AutoDrive Challenge™

Year 4

AutoDrive Challenge™

Contents

Article A1: AutoDrive Challenge Overview and Objectives

SAE International (SAE) and General Motors (GM) have partnered on a new collegiate design competition, AutoDrive Challenge™. This newly established autonomous vehicle competition series will be a four-year competition to develop and demonstrate an autonomous driving passenger vehicle. The technical goal of the competition is to navigate an urban driving course in an automated driving mode as described by SAE Standard (J3016) level 4 definition by year four.

AutoDrive Challenge™ will have collegiate students focus on autonomous mobility technologies and allow for modification and improvement throughout the four-year competition. The focus will be on real-world applications of sensing technologies, computing platforms, software design and implementation, and advanced computation methods such as: image processing, pattern recognition, machine learning, artificial intelligence, sensor fusion, and autonomous vehicle controls.

Joining the already very successful SAE Collegiate Design Series, AutoDrive Challenge™ will provide another hands-on engineering opportunity for collegiate students to demonstrate a wide range of challenging opportunities in the rapidly expanding field of engineering systems for automated driving.

Year 4 is the last year of this inaugural series of the AutoDrive Challenge™ competition and will challenge the teams to show what the previous 3 years of development and learning has produced. The teams will face 2 Dynamic Challenges in this last year. One will be a culminating drive linking together all the elements and features experienced in the previous 3 years. The second will be SAE Standard (J3016) Level 4 proof of concept demonstration drive. Additionally, teams will be required to generate reports, presentations, and perform simulations to highlight their work and communicate what they have learned.

Article A2: Official Competition Announcements & Information

All teams must be familiar with all official announcements concerning the competitions and rule interpretations released by the AutoDrive Challenge™ Rules Committee.

AutoDrive Challenge™ information and announcements will be provided to students in all the below forms of media:

- Emails and newsletters to registered team members through the team profile page http://students.sae.org/cds/autodrive/event/registration/
- Rules updates published online at http://www.autodrivechallenge.com
- NewsFeed on www.Autodrivechallenge.com
- AutoDrive Challenge™ App

Article A3: Competition Judging

CJ.3.1 Good Engineering Practices

Vehicles entered in the AutoDrive Challenge™ competition are expected to be designed and built in accordance with good engineering practices and adherence to the AutoDrive Challenge™ official rules set.

CJ.3.2 Judging Categories

The teams will be judged in a number of static and dynamic vehicle events and reports. Scoring opportunities in technical areas will include; Functional Safety analysis, Engineering Design

Concept, Social Responsibility, MathWorks Simulation Challenge, and two dynamic driving challenges. The static events will be scored on appropriate formatting, accurate technological submissions, and adherence to report guidelines. The dynamic events will be scored based on the vehicles' performance as related to the events objectives. Specific judging criteria for all events within the competition will be laid out in this official rule document.

CJ.3.4 Points Breakdown

Year 4 will have 1,000 points possible and each team will start at 0 points. No points will carry over from the first three years of the competition. Each team will start at 0 points for Year 4.

The below chart summarizes the points breakdown for Year 4:

Events	Possible Points
Static Events:	**300**
Social Responsibility Report	50
Social Responsibility Event	50
Concept Design Report	100
Concept Design Event	100
Functional Safety	**50**
MathWorks Simulation Challenge	**50**
Level 4 Dynamic Challenge	**200**
99% Buy Off Ride (BOR) Drive	**400**
Total	**1,000**

CJ.3.5 Competition Awards

AutoDrive Challenge™ will present awards to the top 3 teams in each judging category of the event, and to the top 3 cumulative scoring teams for Year 4. Placing teams will receive trophies, and monetary awards.

Article A4: Official Competition Language

The official language of the AutoDrive Challenge™ Series is English. Document submissions, Rules Questions, presentations and discussions must be in English.

Article A5: Rules of Conduct

AutoDrive Challenge™ is a technology specific autonomous engineering competition that requires performance demonstration of vehicles and autonomous technology integration. Team members and Faculty Advisors will be held to the highest standard of conduct and must abide by their University's own code of conduct extending that to this competition. It is recognized that this event is an engineering educational experience. In the heat of competition, emotions peak and disputes arise. Our officials are trained volunteers and maximum human effort will be made to settle problems in a reasonable, timely, and professional manner.

