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Rubrics

European Hyperloop Week

Tech Committee

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EUROPEAN
HYPERLOOP
WEEK

Contents

Draft

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1 Guidelines for using the rubrics

For the promising subsystem awards, the respective rubric of the award will be chosen. For a complete system, the scores of all subsystems will be considered with equal weight. In addition, the complete system rubric applies. The scores of all subsystems and complete system rubrics will be summed up.

To calculate the score, the same procedure will be used for every rubric:

1. Every criterion will be graded from 0 to 10.
2. The grade will be multiplied by the weight (W).
3. The points for all criteria are added to a total score.
4. The total score will be multiplied by the demonstration score to get to a final score.

Here is a quick example:

1. If a team demonstrates a good understanding of their mechanical system, they are graded an 8/10 on that criteria.
2. As the weight is 5, we multiply 0.8 x 5 = 4. The team gets 4 points.
3. The same procedure is repeated for every criterion and the team receives a total of 60 points.
4. Then on Demonstration day, they are graded 75% , so the final score is 60 x 0.75 = 45.

Each subsystem will get an individual demonstration score based on the performance of that subsystem.

2 Mechanical Subsystem

ID	Evaluation Criteria	W
Documentation		10
ME.1	Completeness and clarity of the submitted documentation in the FDD.	2
ME.2	Completeness and clarity of the submitted documentation in the SPD.	2
ME.3	Completeness and clarity of the submitted documentation in the PoD.	2
ME.4	Requirements of the subsystem are traceable and design choices are justified.	4
Presentation		10
ME.5	Does the team demonstrate understanding of their system?	5
ME.6	Are they able to communicate the ideas to the general public, while keeping the context technical?	3
ME.7	Are they able to communicate how their research and testing contribute to the hyperloop ecosystem?	2
Chassis/Structure		15
ME.8	Has the system been fully designed by the team? If not, is the make/buy decision well founded?	1
ME.9	Does the team show understanding of the load cases and how they are applied to or influence their structure?	2
ME.10	Has the team identified the right materials and structural solutions for their load cases and other design criteria?	2
ME.11	Has the team effectively verified or validated the structural integrity of their design? FEA, (non)-destructive testing...	2
ME.12	Is the build quality of the structure of high quality?	2
ME.13	Is the chassis easy to maintain or replace in case any component fails?	1
ME.14	Is the chassis able to safely integrate all the other subsystems?	2
ME.15	Does the chosen concept for the chassis provide benefits over alternative solutions, and can the team explain them? E.g. does the team have good justification for their conceptual design choices?	3
Braking System		15
ME.16	Are the brakes well distributed in accordance with the requirements of the vehicle?	1
ME.17	Are redundant mechanisms in place to guarantee the vehicle comes to a standstill?	2
ME.18	Has the deployment mechanism[1] been fully designed by the team? If not, is the make/buy decision well founded?	1

[1] Deployment (retraction) mechanism: System responsible for activating or actuating the braking mechanism (pneumatic/hydraulic/electric)

ME.19	Are the capabilities of the deployment system in line with the requirements of the braking system?	1
ME.20	Does the deployment mechanism integrate well within the vehicle? (Safety, space, installation, weight distribution...)	1
ME.21	Does the chosen concept for the deployment mechanism provide benefits over alternative solutions, and can the team explain them? E.g. does the team have good justification for their conceptual design choices?	3
ME.22	Has the braking mechanism[2] been fully designed by the team? If not, is the make/buy decision well founded?	1
ME.23	Are the capabilities of the braking mechanism in line with the requirements of the braking system?	1
ME.24	Does the braking mechanism integrate well within the vehicle? (Safety, space, installation, weight distribution...)	1
ME.25	Does the chosen concept for the braking mechanism provide benefits over alternative solutions, and can the team explain them? E.g. does the team have good justification for their conceptual design choices?	3
	Aeroshell	10
ME.26	Has the system been fully designed by the team? If not, is the make/buy decision well founded?	1
ME.27	Have experimental correlations been made in order to validate the data obtained from the CFD analysis?	2
ME.28	Are the materials appropriate for the functionality of the aeroshell?	1
ME.29	Is the aeroshell easy to remove?	1
ME.30	Has the shape of the aeroshell been optimized for the demonstration or full case scenarios?	2
ME.31	Does the chosen concept for the aeroshell provide benefits over alternative solutions, and can the team explain them? E.g. does the team have good justification for their conceptual design choices?	3
	Custom Track	15
ME.32	Has the system been fully designed by the team? If not, is the make/buy decision well founded?	1
ME.33	Has the custom track been designed to meet the specific requirements of the system?	2
ME.34	Are innovative design features incorporated into the custom track to enhance performance?	3
ME.35	Assess the safety measures implemented on the custom track, including barriers, grounding, or end-of-track emergency stop.	2

