Rubrics

Edition 2025

European Hyperloop Week

Tech Committee

May 27, 2025

EUROPEAN
HYPERLOOP
WEEK

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Contents

May 27, 2025, the EHW Committee

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1 Introduction

This year, the Overall Award is divided into multiple events, each contributing points toward the final score. The team with the highest combined total across the two categories — Research Submission and Demonstration Category — will be awarded the Overall Award, ensuring a fair and transparent selection of the winner.

This document focuses exclusively on the Demonstration Category. An overview of the point distribution for the Demonstration Category is provided in Table 1.

Demonstration Category	
Engineering Design Award	310
Demonstration Awards	
Levitation & Guidance	170
Propulsion Demonstration	170
Integrated Hyperloop	150

Table 1: Breakdown of the point system for the Demonstration Category.

The document is organized according to the main demonstration categories:

1. Engineering Design Award
2. Demonstration Awards
   (a) Levitation & Guidance
   (b) Propulsion
   (c) Integrated Hyperloop

Each category this year awards a fixed number of points. For the Engineering Design Award, the full breakdown of point distribution will be clearly provided.

For the Demonstration Awards, only the structure of the judging criteria will be published. Since the detailed evaluation criteria are still under development, they will not be released at this time. However, the overall weighting and points allocation for each demonstration will be available, allowing teams to understand approximately how their performance will be evaluated.

2 Engineering Design Award Rubrics

This section outlines the criteria jurors will use to evaluate each team's Final Design Document (FDD). It provides a detailed breakdown of the elements jurors will assess, clearly explaining where points are awarded and how the evaluation process is structured.
The evaluation structure follows the same subsystem organization as suggested for the FDD:

1. System Overview [10P]
2. Mechanical [60p]
3. Traction [60p]
4. Levitation & Guiding [60p]
5. Electrical [60p]
6. Sense & Control [60p]

Each subsystem contains specific evaluation points and structured criteria that jurors will use for assessment. For more detailed information, please refer to the individual rubric provided for each subsystem.

The evaluation is deliberately rigorous and comprehensive. It is designed to reflect the standards of engineering excellence that this competition aims to promote. While teams are not necessarily expected to fulfill every single criterion in full, those that do — or come close — demonstrate a high level of technical maturity and a well-integrated, thoughtfully developed design.

Scoring Tiers:

- Excellent (80–100% per subsystem)
  Definition: Exceeds competition standards.
- Good (60–79% per subsystem)
  Definition: Meets core requirements with minor deficiencies.
- Needs Improvement (<60% per subsystem)
  Definition: Shows fundamental gaps.

2.1 System Overview

ID	Evaluation Criteria	P
	Clarity & Completness	___/3
SO.1	All requested elements are included (CAD render, weight/size, budget table, transport plan).	1
SO.2	Table (System Overview) is fully populated with accurate, measurable data.	1
SO.3	Logical flow; no redundant explanations of basic concepts.	1
	Vision & Innovation	___/3
SO.4	Identifies unique design choices beneficial for a scalable hyperloop application (e.g., "novel levitation method, scalable architecture").	1
SO.5	Explains how prototype decisions benefit a full-scale Hyperloop (e.g., "cost/efficiency trade-offs").	1
SO.6	Outlines future adaptations clearly (e.g., "Our wheeled suspension simplifies scaling to 10x speed").	1
	Feasibility	___/2
SO.7	Budget is itemized and realistic (e.g., outsourcing costs justified).	1
SO.8	Acceleration profile aligns with subsystem capabilities (e.g., motor power matches target g-forces).	1
	Professionalism	___/2
SO.9	Cover page includes all required details (logo, team name, date) and is visually polished.	1
SO.10	Employs concise language and applies domain-specific jargon appropriately.	1
Total Points:		___/10

2.2 Mechanical

A score of 0 points will be assigned to any category for which no documentation is presented.