RC.5.1 Unsportsmanlike Conduct

In the event of unsportsmanlike conduct, the team will receive a written warning from an official. A second violation will result in expulsion of the team from the competition.

RC.5.2 Official Instructions

Failure of a team member to follow an instruction or command directed specifically to that team or team member will result in a twenty-five (25) point penalty.

RC.5.3 Arguments with Officials

Argument with, or disobedience to, any official may result in the team being eliminated from the competition. All members of the team may be immediately escorted from the grounds.

RC.5.4 Problem Resolution

Any problems that arise during the competition will be resolved through the Organizing Committee and the decision will be final.

RC.5.5 Onsite Meetings – Attendance Required

All team members for an event are required to attend the pre-event meeting(s).

RC.5.6 Alcohol and Illegal Material

Alcohol, illegal drugs, weapons or other illegal material are prohibited on the event site during the competition. This rule will be in effect during the entire competition. Any violation of this rule by a team member will cause the expulsion of the entire team. This applies to both team members and faculty advisors. Any use of drugs, or the use of alcohol by an underage individual, will be reported to the local authorities.

RC.5.7 Parties

It is expected that no disruptive parties will be held during competition events or workshops and will be prevented by the Faculty Advisor.

RC.5.8 Trash Clean-up

Cleanup of trash and debris is the responsibility of the teams. The team's work area should be kept uncluttered. At the end of the day, each team must clean all debris from their area and help with maintaining an overall clean event site

Article A6: AutoDrive Challenge Organizing Committee Authority

The AutoDrive Challenge™ Rules are the responsibility of and owned solely by the Organizing Committee and are issued under the authority of SAE International and General Motors Company. Official announcements from the Organizing Committee, Rules Committee, SAE International and General Motors Company shall be considered part of, and shall have the same validity as this rule set. Ambiguities or questions concerning the meaning or intent of these rules will be resolved by the Organizing Committee, SAE International and General Motors Company as appropriate.

OC.6.1 Rules Compliance

- By accepting entrance into the AutoDrive Challenge™ Competition, the team, members of the team as individuals, faculty advisors and other personnel of the entering university agree to comply with, and be bound by, this rule set and all rule interpretations or procedures issued or announced by the Organizing Committee, Rules Committee, SAE International and General Motors.

- Any rules or regulations pertaining to the use of the competition site by teams or individuals and which are posted, announced and/or otherwise publicly available are incorporated into the AutoDrive Challenge™ Rules Set by reference. As examples, all event site waiver requirements, speed limits, parking and facility use rules apply to participants.

- All team members, faculty advisors and other university representatives are required to cooperate with, and follow all instructions from, competition organizers, officials and judges.

- The AutoDrive Challenge™ Rules are to be treated as intellectual property and NOT to be distributed, posted, or made public to anyone not using them for official competition use.

OC.6.2 Understanding the Rules

Teams, team members as individuals and faculty advisors, are responsible for reading and understanding the rules in effect for the competition.

OC.6.3 Participating in the Competition

Teams, team members as individuals, faculty advisors and other representatives of a registered university who are present on-site at a competition are "participating in the competition" from the time they arrive at the event site until they depart the site at the conclusion of the competition.

OC.6.4 Violations on Intent

The violation of intent of a rule will be considered a violation of the rule itself and teams will be penalized accordingly. Questions about the intent or meaning of a rule may be addressed to the Rules Committee through formal channels.

OC.6.5 Restriction on Vehicle Use

Teams are cautioned that the vehicles designed and modified in compliance with these AutoDrive Challenge™ Rules are intended for competition operation only.

These vehicles are ONLY permitted on public roadways or highways under the following conditions;

- If the team individually works with their State Department of Motor Vehicles on obtaining a Title for the vehicle
- Obtaining the proper insurance required by their state and university
- Only driving in manual mode after obtaining DVUL MM approval as later described in this rules document.

The vehicle will not act as transportation for the team. This is an experimental student vehicle that is only to be operated under strict supervision.

OC.6.6 General Authority

The Organizing Committee, General Motors, and SAE International reserve the right to revise the schedule of any competition and/or interpret or modify the competition rules at any time and in any manner, that is, in their sole judgment, required for the efficient operation of the event AutoDrive Challenge™.

Article A7: Graduate Assistant Funding

AutoDrive Challenge™ teams will be sent funding to the University for the project in September 2020 for Year 4.

