplementary material the applicant would like to present and whether this material will be showcased or demonstrated based on the definitions of the Rules and Regulations.

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 2022. Content-wise, it should follow the guidelines described in this section and be self-sufficient without requiring additional material. Although the final acceptance or rejection of the application for research submissions already happens after the ITSR, the FRS is equally, if not more, significant and failure to submit it will result in an unsuccessful application.

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.

The applicant is reminded again that if they wish to showcase or demonstrate additional material relevant to this submission, then they should follow the application process for showcase or demonstration respectively and submit all the relevant documentation.

FRS.1. **Due:** 11 June 2022, 23:59 CET.

FRS.2. **Document format:** Research paper. The submission should be a single PDF file no longer than 100 pages, reference list notwithstanding. This is the uppermost limit on the length of the submission but does not necessarily reflect the recommended page count for research of any scope. The applicant should not be discouraged if their submission is significantly shorter than 100 pages, as long as the content requirements are met.

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

FRS.4. **Minimum content:**

FSR.4.1. General

FSR.4.1.1. Description of the applicant and updated list of team members, advisors, and industry partners.

FSR.4.1.2. Details on the development environment and the research objectives

FSR.4.1.3. The Design Competition Award for which this application is registered for, in the case that the application is withdrawn, but the Award for which this application was registered for in the ITSR cannot be changed.

FSR.4.2. Research

FSR.4.2.1. Abstract:

FSR.4.2.1.1. Research question.

FSR.4.2.1.2. Brief overview of motivation.

FSR.4.2.1.3. Presentation of results.

FSR.4.2.2. Introduction:

FSR.4.2.2.1. Detailed presentation of the topic of research and the motivation for it.

FSR.4.2.2.2. Background information on the topic that may prove useful later.

FSR.4.2.3. Methodology:

FSR.4.2.3.1. Detailed account of methods used. May include simulation software, mathematical models, literature review methods and more. The

methodology should be presented in a way such that the process is repeatable.

FSR.4.2.4. Results and Discussion

FSR.4.2.4.1. Detailed presentation of the outcomes of the research conducted.

FSR.4.2.4.2. Discussion on the significance and validity of those results.

FSR.4.2.5. Bibliography

FSR.4.2.5.1. All references used in writing the paper.

FSR.4.2.6. If referencing a website, or other frequently updated sources, include date accessed.

7.2.3. Posters

All successful applicants must bring to EHW a poster with a 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 in further versions of the EHW 2022 Rules & Regulations. All exhibitors must follow the minimum content requirements outlined below or bring their own medium for showcasing which must be previously approved by the EHW Committee prior to the event.

RSP.1. **Due:** 17 June 2022, 23:59 CET.

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

RSP.3. **Required format:**

RSP.3.1. Minimum size A2

RSP.3.2. PDF, SVG, AI or EPS format.

RSP.3.3. 300 dpi (dots per inch) or fully vectorized.

RSP.3.4. CMYK colour mode.

RSP.3.5. Bleed and registration marks for correct guillotining must be included in the final delivery.

8. Design Competition & Awarding System

8.1. Introduction

As one of the core features of the EHW 2022, the best systems showcased or demonstrated will be awarded. There are seven different awards that an applicant can register for. The grading of the systems applying for an award will be done by an impartial jury consisting of people with a technical, industrial or a design background.

The seven awards are:

- Best Mechanical Subsystem Award.
- Best Electrical Subsystem Award.
- Best Traction Subsystem Award.
- Best Guiding Subsystem Award.
- Complete Pod Award.

- Full-Scale Award - *Technical Aspects of Hyperloop Systems*
- Full-Scale Award - *Socioeconomic Aspects of Hyperloop Development*

There will be additional Best Design Awards sponsored by partners of the Event. Applications to the Complete Pod Award will automatically be added to the Best Design Awards. Event partner representatives will evaluate submissions based on their own criteria, and the recipients of the award will be published at the Event. Best Design Awards may be, but not limited to:

- Most Scalable Design Award.
- Best Heat Management Award.
- Best Power Electronics Award.
- Cost Efficiency and Business Plan Award.
- Hyperloop Community Award.

8.1.1. General Information on the Evaluation

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

AS.1 In order to compete for an award, it is necessary that the corresponding system or work of research is either showcased, demonstrated or presented as a research submission during the event, thus it must go through the application process.