[2]Braking mechanism: System responsible for applying braking force to the vehicle friction (pads/electromagnet)

ME.36	Evaluate the construction quality and durability of the custom track, considering factors such as track alignment, smoothness or cost efficiency.	2
ME.37	Does the chosen concept for the track provide benefits over alternative solutions, and can the team explain them? E.g. does the team have good justification for their conceptual design choices?	3
ME.38	Is the chosen track design relevant for full-scale hyperloop implementation?	2
	Feasibility	15
ME.39	Cost efficiency	3
ME.40	Ease of production	3
ME.41	Sustainability of materials and production processes	3
ME.42	Vacuum compatibility	3
ME.43	Could the system be easily adapted to a full-scale hyperloop system?	3
	Jury impression	20
ME.44	Extensive testing has been performed by the team to guarantee the reliability of the system	5
ME.45	Is the presentation of the prototype subsystem neat and organized?	5
ME.46	Does the system handle effectively all reasonably expected (emergency) cases?	5
ME.47	Does the system contain any single points of failure?	5

	Demonstration	
ME.48	The team follows all procedures to operate the subsystem and does so in a safe way	20%
ME.49	Does the braking system deployment mechanism operate reliably?	30%
ME.50	Does the braking system bring the vehicle to a standstill within the design braking distance ($\pm 10\%$)?	25%
ME.51	Is the aeroshell rigid during the demonstration? (It does not vibrate independently of the chassis)	25%

3 Guiding Subsystem

The Guiding Subsystem Award is open to all suspension and stability systems guiding and keeping the vehicle on track. Levitating systems are included in this award and treated as suspension or stability systems based on their lateral or vertical guiding capability.

ID	Evaluation Criteria	W
	Documentation	10
GU.1	Completeness and clarity of the submitted documentation in the FDD.	2
GU.2	Completeness and clarity of the submitted documentation in the SPD.	2
GU.3	Completeness and clarity of the submitted documentation in the PoD.	2
GU.4	Requirements of the subsystem are traceable and design choices are justified.	4
	Presentation	10
GU.5	Does the team demonstrate understanding of their system?	5
GU.6	Are they able to communicate the ideas to the general public, while keeping the context technical?	3
GU.7	Are they able to communicate how their research and testing contribute to the hyperloop ecosystem?	2
	Suspension	15
GU.8	Has the suspension system been fully designed by the team?	3
GU.9	Does the design of the suspension system meet its requirements? (size, stiffness, damping, etc.)	3
GU.10	Is the performance of the suspension evaluated under varying loads, speeds, and track conditions to ensure stability and safety?	5
GU.11	Does the suspension system provide enough stiffness and damping to comfortably handle induced vibrations?	4
	Levitation	20
GU.12	Has the levitation system been fully designed by the team?	3
GU.13	Does the design of the levitation system meet its requirements? (size, stiffness, damping, etc.)	3
GU.14	Is the performance of the levitation system evaluated under varying loads, speeds, and track conditions to ensure stability and safety?	4
GU.15	Has the team optimized parameters such as number of windings, coil geometry, or magnetic field strength to maximize levitation force to minimize energy consumption?	3
GU.16	Have physical changes within the operating range been taken into account?	1
GU.17	Have interferences with other systems been taken into account and were they modelled? Were actions taken to prevent interference?	1
GU.18	Are measures taken to prevent overheating of components?	2