Article A8: Travel Allowances & Vehicle Shipping to Event(s)

8.1 Travel Allowance(s)

AutoDrive Challenge™ Teams will be given a travel allowance for competitions over the course of the four-year cycle. These amounts will be determined by the Organizing Committee based on location of the workshop and/or event. These funds are to be used for lodging (hotels), meals, and transportation cost of team members only. Teams will be notified at least two months prior to travel on their allotted amount.

For workshops the Organizing Committee will reimburse student members and faculty for their travel within a reasonable budget for the location.

8.2 Vehicle Shipping

AutoDrive Challenge™ Teams will also be aided in shipping their competition vehicle. The Organizing Committee will provide shipping from the university to the competition and back to the university once the event has ended. The Organizing Committee will advise on the shipper being used, schedule, and procedure(s).

Teams are asked to designate one team member as the point of contact for all shipping items. Any team planning to ship their own vehicle must cover their own travel costs.

Article A9 University Continued Commitment

AutoDrive Challenge™ Teams must submit a formal letter of support signed by an academic administrator each year of the competition. The signer can be your dean or other high-level academic administrator. They must include their title in the letter's signature line. They must acknowledge that they are agreeing to meet the commitment from the university to the team/faculty advisor/project in the following areas:

1. Acknowledgement of continued commitment for the full three-year competition.
2. Ability to sign Nondisclosure Agreements and necessary Legal Support to review and approve any necessary competition documentation.
3. Ability to provide funds above what GM and SAE International have designated for the AutoDrive Challenge™ (i.e. additional funding for the full time GRA above the donated funds if necessary).

Letters must be signed and submitted by **November 1, 2020.**

Article A10: Withdrawal or Expulsion of Team

10.1 Withdrawal

Accepted AutoDrive Challenge™ Teams who withdraw from the competition must submit in writing a formal letter to the Organizing Committee detailing their decision and must provide signatures from both an academic administrator and the official team faculty advisor.

Withdrawals are final, teams will NOT be permitted to re-enter in any other year. The letter must state that the team wishes to formally withdraw from AutoDrive Challenge™ and the reason(s) for the decision.

Teams that withdraw, must return any unused portion of the startup funding and graduate assistant funding as soon as possible after the withdrawal letter is accepted by the Organizing Committee and formally expelled from the competition. The competition vehicle must be returned or destroyed as directed by General Motors Asset Recovery policies. All component parts and subsequent information received by the team for the AutoDrive Challenge™ competition must also be returned.

10.2 Expulsion of Team from Competition

All teams accepted into the AutoDrive Challenge™ will be held to minimum standards of performance over the three-year competition cycle to maintain their position as accepted into the competition. Teams who do not meet the following requirements may be expelled from the competition:

1. Missing deadlines of written or technical document submissions.
2. Documents are not well presented grammatically or in formatting, or technically accurate displaying sound engineering practices.
3. Failure of teams/universities to be present at key competition events including workshops or the onsite event.
4. Failure of teams to attend onsite technical inspection or any presentations.
5. Failure of teams to comply with their mentor's onsite visit.

The Organizing Committee will provide the team with one written warning and the team will provide a performance plan (in the time specified in the written warning), working with their mentor to increase their level of performance. Failure to acknowledge and comply with this warning will result in immediate expulsion. After such a time as the team has complied with the recommendations they will be returned to non-probationary status. Probationary periods will be determined by the Organizing Committee and will accompany their recommendations.

Teams that are expelled must return any unused portion of the startup funding and graduate assistant funding as soon as possible after the formal expulsion letter is sent by the Organizing Committee and formally expelled from the competition. The competition vehicle must be returned or destroyed as directed by General Motors Asset Recovery policies. All component parts and subsequent information received by the team for the AutoDrive Challenge™ competition must also be returned.

Article A11: Intellectual Property Creation by Student(s) & University Teams

Intellectual Property created by the students and/or the university team will be initially owned by the student and/or team who thought of the concept or idea that is the subject of the intellectual property. General Motors Company and SAE International as the leading partners in the AutoDrive Challenge™ will be permitted access to its usage as it was created during the competition. Any intellectual property created that violates any sponsor or competition non-disclosure agreement cannot be published or presented without written consent of the party owning the intellectual property or copyrighted material and their written legal approval.

All participants will (as per the Non-Disclosure Agreement) agree that ownership of any intellectual property generated by a Participant who is a student and developed during work on the Project is owned by the student and further agree that GM and its affiliates have the right to make, have made, or otherwise use that intellectual property in GM's business activities.