AS.2 As stated in Chapters **5**, **6** and **7**, a system or work of research must be registered explicitly by the applicant. This shall happen in the Intent to Showcase (ITS), Intent to Demonstrate (ITD), or Intent to Submit Research (ITSR) where applicable.

AS.3 The awarding system is designed such that competitors who demonstrate will have an advantage over teams that can only showcase. There are some points which can only be achieved if a demonstration of the corresponding system occurs. However, teams who only showcase can win an equal amount of points for innovation and scalability as teams who demonstrate. Teams who demonstrate designs which are not innovative or scalable may not be awarded full points in these categories. This is not relevant to the Full-Scale awards.

AS.4 The FDD, FSD, or FRS (whichever is applicable) of the respective system or work of research form an important part of the grading of the system/submission. This means in particular:

AS.4.1 *Subsystem Awards:*

The documentation shall include all aspects of the respective systems included in the award. Systems will be evaluated based on “good engineering,” which includes but is not limited to design, engineering, scalability, cost efficiency and product quality. It may be advantageous to address in detail new ideas, innovative and scalable concepts, and ground-breaking aspects of the system that may appeal as close-to-market designs for ongoing hyperloop development.

AS.4.2 *Complete Pod Design Award:*

Every aspect of the entire pod may be evaluated for the award, but focus is made on the integration of pod subsystems. This means that it will be highly recommended to treat all subsystems of the pod in detail, as well as the systems integration. Systems will be evaluated based on “good engineering,” which includes but is not limited to design, engineering, scalability, cost efficiency and product quality. It may be advantageous to address in detail new ideas, innovative and scalable concepts, and ground-breaking aspects of the system in detail that may appeal as close-to-market designs for ongoing hyperloop development.

AS.4.3 *Full-Scale Awards:*

Every aspect of the submission may be evaluated.

AS.5 Depending on the number of competitors and registered systems for every award, the EHW Committee may further limit the number of systems that are evaluated as part of the Design Competition.

The evaluation schemes for each award will be released after the EHW Committee has decided on all showcase and demonstration applications upon receiving the ITS/ITD/ITSR submissions.

8.2. Subsystem Awards

8.2.1. Description

This category focuses on designs and 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.

For the subsystem awards, two different types exist. For the mechanical and electrical subsystem awards, the entirety of the subsystem is evaluated. Parts included in the evaluation are stated below. For the Traction and Guiding Subsystem Award multiple systems can be entered and will be graded together but participants are allowed to submit only one system.

Subsystems eligible for the Subsystem Awards shall fall under the following four categories, which at the same time also represent the four Subsystem Awards:

1. ***Mechanical Subsystem***
    a. In the Mechanical Subsystem Award, all mechanical systems in the pod are evaluated, including but not limited to
        i. brakes,
        ii. suspension,
        iii. stability,
        iv. chassis, and
        v. shell.
2. ***Electrical Subsystem***
    a. In the Electrical Subsystem Award, all electrical systems in the pod are evaluated, including
        i. sensor network,
        ii. vehicle control unit,
        iii. power stage.
    b. Excluded from this category are
        i. motors,
        ii. levitation systems, and
        iii. braking systems.
3. ***Traction Subsystem***
    a. The Traction Subsystem Award is open to both propulsion and deceleration systems; motors and brakes. These systems may be solely mechanical or electro-mechanical.
4. ***Guiding Subsystem***
    a. The Guiding Subsystem Award is open to all suspension and stability systems guiding and keeping the vehicle on the track. Levitating systems are included in this award and treated as a suspension or a stability system based on their lateral or vertical guiding capability.

8.3. Complete Pod Design Award

8.3.1. Description

This category focuses on the presentation of a complete functional design of a small-scale Hyperloop pod prototype. Prototypes considered in this category should range between 1- and 5-meters length. Prototypes should be self-propelled and self-braked for teams using the I-beam test track. Teams using own custom test track can use the track for propulsion and braking. For this category, applicants present a Final Showcase Documentation (FSD) or Final Demonstration Documentation (FDD) for their prototype. Only one design will be graded per exhibitor.