ID	Evaluation Criteria	P
	Subsystem Descriptions	__/10
ME.1	Chassis-structure described with load paths and key joints.	1
ME.2	Suspension system includes travel range and damping mechanism.	1
ME.3	Braking system details actuation method (pneumatic/electric).	1
ME.4	Aeroshell covers CFD analysis.	1
ME.5	Custom Track is detailed on its track type.	1
ME.6	Vacuum Tube is described in detail with regard to its structure.	1
ME.7	Tables list all critical components (e.g., brackets, fasteners).	1
ME.8	Materials specified with grades (e.g., "Al 7075-T6").	1
ME.9	Pneumatic systems include pneumatic circuit diagram with specifications.	1
ME.10	CAD renders show exploded views and assembly sequences.	1
	Design & Analysis	__/18
ME.11	Chassis-structure designed with focus on weight optimization.	1
ME.12	Suspension prevents any part of the system, including the magnets, from touching the track — even in cases of improper pod mounting.	1
ME.13	The braking system's analysis demonstrates that the prototype can be safely stopped from full speed, based on both simulations and calculations.	1
ME.14	CFD analysis of the aeroshell indicates a significant improvement in aerodynamic performance.	1
ME.15	Custom Track design factors in thermal expansion, weather resistance, ground anchoring and electrical grounding.	1
ME.16	Vacuum Tube details how sections will be joined to prevent leaks.	1
ME.17	The pod is designed to accommodate passengers or freight, with integrated security features.	1
ME.18	Design-for-manufacturing (DFM) principles applied (e.g., "Use off-the-shelf fasteners").	1
ME.19	Manufacturing process matches design intent (e.g., "Laser-cut for ±0.5mm accuracy").	1
ME.20	Static stress analysis done (e.g., "FEM shows 2x safety factor").	1
ME.21	Dynamic analysis done (e.g., "Modal analysis for vibration modes").	1
ME.22	Thermal analysis done (if applicable, e.g., "Brake disc temps $\leq 300°C$, Track expansion rate from summer to winter").	1
ME.23	Mechanical properties justified (e.g., "Ti-6Al-4V for strength-to-weight").	1
ME.24	Cost trade-offs discussed (e.g., "Aluminum vs. carbon fiber").	1

ME.25	Environmental factors considered (e.g., "Stainless steel for corrosion resistance, Seals rated for -20°C to 60°C").	1
ME.26	Compares alternatives (e.g., "Double-wishbone vs. MacPherson").	1
ME.27	Structural connections are validated by engineering benchmarks (e.g., "Bolt shear strength > 3x expected load for bolt connection; Visual inspection of weld connections").	1
ME.28	The design accounts for cumulative tolerances across multiple interface points (e.g., "Tolerance stacking; CAD tolerance analysis tools").	1
	Manufacturing, Integration & Testing	___/10
ME.29	Tolerances match process capability (e.g., "±0.1mm for milled parts").	1
ME.30	Manufacturing methods are appropriate for the selected materials and geometry (e.g., "CNC for metals, composite layup for shells").	1
ME.31	Assembly sequence are reasonable (e.g., "Press-fit before fastening").	1
ME.32	Adequate space and mounting for electrical components in enclosures or frames.	1
ME.33	Cable routing avoids pinch points, heat sources, and moving components.	1
ME.34	Cable routing has been optimized to minimize EMI.	1
ME.35	Cable routing is well-organized (e.g., "Does not dangle freely, fixated through zip ties, Adhered to surfaces, etc.").	1
ME.36	QA/QC checks (e.g., "Torque specs verified post-assembly").	1
ME.37	Teams followed industry practices for lifting, moving, and securing parts.	1
ME.38	Accessibility for maintenance (e.g., "Quick-release panels for battery access").	1
	Scalability	___/10
ME.39	The pod is designed to streamline the transfer of freight/passengers.	1
ME.40	Safety features are incorporated for freight/passenger transport.	1
ME.41	CFD simulations demonstrate the pod's scalability to hypersonic speeds.	1
ME.42	Materials selected are viable for mass production in transportation-scale applications.	1
ME.43	The mechanical joining methods (e.g., "riveting, welding, bonding") are consistent with scalable production workflows.	1
ME.44	Assembly tolerances are feasible (e.g., "0.5mm clearance for press-fit bearings").	1
ME.45	The system design allows for easy access, inspection, and replacement in large-scale operational fleets.	1
ME.46	The design is compatible with expected infrastructure systems (e.g., "tube curvature, station access, power routing, levitation track type").	1
ME.47	The pod's structural and component layout can reasonably be scaled to fit in a full-size Hyperloop tube (e.g., diameter, length).	1
ME.48	Transport/logistics planned (e.g., "Pod disassembles into 1m^3 crates").	1
	Innovation	___/12