Article A12: Publishing

Students and/or university teams are permitted to publish materials that they have developed or researched throughout the AutoDrive Challenge™. Any material that is used in the published work and has/refers to any sponsor companies copyrighted material, or intellectual property must be approved by the company from which it was from. Please use the Publication Request Form on www.autodrivechallenge.com .

Participants are encouraged to read: "How to Write an SAE International Technical Paper" - http://volunteers.sae.org/authors/sae_tech_paper.pdf. Page 4 will help in citing references.

Article A13: Sponsorship and Donated Products

AutoDrive Challenge™ will have Official Supplier Partners and Integrated Suppliers that will donate to the competition with technical support and products. As these sponsors are confirmed we will communicate the specifics of their donations, support, how to contact them, and the delivery/disposal/return of products/services. We will publish this information on both the http://www.autodrivechallenge.com site and https://www.sae.org/attend/student-events/autodrive-challenge/sponsor?tab=2 and in the student newsletters.

Article A14: Mcity Facility Rental

Our Year 4 Event will be held at Mcity Testing Facility in Ann Arbor, Michigan. We realize this is a public facility and available for testing rental, however, being that this is a competition we do ask that your team DOES NOT reserve the facility for testing beginning August 30, 2020 until July 1, 2021 out of respect for all teams and keeping with the spirit of the competition. If your team has any questions, please submit them on the www.autodrivechallenge.com website.

Participant Requirements & Registration

Article B1 : Participant Online Registration

AutoDrive Challenge™ teams selected by the Organizing Committee based upon submitted proposal acceptance will be listed on the Registered Teams List and students can then access their online team profile page on the sae.org website.

Article B2: Individual Team Member Requirements

TMR.2.1 Eligibility Limits

Eligibility is limited to undergraduate and graduate students to ensure that this is a collegiate engineering design competition.

TMR.2.2 Student Status

Team members must be enrolled as degree seeking undergraduate or graduate student(s) in the college or university of the team with which they are participating. Teams cannot be formed with members from two or more Universities.

TMR.2.3 Society Membership

Team members must be members of SAE International. Students can join SAE online at: www.sae.org/students Students will need to select the “Student Membership” link and then follow the series of the questions that are asked. Faculty that wish to be SAE members should choose the “Professional Membership” link and proceed to the series of questions.

Please note all student participants must be SAE International members to participate in the event. It is not mandatory for faculty to join but they must be on the team list on sae.org.

TMR.2.4 Age

Team members must be at least eighteen (18) years of age, at the time of participation on the competition team.

TMR.2.5 Driver's License

Team members who will be a safety driver in the competition vehicle at any time during a competition must hold a valid, government issued driver's license and will be asked to present it onsite at Technical Inspection.

TMR.2.6 Liability Waiver

All on-site participants, including students, faculty and volunteers, are required to sign a liability waiver upon registering onsite.

TMR.2.7 Medical Insurance

Individual medical insurance coverage is required and is the sole responsibility of the participant.

TMR.2.8 Online registration

Every participant, including advisors must affiliate themselves and complete the following information on under the team's registration page on the SAE website http://students.sae.org/cds/autodrive/event/registration/

- Emergency contact data (point of contact (parent/guardian, spouse), relationship, and phone number)
- Participants (your) cell phone number
- Shirt size
- Dietary restrictions
- Accessibility Needs
- Medical Conditions
- Country of Citizenship

TMR.2.9 Onsite Registration Requirement

Onsite registration will be required of all team members, graduate assistants, and faculty advisors. Official registration procedures will be addressed in the student handbook and on the website for teams. This information will be published by February 1, 2019.

Article B3: Faculty Advisor Requirements

Each team is expected to have a dedicated AutoDrive Challenge™ Faculty Advisor appointed by the university. The Faculty Advisor is expected to accompany the team to the competition as well as all appropriate workshops and trainings and will be considered by competition officials to be the official university representative.

1. Faculty Advisor(s) may advise their teams on general engineering and engineering project management theory.

2. Faculty Advisor(s) may not design any part of the vehicle including any part of the autonomous computing/driving system(s) nor directly participate in the development of any documentation or presentation.

3. Additionally, Faculty Advisor(s) may not fabricate nor assemble any components nor assist in the preparation, maintenance, testing or operation of the vehicle.