8.4. Full-Scale Awards

8.4.1. Description

This category focuses on presenting designs and concepts relating to a real-world Hyperloop system. Exhibitors must demonstrate an understanding of the implementation of Hyperloop technologies in today's society, by presenting research relevant to full-scale Hyperloop development.

At EHW 2022, there will be two separate Full-Scale Awards, each concerning a different area of research. The categories are as follows:

- Technical Aspects of Hyperloop Systems.
- Socioeconomic Aspects of Hyperloop Development.

Applicants wishing to compete for the Full-Scale Awards, should clearly indicate which of the two categories they are applying for in the ITSR. Submissions that do not fall within one of those topics will not be considered for the Full-Scale Awards. However, applicants wishing to present research on a different topic at EHW may submit the ITSR document without applying for an award.

The two categories define broad topics that the research questions of the submissions should fall within, however it is not necessary for a submission to examine all aspects of a topic. For instance, submissions towards the "Technical Aspects of Hyperloop Systems" do not necessarily need to examine every single subsystem of the pod and infrastructure in order to be eligible to compete for the award. The categories have been chosen to be broad to allow applicants freedom to explore the topics that they find most appealing and impactful.

Applicants may submit up to one application per award category, however more research submissions are allowed outwith the EHW Design Competition.

8.4.2. Full-Scale Award - *Technical Aspects of Hyperloop Systems*

The purpose of this category of the Full-Scale Award is to explore different aspects of the 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 2022 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. The scope of the submission, both in terms of depth (i.e., how rigorous and detailed the work is) and breadth (i.e., how many different aspects of the category are being considered), is left up to the applicant to determine.

8.4.3. Full-Scale Award - *Socioeconomic Aspects of Hyperloop Development*

This category of the Full-Scale Award is meant to explore the aspects of Hyperloop development that do not have to do with the technology itself, but are equally important. Considerations such as cost estimates, demand modelling for Hyperloop, predictions of socioeconomic effect, route planning and more would fit into this category.

Just as with “Technical Aspects of Hyperloop Systems” above, the topic of the submitted research should fall within the broad category of Socioeconomic Aspects of Hyperloop Development but does not need to be all-encompassing.

9. EHW Infrastructure & Associated Requirements

In this chapter, an overview of the infrastructure provided by the EHW is supplied. As not all details are known yet, an addendum will be added to provide a more detailed description of the test track.

9.1. Test Track

An I-beam is installed in the middle of a railway track at a site in Hilversum. The flat and straight I-beam is split in two sections of 150 and 200 meters. At the beginning and end of each track a space of 3 meters is left open to load and unload the pod on and off the I-beam. At the beginning of the Test Track a workstation is available to use consisting of a table, two chairs and two electrical sockets. A 1000 kg workshop crane will be provided for lifting of the pod.