ME.49	New chassis innovation.	1
ME.50	New brake system innovation.	1
ME.51	New suspension innovation.	1
ME.52	New aerodynamics innovation.	1
ME.53	New custom track innovation.	1
ME.54	New vacuum compatible technology.	1
ME.55	New passenger/freight transport innovation	1
ME.56	Unique mechanisms (e.g., "Morphing aeroshell for drag reduction").	1
ME.57	Material breakthroughs (e.g., "Graphene-enhanced composites").	1
ME.58	Modularity (e.g., "Interlocking track segments").	1
ME.59	Leak-proofing technology (e.g., "O-ring seals at vacuum joints").	1
ME.60	Rapid deployment (e.g., "Foldable track sections").	1
Total Points:		___/60

2.3 Traction

A score of 0 points will be assigned to any category for which no documentation is presented.

ID	Evaluation Criteria	P
	Motor Description	___/10
TR.1	Motor type and operating principle clearly defined (e.g., "LIM with 3-phase windings").	1
TR.2	Peak/continuous power ratings specified (e.g., "25kW peak, 15kW continuous").	1
TR.3	Voltage/current ranges documented (e.g., "600VDC max, 200A peak").	1
TR.4	Efficiency curves provided for 25% /50% /100% load.	1
TR.5	Compliance with EHW voltage limits ($\leq$600VDC per E.5)	1
TR.6	Motor controller specs (e.g., "SiC MOSFETs, 50kHz PWM")	1
TR.7	Thrust force vs. speed profile included	1
TR.8	Safety interlocks documented	1
TR.9	Thrust force vs. speed profile included	1
TR.10	CAD models include cross-sections and critical interfaces.	1
	Motor Design, Analysis & Control System	___/18
TR.11	Force vs. air gap curves are feasible for the weight transported.	1
TR.12	Flux density plots showing saturation margins (<1.8T in core).	1
TR.13	Eddy current losses quantified at max frequency.	1
TR.14	Winding temp rise vs. duty cycle (e.g., "<70°C at 100A for 30s bursts").	1
TR.15	Cooling solution capacity is rational (e.g., "2L/min coolant flow removes 500W").	1
TR.16	Hotspot analysis (e.g., "via infrared validation").	1
TR.17	Litz wire strand count/size justified for skin depth.	1
TR.18	Combination of fill factor and impregnation method is appropriate for the intended application (e.g., "motor type, voltage class, thermal load, etc.").	1
TR.19	End-turn clearance to the stator core is sufficient for the mechanical, thermal, and electrical requirements of the intended application.	1
TR.20	Back-EMF was validated by comparing the simulated waveform at rated speed with design expectations.	1
TR.21	Field-oriented control implementation with anti-windup.	1
TR.22	PWM dead-time compensation documented.	1
TR.23	SDC open to zero thrust in <200ms.	1
TR.24	Shielded motor cables with proper termination.	1
TR.25	Mounting interface FEA with 2x safety factor.	1
TR.26	Cogging torque <5% of rated torque.	1
TR.27	THD <10% at rated speed.	1