In Brief – Faculty Advisor(s) may not design (including software and calibration), build or repair any part of the car, including any part of the autonomous computing/driving system(s).

Article B4: SAE Technical Standards Access for Participants

A cooperative program of SAE International's Education Board and Technical Standards Board is making some of SAE International's Technical Standards available to teams registered for any North American Collegiate Design Series (CDS) competition at no cost. The Technical Standards referenced in the CDS rules, along with other standards with reference value, will be accessible online to registered teams, team members and faculty advisors.

To access the standards:

- 1-your team must be registered for AutoDrive Challenge™
- 2-the individual team member or faculty advisor wanting access must be affiliated to the team on SAE International's website (www.sae.org).

In 2016, the SAE Digital Library became SAE Mobilus.

- Navigate to your profile.
- Click on your Team Name.
- Click the SAE Mobilus link.

Search standards either by J-number assigned or topic of interest such as brake light. A list of accessible SAE Technical Standards can be found in Appendix.

Article B5: Non-Disclosure Agreements

NDA.5.1 General Motors Non-Disclosure Agreements

All AutoDrive Challenge™ Team Members, Team Captains, Graduate Assistants and Faculty Advisors will be required to sign non-disclosure agreements due to the sensitive nature of intellectual property that is given to teams with the donated GM Chevrolet Bolt EV. As more team members are added they will not be considered official members of the team until they upload their signed NDA onto http://www.autodrivechallenge.com

NDA.5.2 Sponsors Non-Disclosure Agreements

All AutoDrive Challenge™ Team Members, Team Captains, Graduate Assistants and Faculty Advisors will be required to sign non-disclosure agreements due to the sensitive nature of intellectual property that is given to teams with the donated components and parts from sponsors. As more team members are added they will not be considered official members of the team until they upload their signed NDA onto http://www.autodrivechallenge.com. As more sponsors are determined each sponsor may ask for a NDA for their product donation and participation in AutoDrive Challenge™

Article B6: Vehicle Donation

VDA.6.1 Vehicle Donation Documentation Package

In addition to receiving the donated Chevrolet Bolt EV university teams will also receive a complete document package related to sub systems of the vehicle as well as component sponsored parts.

Through the http://www.autodrivechallenge.com General Motors will provide materials relevant to team's participation for AutoDrive Challenge™ with the understanding that

these are to be used for the competition only. Given that this is intellectual property downloads will be limited to team members, faculty advisors, graduate assistant, and team captains. As per the NDA signed by each member in these categories you are not permitted to distribute this information for any other use than AutoDrive Challenge™.

Teams will receive the following components in their package:

1. CAD drawings of exterior vehicle surfaces
2. Electrical and wiring schematics
3. Vehicle physical and miscellaneous properties (mass, center of gravity, tire stiffness etc.)
4. DBC Files containing necessary Tx/Rx messages to interact with steering, braking, acceleration, and shifting modules.
5. An instructional guide to interfacing with vehicle serial data:
   a. Higher level data flow diagrams
   b. Low level specifics on using the individual data signals

VDA.6.2 Chevrolet EV Bolt - *https://my.chevrolet.com/learn/2017/Bolt%20EV*

1. Owner's Manual
2. MyLink Infotainment System Guide
3. Maintenance Schedule
4. Get To Know Guide

VDA.6.3 Vehicle Decals and Team Identification

VDA6.3.1 Official Competition Vehicle Design

The competition logo decal will be provided by the organizers to teams for use. SAE will also provide decals with the team's University Name and Team Vehicle Number with location of where to place. Rules and procedure regarding this item can be found on the www.autodrivechallenge.com website under the SAE section of Series Resources.

VDA6.3.2 Competition Sponsor Decals

Teams must reserve space on the vehicle for all AutoDrive Challenge ™ sponsor logos, these logos will be given to teams as sponsors are confirmed throughout the year. Teams may also place their individual team sponsors logos once the competition sponsor logos have been placed. Local sponsor logos are limited to the hatchback area of the vehicle and my not be larger than 5" x 7".

No logos can be placed over windows, mirrors, or anywhere to obstruct vision of the Safety Driver.

NOTE: No team sponsors should be a direct competitor of General Motors or SAE International. Teams must receive approval from SAE prior to placing any decal on the vehicle. No decals can be considered offensive. An approval form can be downloaded on www.autodrivechallenge.com in your Series Resources.