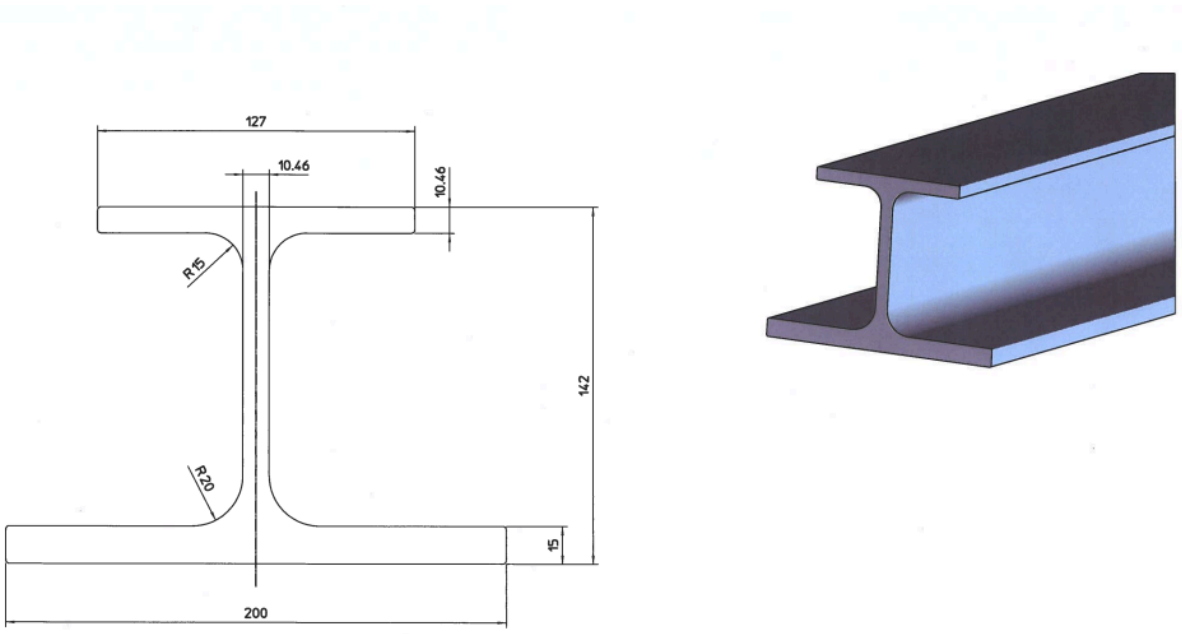

Figure 9.1: Cross section of I-beam (all values are in mm). The slope, length and tolerances of the track will be provided in a later addendum.

9.1.1. Test Track Specifications

TT.1 **Material:** 6061 T6 Aluminium.

TT.2 **Length:** 150 and 200 m

TT.3 **Tolerances:** The track consists of 3.81 m sections. The maximum deviation between the sections is listed below:

TT.3.1 Lateral: 3 mm.

TT.3.2 Vertical: 2 mm.

TT.3.3 Gap between segments: 7 mm.

TT.4 **Slope:** The track can be considered to have no slope,

9.1.2. Test Track Requirements

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

TT.5 Under no circumstances should the keep out zone be violated. The keep out zones are defined in red as below:

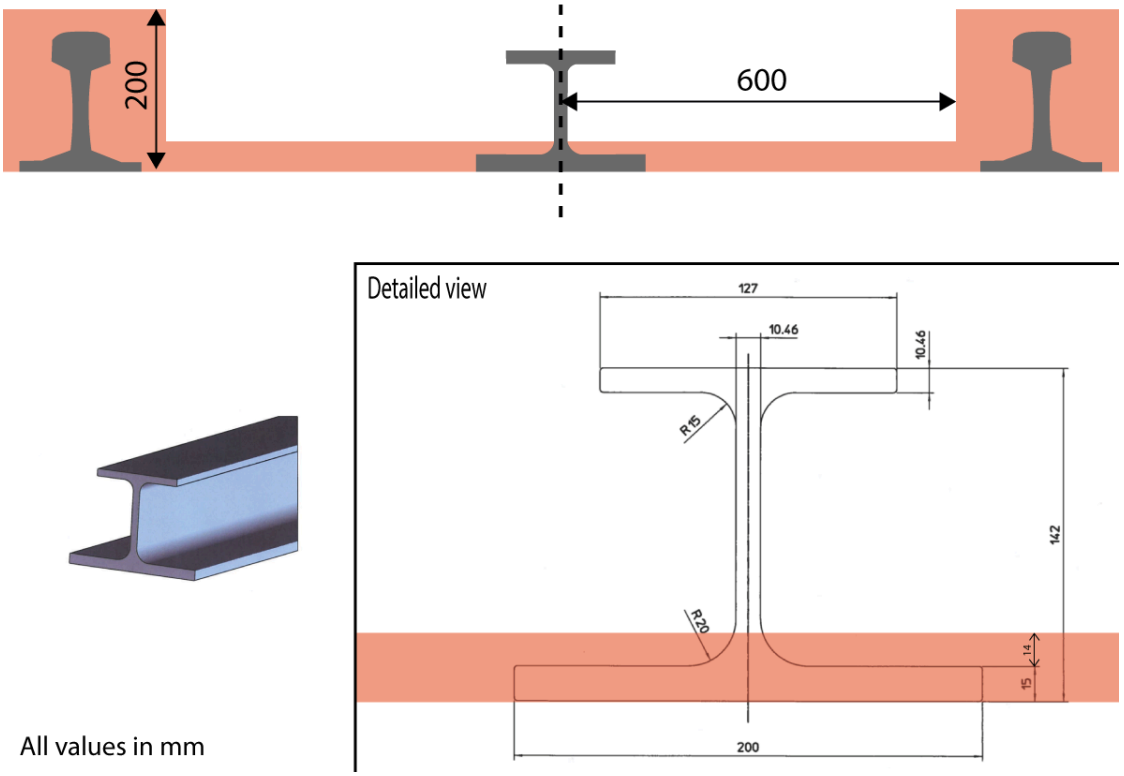

Figure 9.2: I-beam test track keep out zones highlighted in orange.