TR.28	Regenerative braking efficiency calculated (e.g., "Recovers 30% energy").	1
	Manufacturing, Integration & Testing	__/10
TR.29	Parts list distinguishes in-house/outsourced (e.g., "Windings outsourced to ABC Co.").	1
TR.30	Tolerances match process (e.g., "±0.2mm achievable with waterjet cutting").	1
TR.31	Assembly sequence documented (e.g., "Rotor balanced before shaft mounting").	1
TR.32	Winding process documented (e.g., "Automated needle winding").	1
TR.33	Mechanical mounting integrated (e.g., "Isolators reduce vibration transfer").	1
TR.34	Motor is well-connected to its electrical components, with no wiring issues.	1
TR.35	Thermal management integrated. (e.g., "Coil cooling").	1
TR.36	Pre-assembly checks (e.g., "Continuity tests on windings").	1
TR.37	Load testing plan (e.g., "50 cycles at 120% rated current").	1
TR.38	Safety protocols (e.g., "Current-limited bench tests").	1
	Scalability	__/10
TR.39	Power density (Power to weight ratio) analysis for full scale applications.	1
TR.40	Thermal management scalability.	1
TR.41	Cost projection for mass production.	1
TR.42	Maintenance plan for full-scale.	1
TR.43	Efficiency at scaled speeds (>500km/h).	1
TR.44	EMI compliance path for commercial use.	1
TR.45	Redundancy approach for multi-motor systems.	1
TR.46	Track interface compatibility analysis.	1
TR.47	Environmental robustness (e.g., "IP54 rating for dust/water").	1
TR.48	Modularity approach (e.g., "Segmented stator").	1
	Innovation	__/12
TR.49	Unique motor topology (e.g., "Axial-flux dual-rotor design").	1
TR.50	Advanced control (e.g., "Neural network for slip compensation").	1
TR.51	Material breakthroughs (e.g., "High-temp superconductors in windings").	1
TR.52	Loss reduction (e.g., "95% inverter efficiency at 50A").	1
TR.53	Weight savings (e.g., "Carbon fiber motor housing").	1
TR.54	New thermal management innovation (e.g., "Phase-change cooling for peaks").	1
TR.55	Sensor fusion (e.g., "Encoder + Hall + AI fault prediction").	1
TR.56	Energy recovery (e.g., "95% regen efficiency").	1
TR.57	Fault tolerance (e.g., "Phase-independent control").	1
TR.58	AI/ML application (e.g., "Predictive maintenance").	1

TR.59	Safety system (e.g., "Optical current sensing").	1
TR.60	Manufacturing breakthroughs (e.g., "New winding technique").	1
Total Points:		___/60

2.4 Levitation & Guiding

A score of 0 points will be assigned to any category for which no documentation is presented.

ID	Evaluation Criteria	P
	Levitation & Guiding System Description	___/10
LG.1	Levitation method specified (EMS/EDS/HEMS) with operating principle.	1
LG.2	Guiding mechanism type (e.g., "Lateral EMS with 4-quadrant control").	1
LG.3	Nominal air gap and tolerance (e.g., "15mm $\pm$2mm").	1
LG.4	Max current/voltage per module.	1
LG.5	Power consumption at cruise condition.	1
LG.6	Redundancy approach shown (e.g., "Dual windings per electromagnet").	1
LG.7	Compliance with HV isolation rules ($\geq$500Ω/V).	1
LG.8	Emergency descent protocol (discharge <10s).	1
LG.9	CAD models include Halbach array/coil layouts.	1
LG.10	Weight and dimensions with CAD reference.	1
	System Design, Analysis & Control System	___/18
LG.11	2D/3D FEA shown force (N) vs. air gap (mm) at rated current are feasible.	1
LG.12	Transient response simulation (e.g., "step disturbance rejection <0.1s settling time") with documented damping ratio (>0.7 for critical modes) are feasible.	1
LG.13	Block diagram of control loops (e.g., "Dual-loop PID: outer position + inner current control") with bandwidth specifications (>50Hz for inner loop) is documented.	1
LG.14	List of sensors (e.g., "4x LVDTs ±0.05mm, 2x IMUs 200Hz") with data fusion algorithm (Kalman filter/ML) and latency budget (<5ms total) match system requirements.	1
LG.15	FMEA table covers coil shorts, sensor loss and power failure with feasible mitigation methods (e.g., "Auto-shutdown on >10% current imbalance").	1
LG.16	Fault detection (e.g., "Coil short detection <100ms").	1
LG.17	HV-LV isolation design (20mm creepage).	1
LG.18	Wiring diagram showing IMD connection to HV bus and SDC proves isolation.	1
LG.19	State machine integration (Idle/Active/Emergency) aligns with R&R requirements.	1
LG.20	Simulation of touchdown time shows < 10s.	1
LG.21	Modal FEA showing first structural resonance >5x operating frequency (e.g., >250Hz for 50Hz control).	1
LG.22	CFD/winding temp analysis proves <90°C hotspot at max current, with cooling solution (e.g., "Aluminum cold plates + 0.5L/min glycol flow").	1
LG.23	Test report showing radiated emissions <30dBµV/m from 150kHz–1GHz (per CISPR 25), with filter schematics.	1