GU.19	Does the system include a unique idea or a new implementation, never seen before? (in Hyperloop systems).	3
	Control system	15
GU.20	Has the control system been fully designed by the team?	3
GU.21	Is the design of levitation and suspension systems integrated, taking into account how they affect each other to ensure reliability?	2
GU.22	Are suitable control mechanisms used to keep the vehicle from running into hard limits of the guiding system?	2
GU.23	Are suitable control mechanisms implemented to compensate for forces generated by other systems?	2
GU.24	Does the control mechanism minimize the energy consumption of the system?	2
GU.25	Are appropriate sensors used to gather information regarding the position of the Pod with respect to the track?	1
GU.26	Does the control system include a unique idea or a new implementation, never seen before? (in Hyperloop systems).	3
	Feasibility	10
	The components of the guiding subsystem are designed and manufactured taking into account:	
GU.27	Cost efficiency	2
GU.28	Ease of production	2
GU.29	Sustainability of materials and production processes	2
GU.30	Vacuum compatibility	2
GU.31	Could the system be easily adapted to a full-scale Hyperloop system?	2
	Jury impression	20
GU.32	Extensive testing has been performed by the team to guarantee the reliability of the system	5
GU.33	Is the presentation of the prototype subsystem neat and organized, demonstrating a high level of cleanliness and tidiness?	5
GU.34	Does the system handle effectively all reasonably expected (emergency) cases?	5
GU.35	Does the system contain any single points of failure?	5

	Demonstration	
GU.36	The team follows all procedures to operate the subsystem and does so in a safe way	20%
GU.37	Does the guiding subsystem operate reliably?	30%
GU.38	Is the system able to levitate with minimum vibrations statically?	25%
GU.39	Is the system able to handle the vibrations induced by the motor and track?	25%

4 Propulsion Subsystem

ID	Evaluation Criteria	W
	Documentation	10
PR.1	Completeness and clarity of the submitted documentation in the FDD.	2
PR.2	Completeness and clarity of the submitted documentation in the SPD.	2
PR.3	Completeness and clarity of the submitted documentation in the PoD.	4
PR.4	Requirements of the subsystem are traceable and design choices are justified.	4
	Presentation	10
PR.5	Does the team demonstrate understanding of their system?	5
PR.6	Are they able to communicate the ideas to the general public, while keeping the context technical?	3
PR.7	Are they able to communicate how their research and testing contribute to the hyperloop ecosystem?	2
	Motor	35
PR.8	Has the motor been fully designed by the team?	5
PR.9	Does the design of the motor meet its requirements? (size, power, acceleration, etc.)	3
PR.10	Is the performance of the propulsion system evaluated under varying loads, speeds, and track conditions to ensure stability and safety?	4
PR.11	Has the team optimized the System for its designed purpose?	4
PR.12	Does the motor integrate well with the track?	3
PR.13	Have physical changes within the operating range been taken into account?	2
PR.14	Have interferences with other systems been taken into account and were they modeled? Were actions taken to prevent interference?	3
PR.15	Are measures taken to prevent excessive heating of the components?	3
PR.16	Are there measures taken to prevent vibrations induced by the motor?	3
PR.17	Does the system include a unique idea or a new implementation, never seen before? (in Hyperloop systems).	5
	Control system	15
PR.18	Has the control system been fully designed by the team?	3
PR.19	Is the design of the motor and levitation systems integrated, taking into account how they affect each other to ensure reliability?	2
PR.20	Are appropriate sensors used to gather information regarding the position on the track to control the motor?	2
PR.21	Are suitable control mechanisms implemented to utilize information regarding the position on the track to control the motor?	3s

PR.22	Does the control mechanism minimize the energy consumption of the system?	2
PR.23	Does the control system include a unique idea or a new implementation, never seen before? (in Hyperloop systems).	3
Feasibility		10
	The components of the propulsion subsystem are designed and manufactured taking into account:	
PR.24	Cost efficiency	2
PR.25	Ease of production	2
PR.26	Sustainability of materials and production processes	2
PR.27	Vacuum compatibility	2
PR.28	Could the system be easily adapted to a full-scale Hyperloop system?	2
Jury impression		20
PR.29	Extensive testing has been performed by the team to guarantee the reliability of the system	5
PR.30	Is the presentation of the prototype subsystem neat and organized, demonstrating a high level of cleanliness and tidiness?	5
PR.31	Does the system handle effectively all reasonably expected (emergency) cases?	5
PR.32	Does the system contain any single points of failure?	5