Article B7: Securing Computers, Instrumentation & Equipment to the Vehicle

SIE.7.1 Securing Items in Vehicle

All Instruments, computers and equipment must be secured so that they do not shift if/when the vehicle makes a sudden stop or aggressive maneuver.

SIE.7.2 Vehicle Instrumentation Safety Procedure

Teams will follow the "Vehicle Instrumentation Safety Procedure" (which can be downloaded at: www.autodrivechallenge.com) which defines how instruments, computers and other equipment must be placed and secured prior to and during vehicle operation.

SIE.7.3 Requirements

Securing of computers, instrumentation and equipment is required during all vehicle operation, including but not limited to official AutoDrive Challenge™ events.

Article B8: General Motors Mentor Assignment

GMM.8.1 Assignment

General Motors will provide an experienced engineer to each team to mentor and guide them through the three-year competition. Mentors will also serve as a liaison to teams on behalf of GM.

Mentors will provide progress reports to the competition organizers. Participating universities will receive additional mentoring support from competition sponsors to help the teams use the donated components, software, and other products through workshops.

GMM.8.2 Mentor Roles

Team mentors are to guide teams through the three-year competition but are not a member of the team. Their role is to:

1. Act as a sounding board for teams as they define their concept selection and help the team arrive at sound engineering practice decisions as they navigate the learning process for this new technology and integration keeping them within the scope of the competition and helping the students learn by trial and error.
2. Provide constructive educational feedback on technical reports.
3. Educate and enforce safety practices with the GM donated vehicle.
4. Be familiar with the official competition rules and event operations to help guide the teams in becoming compliant with both.
5. Advocate proper storage, use, and management of GM intellectual property information amongst teams.
6. Communicate with teams bi-weekly (twice a month) to make sure they are on track with the competition timeline, either onsite at their university or a conference/video call.

NOTE: Mentors will not assist in the hands-on integration of systems, writing of official documentation including the team's concept and design presentations, nor will they be allowed to participate as a team member in the onsite team presentations.

GMM.7.2 Reporting

Mentors will document and report their teams' status to the competition organizers following each team interaction.

Rules/Technical Questions & Document Submission(s) Procedures

Article C1: Account Signup for Online Submission(s)

RQ.1.1 Account Creation

Account creation for online document submission through http://www.autodrivechallenge.com requires the following steps:

1. Visit http://www.autodrivechallenge.com
2. Follow the account signup instructions on the website. Select "Your Affiliation" as either "Faculty Advisor" or "Team Captain/Team Member"
3. Faculty Advisor ONLY: Will use the SAE "authentication number" for AutoDrive Challenge™ signup. This is the SAE confirmation number that was issued when your team registered on the sae.org website.

   NOTE - There may be a delay of up to three (3) business days between the time your team registers for a competition and the AutoDrive Challenge™ site recognizes the validity of your authentication number and the faculty advisor may create an account. Once your faculty advisor has created an account it will remain valid for the full three years.

RQ.1.2 Faculty Advisor Role

Each team must have at least one person identified on AutoDrive Challenge™ as the Faculty Advisor. The Advisor has unique responsibilities on the site including accepting other team members for site access. Until the faculty accepts a member's signup that person cannot upload or view team documents. Faculty Advisors automatically have the same roles and privileges as their team members.

RQ.1.3 Team Member Restrictions

Team members must be approved by the Faculty Advisor before being able to view or upload team documents. Once a team member leaves the team or graduates they **MUST** be removed immediately by the Faculty Advisor removing their access to any competition materials/documents etc.

RQ.1.4 Uploading Documents

All team members and the team captain have equal authority to upload and/or replace documents in the name of the team.

RQ.1.5 Document Access

Team uploaded documents can only be viewed by

1. Members of the submitting team,
2. Authorized judges, technical inspectors and officials
3. Organizing Committee Members

Reminder – The website does not know what you intended to submit or what you thought you were doing. Anything your team uploads to the site is an official action by your team.

NOTE – All Non-Disclosure Agreements need to be uploaded and approved before team members have access to documents. All team members need to be affiliated on the AutoDrive Challenge™ website as the Non-Disclosure Agreements will be present on that site.

Article C2: Official Question & Answer Process

All AutoDrive Challenge™ rules or technology (sponsoring company) questions will be asked through the official website http://www.autodrivechallenge.com .