LG.24	Component derating report (e.g., "Coils at 70% of max current, MOSFETS at 60% of Vds_{max}").	1
LG.25	Analysis of position error vs. guideway misalignment (±5mm), including control compensation strategy.	1
LG.26	Calculation of losses in conductive guideway materials (e.g., "$\leq$5% of lift force at 100km/h")..	1
LG.27	Schematic of redundant sensors/coils with voting logic (e.g., "2-out-of-3 sensor agreement").	1
LG.28	Control loop timing analysis (e.g., "200μs ISR period" with jitter <10μs) on documented hardware (e.g., Xenomai RTOS).	1
	Manufacturing, Integration & Testing	___/10
LG.29	Coil winding specs match machine limits (e.g., "Max 500 turns/layer").	1
LG.30	Magnet assembly process (e.g., "Epoxy cure at 80 °C for 2h").	1
LG.31	Outsourcing plan (e.g., "Halbach arrays CNC-machined by MagTech").	1
LG.32	Tolerance stack-up analysis.	1
LG.33	Alignment jigs described (e.g., "Laser-guided for ±0.3mm").	1
LG.34	HV insulation checks (e.g., "5kV hipot test").	1
LG.35	Modular replacement plan (e.g., "Single module swap in <15min").	1
LG.36	Levitation startup sequence validated.	1
LG.37	Vibration spectra logged.	1
LG.38	Emergency landing procedure tested.	1
	Scalability	___/10
LG.39	Force/weight ratio at full-scale considered.	1
LG.40	Power distribution strategy for larger amounts of modules	1
LG.41	Cost/kg estimate for mass production	1
LG.42	Maintenance access design.	1
LG.43	Thermal management scalability.	1
LG.44	Fault containment strategy.	1
LG.45	Guideway interface standardization.	1
LG.46	Installation tolerance analysis (±5mm guideway misalignment).	1
LG.47	Redundancy approach for 1000+ km operation.	1
LG.48	Energy efficiency at high speeds (e.g., "500+ km/h").	1
	Innovation	___/12
LG.49	Novel topology (e.g., "Hybrid EDS/EMS").	1
LG.50	Advanced control (e.g., "Adaptive gain scheduling").	1
LG.51	Material use (e.g., "High-Tc superconductors").	1

LG.52	Loss reduction (e.g., "Litz wire reduces AC losses").	1
LG.53	Weight savings (e.g., "3D-printed coil forms").	1
LG.54	New thermal management solution (e.g., "Phase-change cooling").	1
LG.55	Passive stabilization (e.g., "Diamagnetic backup pads").	1
LG.56	Active recovery (e.g., "Auto-rebalance during roll").	1
LG.57	Sensor fusion (e.g., "ML-based gap estimation").	1
LG.58	Human factors (e.g., "Audible alarm for gap violations").	1
LG.59	Self-diagnostic capability.	1
LG.60	Guideway interaction (e.g., "Zero-power hovering").	1
Total Points:		___/60

2.5 Electrical

A score of 0 points will be assigned to any category for which no documentation is presented.

ID	Evaluation Criteria	P
	Electrical System Description	___/10
EL.1	HV/LV system specifications with voltage/current ranges (e.g., "800V DC bus, ±5% regulation").	1
EL.2	Battery/supercapacitor metrics including cycle life and C-rate (e.g., "Li-ion NMC: 1000 cycles @ 1C").	1
EL.3	Environmental ratings for all components (e.g., "IP67 for battery enclosures").	1
EL.4	BMS topology presented with focus on centralized vs. decentralized architecture and integrated fault-response logic.	1
EL.5	Thermal analysis under peak loads (e.g., "Inverter heatsink <80°C @ 150A").	1
EL.6	Circuit simulation results (e.g., "Voltage ripple <1% at full load").	1
EL.7	Fault scenario validation (e.g., "Short-circuit protection trips in 2ms").	1
EL.8	Efficiency curves across load range (e.g., "94% peak efficiency at 50% load").	1
EL.9	Communication protocols clearly defined.	1
EL.10	Complete wiring diagrams with isolation boundaries.	1
	System Design, Analysis & Power Architecture	___/18
EL.11	BMS functional safety: Documented fault tree analysis (FTA) covering all critical failure modes with quantitative failure rates.	1
EL.12	Circuit diagram showing IMD connection to HV bus and SDC.	1
EL.13	PCB design appropriate for application (e.g., "6+ layers fo HV sections, with clear HV/LV separation").	1
EL.14	Precharge Circuit Design — Includes resistor selection and power rating calculations, with clear justification based on inrush current analysis.	1
EL.15	Isolation monitoring system specs (e.g., "IMD with 500kΩ threshold").	1
EL.16	Fault recovery procedures (e.g., "Auto-reset on transient under-voltage").	1
EL.17	Fault response times for critical scenarios.	1
EL.18	HVIL implementation details schematic showing all service points.	1
EL.19	Grounding strategy documentation (e.g., "Single-point star ground").	1
EL.20	Communication interfaces (e.g., "CAN FD for BMS comms @ 5Mbps").	1
EL.21	Thermal management integration (e.g., "Coolant manifolds shared with motors").	1
EL.22	Measured efficiency at key operating points.	1
EL.23	Compatibility and timing coordination between subsystems is addressed (e.g., "latency, refresh rates").	1
EL.24	Sensors and actuators are electrically mapped to controllers for each subsystem.	1
EL.25	Communication link reliability, latency, and bandwidth requirements are detailed.	1

