Rules Update #7:

Indy Autonomous Challenge Safety Manual

Version 1.2 Dated July 29, 2021
Preface

This document is intended to provide guidelines for safe operation and cooperation of teams during IAC track events.

Changes are intended to be made to this document as the competition develops. The expected reasons for changes are to increase safety, increase efficiency, and manage the unforeseen complexities of track operation.
1 General

1.1 The ultimate decision to postpone track operations is up to the venue staff and Safety Crew, followed by Series Staff, IAC safety officer and Team Crew Chief. This includes but is not limited to: Indianapolis Motor Speedway, Juncos Racing, and Energy Systems Network.

1.2 A safety plan must be created by the team’s Crew Chief and discussed with track Safety Crew and Series Staff prior to any track operations.

1.3 All members must, at a minimum, adhere to the safety regulations for each venue.

1.4 A dedicated radio channel shall be reserved for communication between Crew Chiefs and Race Control that shall be monitored by Crew Chiefs at all times.

1.5 All safety incidents must be reported to the officials. If necessary, safety procedures will be updated and all teams will be notified.

1.6 A briefing between Race Control, Crew Chiefs, and Track Safety Crew must be conducted before any car is started.

1.7 A log of radio channels and designations shall be maintained by Race Control.
2 Vehicle Handling

2.1 Teams are fully responsible for:
   ● Warming up the engine and gearbox
   ● Loading code onto the ADLINK computer.
   ● Assuring their vehicle is ready to run by appropriate pre-session tests of sensors, actuators and software

2.2 Teams perform the following under the supervision of Juncos Racing:
   ● Start up engine
   ● Move vehicle

2.3 Any task not listed above is reserved for Juncos Racing only and shall not be performed by any team member.

3 Pit Operation (Single-Vehicle)

3.1 Each Team will be designated a Pit Box for a track day.
3.2 The day will be divided into separate sessions for each team. The scheduling of the sessions is to be done prior to the testing day.
3.3 Teams should move their vehicle to the pitlane at the beginning of their sessions manually.
3.4 When the track is cleared, Race Control sends the command to fire the engine. After this, the car can go out on the track (potentially with a chase vehicle).
3.5 After it’s run the car has to stop at the pit entry and the engine has to be shut off from race control.
3.6 Teams who are not running are allowed to work on their cars during the sessions.
3.7 If a team is not ready to run, a queue of teams who are ready to test is used to fill up the slots.
4 Pit Operation (Multi-Vehicle)

4.1 Each Team will be designated a Pit Box for a track day.

4.2 The Pit Lane is divided into Pit Boxes, Safety Buffer and a Driving lane. See below for a visual image of how the Pit Lane is broken up.

4.3 The testing day is divided into multiple sessions. Teams have to agree upon joint testing slots.

4.4 The cars are moved out to the Driving lane prior to the beginning of the session. Once Pits have been determined closed, Race control sends the command to launch the engines. After this, cars are released from the Pit Lane.

4.5 Cars shall stop in the Driving Lane before the Pit Out Line and turn off the motor in the order of which they return from the racing surface. Once Race Control declares Open Pits, the cars shall be moved back to their designated Pit Box by team crew members.

4.6 There shall be no passing in Pit Lane.

4.7 Teams are allowed to connect to the car and perform data operations while the car is in their designated pit box.

4.8 The pits shall remain clear of personnel until Race Control declares Open Pits, at which point it is safe for personnel to traverse the pits.

4.9 Teams should allow for a minimum of 10 minutes between testing sessions to prepare their car for the next run session. The scheduling of the sessions is to be determined prior to beginning of the testing day.
5 Autonomous Driving Capabilities

5.1 The vehicle should demonstrate object detection and avoidance, raceline following, and overtaking capabilities. In addition, it should demonstrate capability to adhere to the general race rules (pit entry, pit exit, racing flags, and safety stops).

5.2 All initial tests should be done utilizing dry race conditions at Lucas Oil Raceway with the Indianapolis Motor Speedway being reserved for more advanced testing.

5.3 The following are intended minimum tests to determine the ability of a team’s autonomous system to meet the above criteria. The test should be done under the supervision of at least one other team.

5.3.1 The vehicle is launched from the Pit Lane, does the warm-up lap, one Performance Lap, a caution lap, a Performance Lap and comes back to the pitlane.

5.3.2 The vehicle is launched from pitlane, does the warm-up lap and one performance lap, and is stopped in a controlled manner on track via a Race Control request.

5.3.3 The vehicle responds safely to static and dynamic objects on the track during three Performance Laps. These objects are pre-defined schemes for all teams which are passed to the autonomous system virtually. The objects have reduced performance (approx. 75% of the speed) in comparison to the target performance of the teams.