TT.6 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 6061-T6 aluminium) than the test track.

TT.7 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 as they are defined in the addendum.

TT.8 Loading and unloading of a demonstrator must happen in the designated loading and unloading area respectively.

TT.9 The demonstrator shall preferably be designed such that it can propel itself to the unloading area. Demonstrators which 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.10 The only manipulations allowed to be performed at the demonstrator while it is on the test track are to recover a stuck demonstrator and only after **TT.9** is fulfilled. Any other manipulations are solely permitted if the demonstrator is either at the loading or the unloading area.

TT.11 A moving demonstrator on the test track must use at least two independent and appropriate methods to measure its location or velocity.

TT.12 Further details on the exact procedures for a demonstration on the Test Track will be provided at a later stage.

9.1.3. Alternative Test Track Location

For the alternative tracks, a space of approximately 150 meters in length by 20 meters in width. The ground floor consists of 2 by 2-meter Stelcon plates, 16 cm thick.

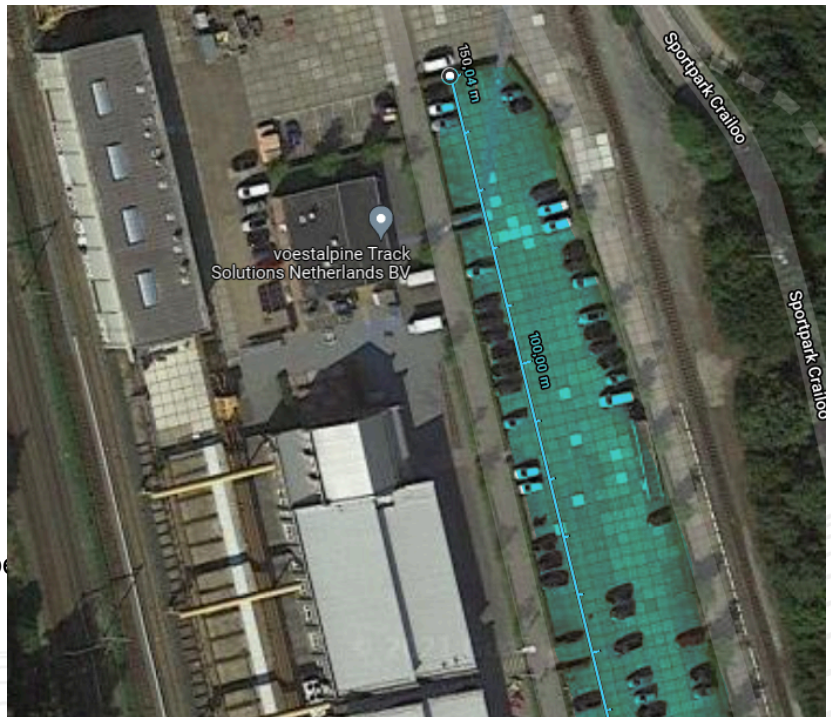

Figure 9.3: Available space for the alternative tracks highlighted in blue. (Location: voestalpine Track Solutions Netherlands B.V. , Nieuwe Crailoseweg 8, Hilversum, the Netherlands.)

ATT.1 All teams who would want to bring their own Test Track to demonstrate should mention this in the FDD.

ATT.2 A team can suggest a spot in the area highlighted in blue in figure 9.3 in which they would like to place their alternative track. The EHW will assign the final spot. The suggestion with dimensions of the track should be mentioned in the FDD.

ATT.3 Participants are only able to drill in the Stelcon plates when details about the holes (location, size and depth) are approved by the EHW. The details should be put in the FDD.

ATT.4 Participants can start only one week before the demonstration day with assembling their own track. If they need more time, the team has to discuss this with the EHW.

9.2. Communications

General EHW Pod Communications Rules & Requirements:

CM.1 **Test track** communication: Under no circumstances shall the exhibitor transmit in frequency ranges other than the bandwidths shown in Table 6.1 and with power and duty cycles higher than shown in Table 6.1.