EL.26	Redundancy implemented (e.g., "Dual independent power supplies").	1
EL.27	Grounding system validated through ground loop analysis demonstrating noise in sensitive circuits.	1
EL.28	Timing diagram showing contactor sequencing logic for precharge relay activation and main contactor closure.	1
	Manufacturing, Integration & Testing	___/10
EL.29	HV safety clearances implementation to prevent arcing. (e.g., "600-1000V min. air clearance @ 8mm").	1
EL.30	Testing jig designs for production validation.	1
EL.31	HV activation sequence documentation to define safe power-up.	1
EL.32	Torque specs for all power connections to ensure contact pressure.	1
EL.33	Labeling system for cables/components to ensure traceability.	1
EL.34	Insulation resistance test results. (e.g., "@ 1kV min. IR value $\geq$ 100MΩ/km for power cables	1
EL.35	Burn-in testing duration and parameters. (e.g., ">8 hours for power electronics @ nominal load with temperature logging")	1
EL.36	Failure mode injection testing.	1
EL.37	BMS calibration with documented cell voltage measurement error across range.	1
EL.38	HiPot Testing — All high-voltage (HV) assemblies pass a >2.5kV test for 1 minute.	1
	Scalability	___/10
EL.39	Automated PCB assembly method (e.g., "Automated SMT for power stages").	1
EL.40	Derating taken into account (e.g., "Components at 70% of max ratings").	1
EL.41	Eliminate redundancy (e.g., "Dual-contact relays for critical paths").	1
EL.42	Fixture designs for production-line validation.	1
EL.43	Energy density analysis with Wh/kg improvement roadmap (e.g., "SiC converters").	1
EL.44	Maintenance intervals defined (e.g., "Quarterly impedance checks").	1
EL.45	Automated testing method (e.g., "Fixture designs for production-line validation").	1
EL.46	Busbar design with current density <3A/mm^2 for mass production.	1
EL.47	Demonstrates fault containment strategy with fire barriers physically separating battery segments.	1
EL.48	Wiring standardized (e.g., "Connector types reduced to $\leq$3 variants").	1
	Innovation	___/12
EL.49	Advanced BMS (e.g., "AI-based cell balancing").	1
EL.50	Materials use (e.g., "Graphene-enhanced supercapacitors").	1
EL.51	Advanced control (e.g., "AI Predictive fault detection").	1
EL.52	Loss reduction (e.g., "SiC MOSFETs with 98% efficiency").	1

EL.53	Novel Isolation (e.g., ”Optical current sensors replacing shunts”).	1
EL.54	Fault Tolerance (e.g., ”Self-healing fuses (e.g., polymeric PTC)”).	1
EL.55	Manufacturing innovation (e.g., ”Automated HV cable crimping process”).	1
EL.56	Active safety (e.g., ”Arc-flash detection via UV sensors”).	1
EL.57	Communication (e.g., ”TSN for deterministic power management”).	1
EL.58	Use of smart components or edge computing (e.g., ”subsystem-level intelligence”).	1
EL.59	Modularity (e.g., ”Innovative plug-and-play battery segments”).	1
EL.60	Fast Charging (e.g., ”$\leq$15min to 80% SOC”).	1
	Total Points:	__/60

2.6 Sense & Control

A score of 0 points will be assigned to any category for which no documentation is presented.