QA.2.1 How to Submit Rules-Related Questions

1. **Create an AutoDrive Challenge™ account**
   This same account is used for submitting competition reports and documents, submitting rules questions, etc.

2. **Affiliate to your Team/University**
   Not everyone who has an AutoDrive Challenge™ account is a member of a student team. If you are, be sure to affiliate your account with the correct School and Team at that school so that you can use the Team Member parts of the AutoDrive Challenge™ system.

3. **Login and go to "Ask a Rules Question" under the Team Member menu**
   Choose “submit a new rules question”. Also, available on this menu is "My Team's Rules Questions", where you can view all the questions your team has asked, and the answers given for those questions. You will also be able to add more information / attachments, respond to questions back from the Rules Reps, and browse published Rules FAQs.

QA.2.2 Response Time

Please allow a minimum of two (2) weeks for a response. The Rules Committee will respond as quickly as possible, however responses to questions presenting new issues, or of unusual complexity, may take more than two weeks. Please do not resend questions.

Teams should check the FAQs before posting a question. The Committee will answer questions that are not already answered in the rules or FAQs or that require new or novel rule interpretations. The Committee will not respond to questions that are already answered in the rules.

Article C3: Document Submission(s) & Deadlines

DS.3.1 Required Documents and Required Forms

The following documents must be submitted by the action deadlines posted on the competition website or otherwise published by the organizers.

All forms are located at http://www.autodrivechallenge.com

DS.3.2 Deadlines

Volunteer judges evaluate all the required submissions and it is essential that they have enough time to complete their work. There are no exceptions to the document submission deadlines and late submissions will incur penalties. Please note that different documents or submissions have different deadlines.

Carefully read the event rules and check the website of the competition. Teams will **not** be notified if a document is submitted incorrectly. Each team is responsible for confirming that its documents have been properly uploaded and that the deadlines have been met. Email confirmations to teams are **not** sent.

Document	Deadline
Non-Disclosure Agreements from ALL TEAM MEMBERS; FACULTY ADVISORS; GRA	Due as new team members are added available on www.autodrivechallenge.com
Concept Design 3 Failure Topics Submission	January 31, 2021
Roof Rack Antenna Mounting Form	February 13, 2021
AutoDrive Challenge™ Team Photo Submission	April 1, 2021
AutoDrive Challenge™ Team Profile Information	April 1, 2021
Social Responsibility Report	May 13, 2021
Concept Design Report	May 6, 2021
Final Team Roster/Fast Track Roster	May 25, 2021
Year 4 System Safety Updates	June 1, 2021
Autonomous Vehicle Safety Assessment Final Version	June 1, 2021

Article C4: Competition Document Penalties

DP.4.1 Late Submission Penalties

Documents or submissions that are uploaded after the deadline, or are submitted largely incomplete within the deadline, will receive a point penalty per day, based on the time difference between the deadline and the actual date and time of receipt or upload, subject to official discretion.

The applicable point penalties are shown below.

Document	Deadline	Penalties
Social Responsibility Report	May 13, 2021	-5 points per day
Concept Design Report	May 6, 2021	-5 points per day

Article 1: Concept Design Report Year 4

CDR.1.1 Concept Design Report Objective

The concept of the design report is to evaluate the engineering effort that went into the design of the vehicle and how the engineering meets the intent of the autonomous market both in terms of vehicle performance and overall value. The intended audience for the report and presentation are professional engineers from the AutoDrive Challenge™ sponsor companies.

Teams will be required to submit a written concept design report before each year's competition and participate in an oral presentation at each year's competition (see Article 2 for presentation details). The format of the concept design report and review was the same, with growing complexity, for Years 1 and 2. For Year 3, each team focused on specific concepts – 3 chosen for them and 2 Team's Choice – in order to highlight the innovativeness and uniqueness of each team's designs.

For year 4, the focus is on achieving SAE Level 4 of Driving Automation. The Concept Design Report will cover how your team has achieved this through the 4 years of competition, including how the design has changed year over year.

Level 4 is defined as the vehicle driving autonomously without human intervention needed. The caveat is that the vehicle can only operate under limited conditions.

- What are these limited conditions for your competition vehicle?
- Can it only operate when the weather is ideal?
- Only in a geo-fenced area?
- What sensors, communication, etc are needed for the vehicle to operate autonomously?
- Can your vehicle still operate if a sensor is not functioning as expected or if communication is lost?
- To coincide with a challenge in Year 4, the report will also detail how your team's vehicle reacts to loss of GPS.