CM.2 Communication during demonstration happening in infrastructure provided by the Applicant: Under no circumstances shall the exhibitor transmit in frequency ranges other than the bandwidths shown in Table 6.1 and with power and duty cycles higher than shown in Table 6.1.

CM.3 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.4 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.5 The pods should not have connection to the Internet. Connections are restricted to the IP address of the EHW internal networks.

CM.6 Exhibitors should be equipped with at least one NAP (Network Access Point) for the correct development of all the testing.

CM.7 All IP addressing will be static thus DHCP or DNS Servers are not needed.

9.3. Transport, Storage and Lifting Requirements

TS.1 Each demonstrator needs a method to move around either by hand or on a transport cart.

TS.2 Any transport cart must be tested prior to EHW with its maximum payload. The conducted test shall either be covered in the TSD or in the SI whichever is applicable.

TS.3 Each demonstrator shall provide the possibility of being lifted either by hand or with a forklift/small crane.

TS.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 or FSD.

TS.5 If a demonstrator is hand-lifted, the allowable weight for each person is limited to 25 kg.

TS.6 A demonstrator must have as many lifting points as required to ensure the previous requirement to be allowed to be hand-lifted.

TS.7 If a demonstrator needs a forklift, please contact the EHW organization.

TS.8 Unstable demonstrators must have a straight base for the demonstrator handling.

TS.9 There is limited storage space during the EHW, so please specify the amount of storage the participant needs.

TS.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 own storage.

TS.11 Each Participant must provide wooden box(es) in which they store their demonstration/showcase materials. The dimensions must be specified in the FDD/FSD.

TS.12 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 with EHW organisation.

TS.13 Exhibitors must provide the Transport Procedure in which they explain how they will transport their system, always ensuring the safety requirements. Demonstrator handling includes:

- TS.13.1 From the EHW entrance to the storage location where the demonstrators will be kept.
- TS.13.2 From demonstrator storage to EHW venues.
- TS.13.3 From demonstrator storage to the cargo trucks.

TS.13.4 From the cargo trucks to Demonstration venues.

TS.13.5 From the cargo trucks to the location of the Final Event.

TS.14 The exhibitor shall contact the EHW Committee if they intend to ship their demonstrator themself.

TS.15 The EHW organization will oversee the storage of the demonstrators. More details will be included in further editions of the R&R.

10. Administrative Information

10.1. Representative of the Applicant

Each applicant shall determine one representative, who will be in correspondence with the EHW Committee. The representative will be responsible for submitting the documentations 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.

10.2. Submission of Documentations

All required documentations should be uploaded as a single PDF document to the respective team folder, which will be created by the EHW Committee and shared with each participant by email, with the following naming convention:

[Applicant_name]/[Documentation_acronym]

If the PDF document exceeds the maximum uploadable size for mail attachments, an alternative will be offered.

All video submissions related to the TSD need to be submitted through an online streaming service as specified in Section **6.3.3**.

10.3. Questions & Suggestions

In case of any uncertainties or suggestions concerning the present version of the *EHW 2022 Rules & Regulations* please contact the following email address:

info@hyperloopweek.com
subject: Rules & Regulations Query

10.4. Document Version and Further Updates

- 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.
- Any exhibitor who wants to compete in the EHW 2022 must implement any changes from this document and must comply with the latest version at the EHW 2022.
- Any updates from the EHW Committee's side will be sent to the representative via email.

- **The copyright for the present document lies with the EHW 2022 Committee. It is prohibited to copy, reproduce, or distribute extracts from this document in any form.**
- The present document represents version 2.0 of the *EHW 2021 Rules & Regulations* and dates on 11 October 2021. It replaces version 1.4 of the *EHW 2021 Rules & Regulations*, thus version 2.0 is the only valid version as of 11 October 2021.

10.5.Changelog

Subsequently, the major changes between different published versions of this document are listed.

10.5.1. Version 2.0

- First published version of EHW 2022 Rules & Regulations.
- Dates on Friday, 11 October 2021.

10.5.2 Version 2.1

- Complete changelog of version 2.1 provided as a separate document to applicants.
- Dates on Tuesday, 16 November 2021.