ID	Evaluation Criteria	P
	Sense & Control System Description	___/10
SC.1	Full sensor list with resolution/accuracy specifications (e.g., "IMU: ±0.1°accuracy, 200Hz update rate")	1
SC.2	Communication protocols and network topology documented (e.g., "CAN FD @ 2Mbps with ring topology")	1
SC.3	Environmental operating conditions specified (e.g., "-20°C to 60°C operating range")	1
SC.4	Network stress testing data (e.g., "70% bandwidth utilization at peak load")	1
SC.5	Detailed network architecture diagrams (e.g., "Vehicle CAN network with gateway to Ethernet")	1
SC.6	PCB schematics with critical interfaces labeled (e.g., "Opto-isolated CAN transceiver circuit")	1
SC.7	Version-controlled code repository with documentation (e.g., "Code repositories with firmware and software code")	1
SC.8	Sensor calibration procedures documented (e.g., "Magnetometer hard/soft iron calibration steps")	1
SC.9	Firmware update protocol described (e.g., "OTA updates via encrypted WiFi connection")	1
SC.10	Processor performance margin (e.g., "<80% CPU utilization at peak load")	1
	System Design, Analysis & Control Architecture	___/18
SC.11	Complete state machine implementation including: • All operational states defined (e.g., "Boot, Precharge, Active, Fault") • All transition conditions specified (e.g., "Active → Fault on HV undervoltage") • Visual state diagram provided (e.g., "Precharge → Active when HVIL closed")	3
SC.12	Redundancy measures for critical components (e.g., "Dual redundant encoders on traction motor")	1
SC.13	Worst-case latency analysis for control loops (e.g., "PID loop completes in <5ms")	1
SC.14	Fault injection and recovery testing results (e.g., "CAN bus dropout recovery in 50ms")	1
SC.15	Hardware-in-the-loop test coverage report (e.g., "90% of state transitions validated")	1

SC.16	Sensor fusion algorithm validation (e.g., "Kalman filter reduces position error by 30% ")	1
SC.17	Graceful degradation modes implemented (e.g., "Reduced performance mode on sensor failure").	1
SC.18	Manual override procedures documented (e.g., "Physical E-stop bypasses software controls").	1
SC.19	Processor specifications matching requirements (e.g., "STM32H743 @ 480MHz with FPU").	1
SC.20	Watchdog timer implementation (e.g., "Independent hardware WDT with 500ms timeout").	1
SC.21	Power-on self-test sequence defined (e.g., "RAM test, sensor comms check, actuator test").	1
SC.22	Signal integrity measures implemented (e.g., "Twisted pair CAN lines with 120Ω termination").	1
SC.23	Data logging frequency and capacity (e.g., "1kHz logging for 8 hours of operation").	1
SC.24	GUI refresh rate and latency (e.g., "Dashboard updates at 20Hz with <100ms latency").	1
SC.25	Network bandwidth utilization (e.g., "Peak CAN bus load under 70percentage")	1
SC.26	Boot time from power-on to operational (e.g., "Full system ready in <3 seconds").	1
	Manufacturing, Integration & Testing	___/10
SC.27	PCB design for manufacturability (e.g., "4-layer board with 0.2mm traces for 100V isolation").	1
SC.28	Connector selection for robustness (e.g., "M12 connectors for all track-side sensors").	1
SC.29	Cable harness design documentation (e.g., "Strain relief at all moving cable junctions").	1
SC.30	Firmware flashing procedure (e.g., "SWD programming jig for mass production").	1
SC.31	Sensor calibration methodology (e.g., "Automated IMU calibration fixture").	1
SC.32	Environmental protection measures (e.g., "Conformal coating on all PCBs").	1
SC.33	Labeling and identification (e.g., "Color-coded connectors for HV/LV separation").	1
SC.34	Unit test coverage (e.g., "90% of MCU code paths validated").	1
SC.35	Integration testing results (e.g., "End-to-end sensor-to-actuator latency <20ms").	1
SC.36	Field testing duration (e.g., "Propelling logs during demonstration").	1
	Scalability	___/10
SC.37	Signal integrity validation (e.g., "Clean I2C waveforms at 400KHz confirmed via oscilloscope").	1
SC.38	EMI mitigation measures (e.g., "Ferrite beads on all digital lines").	1