Demonstration		
PR.33	The team follows all procedures to operate the subsystem and does so in a safe way	20%
PR.34	Does the propulsion subsystem operate reliably?	30%
PR.35	Does the motor operate without producing ripples (or minimum ripples)?	25%
PR.36	Can the motor handle the vibrations of the levitation system?	25%

5 Electrical Subsystem

ID	Evaluation Criteria	W
	Documentation	10
EL.1	Completeness and clarity of the submitted documentation in the FDD.	2
EL.2	Completeness and clarity of the submitted documentation in the SPD.	2
EL.3	Completeness and clarity of the submitted documentation in the PoD.	2
EL.4	Requirements of the subsystem are traceable and design choices are justified.	4
	Presentation	10
EL.5	Does the team demonstrate understanding of their system?	5
EL.6	Are they able to communicate the ideas to the general public, while keeping the context technical?	3
EL.7	Are they able to communicate how their research and testing contributes something new to the hyperloop ecosystem?	2
	High voltage power distribution	10
EL.8	Has the system been fully designed by the team?	2
EL.9	Is the chosen topology justified? Does it integrate well with the relevant subsystems?	2
EL.10	Are safety mechanisms like isolation, overvoltage- and overcurrent protection implemented?	2
EL.11	Does the system handle unexpected shutdowns of coupled systems well?	2
EL.12	Does the system operate reliably?	2
	Low voltage power distribution	5
EL.13	Has the system been fully designed by the team?	2
EL.14	Is the system modular and flexible in terms of loads?	2
EL.15	Is there a device able to charge up the LV battery while in operation?	1
	High voltage battery	10
EL.16	Does the battery integrate well within the pod? (space, installation, weight distribution)	2
EL.17	Are the batteries optimized for the projected use cases?	2
EL.18	Are the batteries actively cooled? If not, why?	1
EL.19	Has the BMS been developed by the team?	2
EL.20	Is the mechanical assembly compact and strong?	3
	Low voltage battery	5
EL.21	Does the battery integrate well within the pod? (space, installation, weight distribution)	1
EL.22	Are the batteries optimized for the projected use cases?	1

EL.23	Are the batteries actively cooled? If not, why?	1
EL.24	Has the BMS been developed by the team?	1
EL.25	Is the mechanical assembly compact and strong?	1
	Propulsion motor drive	10
EL.26	Has the drive been developed by the team?	4
EL.27	Is the cooling of the drive integrated with other subsystems?	1
EL.28	Are the capabilities of the drive in line with the requirements from the motor?	2
EL.29	Is the mechanical assembly compact and strong?	3
	Levitation inverter	10
EL.30	Has the inverter been developed by the team?	4
EL.31	Is the cooling of the drive integrated with other subsystems?	1
EL.32	Are the capabilities of the inverters in line with the requirements of the levitation system?	3
EL.33	Is the mechanical assembly compact and strong?	2
	Feasibility	10
	The components of the electrical subsystem are designed and manufactured taking into account:	
EL.34	Cost efficiency	2
EL.35	Ease of production	2
EL.36	Sustainability of materials and production processes	2
EL.37	Vacuum compatibility	2
EL.38	Could the system be easily adapted to a full-scale Hyperloop system?	2
	Jury impression	20
EL.39	Extensive testing has been performed by the team to guarantee the reliability of the system	5
EL.40	Is the presentation of the prototype subsystem neat and organized, demonstrating a high level of cleanliness and tidiness?	5
EL.41	Assess the safety measures implemented on the electrical subsystem, including, among others, protection of high voltage components.	5
EL.42	Does the system contain any single points of failure?	5

	Demonstration	
EL.43	The team follows all procedures to operate the subsystem and does so in a safe way	20%
EL.44	The batteries are able to deliver the energy reliably without malfunctions.	30%
EL.45	The propulsion motor drive drives the motor as expected with no faults occurring.	25%