5.3.4 The vehicle is able to correctly detect other vehicles in standstill. Two other vehicles are placed in front of the vehicle at 20m and 60m from the vehicle being tested. Vehicle position has to be determined correctly up to an error of 10% in range and angular position with respect to the ego vehicle.

5.4 The above test along with top speed achieved by each vehicle shall be used to determine performance groups for joint track testing.

5.5 The above test must be documented and data shared with other teams for the purpose of validation. This includes speed profiles, acceleration profiles (lateral and longitudinal), steering angle request, throttle request and brake requests. In addition, teams have to visually document the performance on camera for future reference.
6 Software Safety Documentation

6.1 Teams are required to take reasonable precautions against software failure to prevent their vehicle from crashing or causing another vehicle to crash.

6.2 Teams shall record these precautions in a document containing three main sections: Software architecture, safety checks, and quality aspects. This document shall be made available to all teams, Race Control, and the organizers.

6.3 The software architecture should give a brief overview of the potential failure modes from software crashes to available redundancies. This does not have to include details on the algorithms used. The sole intent of this section is to understand available redundancy in case of e.g. sensor or software failures.

6.4 The safety checks should document the implemented supervisory functionalities. Such as heartbeats, actuator performance supervision, or double-checking of algorithm results.

6.5 The quality aspects should document activities on project management level to ensure that the software which is allowed on the car is ready to drive. Such as automated software tests or code reviews.

7 Vehicle Recovery

7.1 A Yellow Flag shall be flown following any contact with the wall, stoppage of any vehicle on or near the track, or debris deposited on track during the on track session.

7.2 Once all cars are under the maximum speed allowed under Yellow Flag conditions, each car shall be told to pit using the Black Flag. The Red Flag shall be shown once all cars are stopped.

7.3 Depending on the severity of the incident, Race Control might decide to declare a Red Flag immediately.

7.4 Once the racing surface has been determined safe by Race Control the recovery vehicle shall be dispatched to approach from the rear of the affected car.

7.5 All physical safety switches shall be disengaged and power turned off from the car. After all physical safety switches are disengaged and the car is powered off, the Safety Crew will remove the affected vehicle.
8 Definitions

- **Black Flag** - Signifies that a vehicle is required to return to the Pit Lane.
- **Closed Pit** - Vehicles may come down Pit Lane, but are not to be worked on. All personnel are not permitted to be on the Pit Lane surface.
- **Cold Track** - When the racing surface is not secure and no car should be propelled by its own power.
- **Crew Chief** - Responsible for safety of the team and vehicle. Communicates with race control and other teams to make intentions to use the track known.
- **Driving Lane** - The farthest lane out from pit boxes where cars shall be placed if they intend to go out for a test session.
- **Hot Track** - When the racing surface has been cleared and secured with the intent that cars can utilize full race operations.
- **Indy Autonomous Challenge (IAC)** - the IAC is the competition sanctioning body and shall be referred to as the series or IAC.
- **Open Pit** - Vehicles are allowed to be worked on and personnel are permitted on the Pit Lane surface.
- **Performance Lap** - A lap that is intended to be run at or near race lap pace.
- **Pit Box** - The area of the Pit Lane specified to a team for service of a Car including fueling, data management, charging, and updating of systems. This area includes both sides of the Pit Wall.
- **Pit Lane** - The part of the Track that leads from the Racing Surface to the Pit Boxes or from the Pit Boxes back to the Racing Surface. It has specified starting and ending points and is defined by painted lines, cones and/or other visible markings.
- **Pit Out Line** - The line at the end of Pit Lane that indicates cars are leaving Pit Lane and are returning to the racing surface.
- **Race Control** – The race director and the corresponding staff overseeing the race.
- **Red Flag** - Signifies a suspended practice, qualifying, or race session.
- **Safety Buffer** - Area between the Pit Boxes and the Driving Lane along with between the Driving Lane and outside pit wall where no vehicle should be in.
- **Safety Crew** - Track personnel that are responsible for recovery of the Vehicle.
- **Series Staff** - This is any member from ESN or Juncos working to facilitate the Indy Autonomous Challenge competition. Series staff also includes members of race control.
- **Team** - A single group responsible for a vehicle and the operation of that vehicle.
● **The Vehicle** - Refers to the Dallara AV-21. This is the official vehicle designated to be used for the Indy Autonomous Challenge.

● **Yellow Flag** - Signifies that speed should be reduced and cars should be prepared to avoid obstacles or come to a stop.