11. ANNEX A – ITD/ITS/ITSR COVER PAGE

12. ANNEX B – TESTING GUIDELINES

12.1. Purpose

Subsequently, we provide an idea of the testing information that could be expected the applicant to deliver in the Testing and Safety Documentation (TSD). Some of the points mentioned could be considered for any system tested while others refer to specific systems. Please note that the listed points are not a requirement but just a suggestion. Thus, some points might remain unconsidered while other points not included in the list could be added in the TSD. For the content of the TSD, refer to Section **6.3.3**.

12.2. General Safety Remark

Always be safe when testing a system!

Although the EHW is not responsible for any conducted tests, we strongly encourage you to NOT test a system in an unsuitable environment, with insufficient equipment and protection gear, or in an unsafe manner.

12.3. Guidelines

12.3.1. General

- Execute the tests according to the various procedures that are demanded for demonstrations at EHW anyways. By doing so, train the workflows and improve the procedures.
- Show and/or describe the safety measures that are implemented in the operation of a system. List the utilised safety gear and emergency equipment.
- For each performed test provide the relevant data to assess the tested system undoubtedly, especially the peak values and the respective durations.
- Make use of video recordings where appropriate. Note, however, that although video recordings can provide information about the basic functionality, the exact behaviour and the condition of a system can only be assessed using measurement data.
- It is recommended to test a system beyond the operating point to be used in a demonstration on site of the EHW to prove the reliability of the system.
- Compare the tests and the resulting measurement data with the expected behaviour of the system
- Provide the mass of the system
- Show how the connecting elements are fastened appropriately and secured against unintentional loosening. This could include:
    - Mechanical connections, such as screws, bolts, etc.
    - Electrical connections, such as connectors, cables, etc.

12.3.2. Mechanical Systems

- Top-level:
    - Prove that the assembly does not contain any hazardous sharp edges that might cause damage to the vacuum chamber, the track, or the public
    - Testing data and videos that prove that the system can withstand applicable vibrations. If possible, suggested to perform vibration testing by placing the whole assembly on a vibration plate to ensure it can undergo the full range of frequencies without failure
    - Demonstrate an emergency mechanism in case of power outage during run
    - Prove that the system does not damage any infrastructure in case the emergency mechanism is triggered

- System specific:
    - Braking
        - Perform braking (friction, magnetic, etc) performance test to ensure proper deceleration (to zero speed) with pod trajectory and telemetry data presented for worst case scenario
        - Prove that braking will not damage the provided or the custom track
        - Demonstrate the redundancy of brakes (the design should be at least 1-fault tolerant)
        - Prove that braking is capable of handling the misalignments in the track
    - Suspension
        - Proof of the guidance systems reliability through strength test (FEM and/or test video)
        - Test shock absorber with maximum loads and show that suspension is capable of withstanding misalignments in the track
    - Propulsion
        - Demonstrate that the pod can withstand maximum design speeds while being stable on the track through video and sensor data
    - Structures
        - Perform an I-beam (or customized track) assembly test while showing that the keep-out zone is not violated at all times
        - Pull-out/shear tests for main subsystems (chassis, shell, etc.), any critical linkages and subsystems interfaces (FEM is acceptable too)
    - Levitation Systems
        - Prove that the system does not damage the test track/infrastructure in case of power outage of the levitation system (defined contact points)

12.3.3. Electrical Systems

- Description of functionality of the device/subsystem (e.g. conventional three-phase inverter using PWM driven IGBTs)
- Documentation of electrical characteristics (supply voltage, peak and continuous power)
- Proof (video or time series) of the system in operation, displaying supply voltage and current drawn

- Proof (video or time series) of induced failure of the device and reaction of the system
- Proof (video or time series) of the thermal characteristics of the system (e.g. FLIR camera, thermistors)
- Proof (photo or schematic documentation) of isolation, electromagnetic interference, short circuit protection mechanisms
- Proof (photo or description) of battery enclosure(s)
- Proof (photo or list) of safety equipment