EL.46	The levitation inverters work as expected with no faults occurring.	25%

6 Sense & Control Subsystem

ID	Evaluation Criteria	W
	Documentation	10
SC.1	Completeness and clarity of the submitted documentation in the FDD.	2
SC.2	Completeness and clarity of the submitted documentation in the SPD.	2
SC.3	Completeness and clarity of the submitted documentation in the PoD.	2
SC.4	Requirements of the subsystem are traceable and design choices are justified.	4
	Presentation	10
SC.5	Does the team demonstrate understanding of their system?	5
SC.6	Are they able to communicate the ideas to the general public, while keeping the context technical?	3
SC.7	Are they able to communicate how their research and testing contributes something new to the hyperloop ecosystem?	2
	Communication network	10
SC.8	Are the chosen communication protocols justified? Are they optimal for the use case of the vehicle?	3
SC.9	Is the network topology (bus, one level ring, all to all...) justified? Is it optimal for the use case of the vehicle?	2
SC.10	Does the code implement error handling for incorrect format and corruption detection (parity bits, CRC...)?	1
SC.11	Are the communication channels isolated? If not, is there a good reason?	1
SC.12	Is the latency acceptable for a real-time system?	3
	Sensor network	10
SC.13	Do the corresponding sensors measure position and velocity accurately?	5
SC.14	Does the team have redundant sensors for measuring position? Do they implement any system to detect anomaly errors?	2
SC.15	Do the corresponding sensors measure temperature in the hottest point of the unit? Have they validated that point?	3
	Hardware	17
SC.16	Are the control boards designed by the team?	5
SC.17	Do the control boards design include any protection against under-over currents and voltages?	3
SC.18	Do the control boards design respect the appropriate spacing between ICs and components?	1
SC.19	Do the boards include any interface for debugging?	2
SC.20	Are all the conductive parts, like non-used jumpers protected from short circuits?	1

SC.21	Are all the wires identifiable by ID or color code?	2
SC.22	Is the tension and length of the wires appropriate?	1
SC.23	Are the boards and connectors properly protected against impacts?	1
SC.24	Are the boards properly protected against dust and other erosive particles?	1
	Firmware	5
SC.25	Is the firmware designed and programmed by the team members?	2
SC.26	Do they implement any system for flashing the boards in a safe way?	3
	Graphical User Interface (GUI)	10
SC.27	Does the GUI follow appropriate graphical design conventions?	2
SC.28	Is the data logged at an adequate frequency for every variable?	2
SC.29	Is every variable in an appropriate format and distinguishable from every other?	2
SC.30	Are errors visible and readable?	2
SC.31	Are warnings correctly separated from errors and in a different color and style?	2
	Feasibility	8
	The components of the subsystem are designed and manufactured taking into account:	
SC.32	Cost efficiency	2
SC.33	Ease of production	2
SC.34	Vacuum compatibility	4
	Jury impression	20
SC.35	Extensive testing has been performed by the team to guarantee the reliability of the system	5
SC.36	Is the presentation of the prototype subsystem neat and organized, demonstrating a high level of cleanliness and tidiness?	5
SC.37	Does the system handle effectively all reasonably expected (emergency) cases?	5
SC.38	Does the system contain any single points of failure?	5

	Demonstration	
SC.39	The team follows all procedures to operate the subsystem and does so in a safe way	15%
SC.40	Position and Velocity are measured and logged during the whole demonstration.	20%
SC.41	The state of the batteries is measured and logged during the demonstration.	20%
SC.42	The vehicle transitions automatically through all the demonstration states.	20%
SC.43	The vehicle responds to the GUI commands flawlessly.	25%

