FORMULA SAE ITALY 2026
REAL CASE SCENARIO

Beat the Heat – Designing Cooling Solutions for Extreme Heat
BEWARE!! DRIVERLESS VEHICLES HAVE A DIFFERENTIATED CHALLENGE, TEAMS PARTICIPATING WITH BOTH DV AND EV WILL HAVE TO DO BOTH READ THE FOLLOWING LINES WITH ATTENTION

The Challenge

Climate change is altering the operating conditions under which vehicles must be designed. Rising ambient temperatures require manufacturers to consider not only vehicle performance and reliability, but also driver safety and fatigue management. In this Real Case Scenario, teams are asked to address a real-world **design of the driver cooling system of a Formula SAE vehicle** — where "driver" shall be understood as the **passenger** for Class 1D teams — assessing the engineering solution together with its impact on **cost, manufacturability, mass, Bill of Materials (BOM), and CO_2 emissions**.

The challenge is to introduce a driver cooling system suitable for hot-climate operation, taking as a reference the typical conditions of **GCC (Gulf Cooperation Council) markets**, as defined by the **GSO (GCC Standardization Organization)**. In this context, the system becomes available above an **activation threshold of 35 °C** to support driver thermal comfort, while its sizing and robustness shall be assessed against a more severe **design reference temperature of 50 °C ambient**, representative of extreme Gulf-market operating conditions.

The device is therefore not intended to operate continuously in all environments. Below the 35 °C threshold, its use would provide limited benefit while increasing energy consumption, mass, cost, and system wear; above this threshold, it may be activated, but it shall still be evaluated against the 50 °C reference condition to ensure robustness in the most demanding hot-climate scenarios.

The system shall improve driver thermal comfort and reduce heat stress risk without compromising vehicle safety, packaging, serviceability, or cost-event compliance.

- **Classes 1CV, 1EV, and 3** shall design, calculate cost and emission of a liquid-based driver cooling solution. The cold-side is a **refrigerant-to-water heat exchanger**, used to cool a closed water loop feeding a **driver cooling jacket**, inspired by the approach introduced in recent Formula 1 regulations.
- **Class 1DV** shall design, calculate cost and emission of an air-based passenger-cockpit cooling solution. The cold-side is a **refrigerant-to-air heat exchanger**, used to cool the passenger-cockpit air stream directly. In this configuration, the water loop is not used, and teams shall focus on heat-exchanger positioning and cold-air delivery to the passenger cockpit area.

The analysis shall enable the proper sizing of the main non-black-box components, including e.g. **condenser module, coolant lines, fittings, ducts, mounting brackets, System Assumptions and Black-Box Interfaces.**

- The **compressor, refrigerant fluid, cold-side heat exchanger, and driver jacket system** shall be considered black-box components and do not need to be designed internally by the teams. For the cold-side heat exchanger, the required **envelope and thermal performance** are provided as input assumptions. The driver jacket system includes the **jacket with internal coil/serpentine and the small water circulation pump** and all interfaces with cold-side heat exchanger.

- For **Class 1DV**, the cold-side heat exchanger shall be considered a **refrigerant-to-air heat exchanger**.
- The refrigerant shall be assumed as **R1234yf**, representative of modern mobile air-conditioning systems.
- The compressor black box shall be assumed to be an **electric compressor** with a cylindrical envelope of **Ø50 x 100 mm**.
- For Classes **1CV, 1EV and 3**, the driver jacket system shall be assumed to require a closed water loop sized for approximately **300 W** of heat removal, and dimensions of **120 x 70 x 35 mm**.
- For Class **1DV**, the cockpit chiller shall be assumed to dissipate approximately **300 W** from the passenger-cockpit air stream. Teams shall define the air flow rate and ducting concept, targeting a practical air-side temperature drop of approximately **8-12 K** across the cold-side heat-exchanger with dimensions of **120 x 100 x 50 mm**.
- Teams shall define the remaining mechanical circuit architecture and show its **virtual integration on the vehicle**, including **packaging**, **routing**, **supports**, and ducts or air inlet/outlet strategy where applicable. Electrical and control integration shall not be considered for layout purposes.

Cost & Manufacturing
The design shall be addressed according to a **Design-to-Cost** and **Design-for-Manufacturing** approach with direct implications for **cost, mass, manufacturing complexity, and packaging** for all designed and modified components.

1. Based on the proposed technical solution, each team shall identify the vehicle components affected by the modification in the **BOM (Bill of Materials)**, where these components are not already included in the **Engine and Tractive System (E&TS)**.
2. Particular attention shall be paid to the **CCBOM (Cost & Carbon Bill of Materials)**. Each team shall quantify the cost variation associated with the proposed solution and estimate the corresponding variation in **embodied CO_2 emissions**, considering, where applicable, raw materials, manufacturing processes, machining/processing operations, purchased components, and component sourcing.
3. The objective is to identify the **best trade-off between cost, mass, manufacturability, packaging, and environmental impact**.

Required Deliverables
Each team shall present a technically validated solution including:

- Complete system layout and sizing of the main non-black-box components, providing justification for the design choices and engineering trade-offs;
- virtual vehicle integration of the proposed solution, showing component position, routing, ducts or air openings where applicable, mounting points, and main packaging constraints on the car;
- **Cost & Manufacturing** analysis (CCBOM) of the proposed solution (excluding black-box components) with costs and CO2 emissions;
- comparison between the **baseline configuration** and the **new configuration with "Driver Cooling System"**.