SC.39	Modular node architecture (e.g., "Ability to add/remove sensor/control nodes without reconfiguration (plug-and-play CAN/Ethernet)").	1
SC.40	Maintenance schedule (e.g., "Monthly sensor calibration required").	1
SC.41	Debug access points (e.g., "JTAG header available under service panel").	1
SC.42	Field update capability (e.g., "Wireless firmware updates possible").	1
SC.43	Data retention policy (e.g., "30 days of operational logs stored").	1
SC.44	Data storage scalability (e.g., "Cloud based database").	1
SC.45	Energy density analysis with Wh/kg improvement roadmap (e.g., "SiC converters").	1
SC.46	Protocol standardization (e.g., "Unified messaging framework (ROS 2/DDS) across all subsystems").	1
	Innovation	___/12
SC.47	Machine learning implementation (e.g., "Neural network for anomaly detection").	1
SC.48	Advanced networking (e.g., "Time-Sensitive Networking for determinism").	1
SC.49	Unique sensor fusion (e.g., "LIDAR-IMU tight coupling algorithm").	1
SC.50	Wireless Comms Redundancy (e.g., "Secondary mesh network (e.g., Bluetooth 5.2) for critical signals").	1
SC.51	Computational optimization (e.g., "Fixed-point math for DSP routines").	1
SC.52	Latency reduction (e.g., "Bare-metal RTOS for critical loops").	1
SC.53	Redundancy architecture (e.g., "Triple modular redundancy for state machine").	1
SC.54	Cybersecurity measures (e.g., "CAN bus message authentication").	1
SC.55	Fail-safe mechanisms (e.g., "Independent hardwired E-stop circuit").	1
SC.56	Hardware Acceleration (e.g., "FPGA-based preprocessing (e.g., 10x faster FFT for vibration analysis)").	1
SC.57	HMI Augmentation.	1
SC.58	Dynamic Reconfiguration (e.g., "Control algorithms that auto-tune for track conditions").	1
Total Points:		___/60

3 Demonstration Award Rubrics

This section outlines the rubrics that jurors will use to assess each team's demonstration across the different disciplines, as well as the team's overall engagement and practices. Each evaluation category is structured as follows:

- Design
- Performance

In the Design category, jurors will evaluate the team's system throughout the entire exhibition period. This includes observations made during scrutineering as well as during exhibition times. The design assessment will be based on the evaluation criteria provided and aims to complement the Final Design Document (FDD) evaluation by assessing the actual implementation and quality of the systems the teams have built.

The Performance category focuses solely on the pod's performance during its demonstration. Jurors will assess the system based on the specific performance criteria outlined for each discipline.

3.1 Levitation & Guidance

Category	Evaluation Criteria	Points
	Design	
tbd	• tbd	____/25
tbd	• tbd	____/10
tbd	• tbd	____/15
	Total points for Design:	____/50
Category	Evaluation Criteria	Points
	Performance	
	A score of 0 points will be assigned to any category for which no demonstration is presented.	
tbd	• tbd Draft	____/40
tbd	• tbd	____/20
tbd	• tbd	____/30
tbd	• tbd	____/30
	Total points per Performance:	____/120
	Total points per Levitation & Guidance Demonstration Award:	____/170

3.2 Propulsion

Category	Evaluation Criteria	Points
	Design	
tbd	• tbd	____/25
tbd	• tbd	____/10
tbd	• tbd	____/15
	Total points for Design:	____/50

Category	Evaluation Criteria	Points
	Performance	
	A score of 0 points will be assigned to any category for which no demonstration is presented.	
tbd	• tbd	____/40
tbd	• tbd	____/20
tbd	• tbd	____/30
tbd	• tbd	____/30
	Total points per Performance:	____/120
	Total points per Propulsion Demonstration Award:	____/170

3.3 Integrated Hyperloop

Category	Evaluation Criteria	Points
	Design	
Vacuum	• tbd	___/25
Aerodynamics	• tbd	___/10
Passenger/ Freight Transport	• tbd	___/15
	Total points for Design:	___/50
Category	Evaluation Criteria	Points
	Performance	
A score of 0 points will be assigned to any category for which no demonstration is presented.		
Vacuum	• tbd	___/35
Aerodynamics	• tbd	___/15
Passenger/ Freight Transport	• tbd	___/25
Team Performance	• tbd	___/25
	Total points per Performance:	___/100
	Total points per Integrated Hyperloop Demonstration Award:	___/150