7 Complete System

ID	Evaluation Criteria	W
	Presentation	70
CPT.1	Does the team demonstrate an understanding of their system?	40
CPT.2	Are they able to communicate the ideas to the general public, while keeping the context technical?	20
CPT.3	Are they able to communicate how their research and testing contribute something new to the hyperloop ecosystem?	10
	Innovation Criteria	60
CPT.4	Development of unprecedented technology that substantially reduces economical costs on a real hyperloop vehicle (even if it is more expensive for the prototype)	20
CPT.5	Development of unprecedented technology that substantially reduces the total energy consumption of the system, directly or indirectly.	20
CPT.6	Development of unprecedented technology that solves a real hyperloop logistic problem (Cabin pressurization, Automatization of procedures, Cooling of the tube/system as air gets stuck in the front...)	20
	Integration Criteria	60
CPT.7	The acceleration/deceleration cruising system has been designed to increase overall energy and cost efficiency	20
CPT.8	The pod is easy to operate (easy connection of wires, safe extraction of batteries, accessible extraction of boards for repairing)	20
CPT.9	The distribution of space is optimal, utilizes the minimum necessary space, and is scalable to a real-size hyperloop vehicle.	20
	Full Scale Criteria	60
CPT.10	The technologies used in the system are scalable to a human-size hyperloop vehicle (economical, logistical, and energetical)	20
CPT.11	The technologies used are safe and can be compared to existing technologies with existing safety certificates.	20
CPT.12	The technologies used can be scaled to accelerate/decelerate a vehicle in the range of 800 km/h (acceleration, braking, measurement sensors, energy consumption, and capacity)	20
	For Demonstration only: Testing proof	
CPT.13	The vehicle as a whole performs a flawless demonstration	100%

8 Full-Scale Submission

ID	Evaluation Criteria	W
	Research	60
FS.1	General understanding of full-scale hyperloop.	10
FS.2	Relevance and value of the topic for hyperloop development.	10
FS.3	Novelty and relevance of the identified knowledge gap within the topic of interest.	10
FS.4	The choice of research scope makes sense and is effective in addressing the identified knowledge gap.	10
FS.5	Depth and level of difficulty of the research.	5
FS.6	The research offers valuable insights into the knowledge gap, demonstrating a clear interpretation of the results and their implications for hyperloop research and development.	10
FS.7	Clear understanding of the impact on the hyperloop field.	5
Jury Notes		
	Methodology	50
FS.8	Performed an extensive high-quality literature review and the relevance of it is presented.	10
FS.9	The research methodology is novel and creative.	5
FS.10	Alignment of the research objectives with the methodology	5
FS.11	The methodology is well-suited for the topic and leads to results that contribute to the purpose of the research.	10
FS.12	The methodology is correctly executed through systematically implemented and robust data collection and analysis.	10
FS.13	The description of the methodology is complete and allows verification.	10
Jury Notes		
	Content of Submission	50
FS.14	The abstract includes a clear summary of research objective, motivation, methodology, main results, and conclusions.	5
FS.15	The introduction gives a clear definition of the knowledge gap with related background information.	5

FS.16	A clear description of the scope and the corresponding limitations are given. Any assumption made is well-substantiated and constitutes a reasonable representation of the reality of the considered topic.	5
FS.17	The overall structure of the research is understandable and follows a logical path to the results.	5
FS.18	The presented information and arguments on the topic are complete and relevant. No crucial information is missing.	10
FS.19	Results are presented clearly for every part of the methodology and they are subject to critical reflection in terms of validity, reliability, limitations and overall usefulness.	10
FS.20	The conclusion effectively indicates all the key finding in the research.	5
FS.21	The presented suggestions for follow-up research are useful, creative, and inspiring.	5
Jury Notes		
	Report Style	30
FS.22	The grammar and spelling are correct, the sentences are structured in a readable manner.	5
FS.23	The style of writing is concise, objective, to the point and consistent throughout the submission.	5
FS.24	Non-essential/additional information is presented in the appendix or referred to for the interested/critical reader.	5
FS.25	Graphs and tables are sized and placed well, and they are referred to in a proper way.	5
FS.26	Any information that is not from the author is cited properly and included in a structured bibliography.	10
Jury Notes		
	Presentation	40
FS.27	The (video)presentation is well-structured.	10
FS.28	The information is transferred comfortably and concisely.	5
FS.29	The presenter(s) is/are able to explain complex concepts clearly.	10
FS.30	The presenter(s) is/are able to answer questions efficiently and comfortably at the conference stands.	10

FS.31	The presentation is of additional value to the submission and it puts the work into perspective.	5
Jury Notes		
Bonus Points for Outstanding Performance		10
Jury Notes		

Note: Please make sure to follow the Rules and Regulations regarding Full-Scale Submissions. Participants that do not adhere to these might be excluded from participating in the Competition and are not eligible for an award.