12.3.4. Thermal Systems

- Temperature time history during intended operation at least for desired duration of demonstration(s)
- Proof (data and/or videos) that temperature does not exceed any justified temperature limits, (e.g. material properties)
- (Recommended) Thermal imaging video (i.e FLIR) of test(s) highlighting relevant Temperature distribution and time-development during operation
- Atmospheric conditions (ambient temperature, pressure) at which the tests were conducted
- Operating boundary conditions/value setpoints of all relevant powered systems (for reference see the previously defined data to be provided depending on the subsystem) that correspond to the thermal measurements
- For electrical devices:
    - Description of short circuit projections (e.g. max short for 5 ms @ 200 A → heat up to 75°C)

12.3.5. Pressurised Systems

- Define the operating pressure P_{op} and the maximum pressure P_{max} of the system such as $P_{op} < P_{max}$
- Suggested data:
    - Prove that the system is able to withstand an adequate time at a pressure of P_{max} in order to detect evidence of malfunctioning and verify the system.
    - Prove that the system has no leaks:
        - Unplugging the pressure vessel after filling the pressurised circuit at P_{op} and studying the evolution. Prove that there are no leaks.
    - Test that the electro valves can protect against a regulator failure.
- If the pressurised system is part of the braking system:
    - Ensure the actuators have no leaks and the piston movements are correct for different values of pressure.
    - Check that the return system is well dimensioned, and it can reach its initial position (different values of pressure).
    - Increase the pressure to P_{max} gradually and verify the system has no losses and the structure does not experience any problem.
    - Perform a test of an adequate number of cycles on the actuator with the most convenient pressure studied on the previous points and demonstrate the system continues working properly.

    - Perform a load test in which the actuator performs some cycles at high pressure values and some load is added to simulate shear stress. Ensure the system dynamics is not affected by the load.
    - If it is going to be implemented into a vehicle/pod, it is required to test it in a testbench simulating a real run (video-test).
- If the pressurised system is part of the propulsion system:
    - Ensure the propulsion system has no leaks.
    - Perform a test of an adequate number of cycles of pressurization and depressurization with the most convenient pressure limits.
    - Define the pressure limits of the system (P_{max} and P_{min})
    - Increase the pressure as much as possible and verify the system is able to withstand the forces.
    - Decrease the pressure until its minimum and verify the system is able to withstand the forces.
    - Test previously the correct work of the system (video-test). General data:
        - Thrust
        - Temperature evolution

12.3.6. Rotating Systems

- Identify rotating components. Specifications that could be considered for each component:
    - Inertia
    - Maximum operational rotational speed and stored energy
    - Are components/assemblies balanced; what are possible outcomes that imbalance could lead to.
    - Describe how the speed will be measured and monitored
    - State and illustrate loads that are on the assembly: static, inertial, centrifugal, imbalance
    - Identify bearing types and include specifications (load and speed ratings)
    - Show the load paths from component/assembly to the chassis/supporting structure
- Structural integrity proof for their expected operational speeds and loads.
- Video or photos to show the test and measured speed of the rotating component/assembly.

12.3.7. Complete Systems & Pods

- Full Video of the complete system demonstration in the manner as intended at the EHW, preferably different angles or viewpoints that show the behaviour of critical subsystems (for instance levitation, braking, stability, and acceleration)
- General data:
    - Achieved maximum speed, maximum horizontal/vertical acceleration, and deceleration
    - Horizontal and vertical Acceleration-time, speed-distance, and speed-time plot
    - Mention of braking distance and distance safety margin to end of track in worst case
    - Total Duration of demonstration

    - Sensor data for vertical or horizontal distances between pod and track throughout the whole test
    - Time series of total power consumption (e.g. v(t) and i(t) for all sources of power
- Operating boundary conditions, value setpoints and value limits of all relevant powered systems (for reference see also the above suggested data to be provided depending on the subsystem), that are specified and measured during the complete system demonstration. Examples of the most important values to be recorded are:
    - Voltage, current, electrical power consumption of electrical systems
    - Rotational speed of rotating systems
    - Operating pressure and actuator speeds of pressurized systems
    - Temperature of thermal systems
    - Ambient pressure and temperature
- Images, short protocol of condition of or any damage to infrastructure after test
- Images, short protocol of an inspection of the pod systems after the test
- Procedures for complete system power-on/power-off and operation during demonstration
- Conditions and critical values that lead to abortion of the test/demonstration. Verify that they work properly and reliably
- Provide the state diagram of the system and test all states and conditions of the system as far as possible