To better understand the failure analysis performed on the vehicle to achieve Level 4, each team will choose three (3) of their top failure modes (chosen via DFMEA or another method of the Team's choosing) and discuss in detail how the vehicle reacts under that scenario. For example, loss of a forward-facing camera may be a serious failure for your vehicle, and it will immediately exit autonomous mode and perform emergency braking.

Submit your three failure topics by January 31st, 2021 to receive approval from the rules committee. Teams are welcome to submit their topics for approval earlier. Approval is to ensure your team has chosen topics which align with the intent of the report.

CDR.1.2 Concept Design Report Contents

The judges will evaluate the Concept Design Report based on the Design Judging Score Sheet found at http://www.autodrivechallenge.com.

1. Abstract
2. Introduction
    a. Introduce your vehicle and what has changed between all four years of the competition. Why is your vehicle the most prepared for Year 4 than in all previous years?
3. Loss of GPS
    a. If your vehicle loses its GPS, how will it react to keep SAE J3016 Level 4? Describe in detail how your system detects the loss, and the fall back strategy when GPS is not present, and how this aligns with the SAE J3016 Level 4 safety strategy.
    b. Include helpful test results and figures to support the discussion
4. Failure Modes
    a. Year 4 your vehicle was expected to be a SAE J3016 Level 2 except for your loss of GPS of your vehicle which must be at SAE J3016 Level 4. This Failure Mode Analysis will cover planned hypothetical Level 4 of the entire vehicle system but is not required to be implemented in Year 4 in the vehicle.
    b. A failure mode is the way in which something might fail – in this case – ways your Autonomous Vehicle will cease to fully function. First determine what the failure modes are in your vehicle and which 3 are the most severe. The failure modes may be determined by FMEA – Failure Mode Effect Analysis – or by another method the team deems appropriate.
    c. For the top 3 failure modes, explain why each received that rating, and walk through how the vehicle reacts to accommodate these failures. Include design aspects of your vehicle if that is helpful in explaining the failures effect on your system.
5. SAE Level 4 Conditions
    a. Per SAE's J3016 "Levels of Driving Automation", there are 6 Levels of Automation (0 through 5). Year 4 focuses on achieving Level 4, which is defined as the vehicle being capable of performing all driving functions under certain conditions. If your vehicle were to be Level 4, explain what these certain conditions are for your vehicle – weather, location, speed limitations, etc.
6. Patents, Papers and Conferences
    a. List of all patents, papers and conferences written and attended by the Team throughout all 4 years of the competition
7. Conclusion
8. References

CDR.1.3 Concept Design Report Format

The Concept Design Report must not exceed twenty-five (25) pages:

- 10 Pages for Introduction, Year 1 to Year 4 vehicle design changes, conclusion, Patent/Papers/Conferences and references
- 10 Pages for Failure Modes
- 5 Pages for SAE Level 4 Conditions

All Concept Design Reports should be put into SAE Technical Paper Formatting. See website for format. In the event of conflicting requirements, this Concept Design Report

Article supersedes the SAE Technical Paper Formatting (for example, total report length).

Article 2: Concept Design Event Year 4

The onsite concept design event for Year 4 will be an opportunity for all teams to present and learn from each other's experiences across the 4 years of the AutoDrive Challenge™. The presentations will take place on the last day of the competition so that each team may reflect on their performance of the final year. Each team will be presenting to judges and teams.

Judges will make up 60% of the overall score.

New for Year 4 -Team crowd sourced judging, will make up the remaining 40% of the score.

Presentations are to be **submitted 1 week prior** to the competition. The performance of the vehicle during the Year 4 competition should the only outstanding, highlighted presentation item (this can be verbally presented without a slide update).

For the presentations:

- Each team will discuss the design of their vehicle
- How the design progressed over the 4 years of competition,
- The team's strategy for winning the competition.

For design:

- Include details on sensors used, placement, software strategy, perception, mapping and planning, and user interaction.
- Why is this design that the team has now for year 4 the best of all 4 years?
- How has the design changed over these 4 years and what did the team struggle with?

For strategy:

- Discuss the tips and tricks your team used to gain as many points as possible given the constraints of the competition. For example, during a dynamic challenge including stop lights, the team may have focused on the route planning and making it to the finish knowing that they could not comprehend the stop lights.

CDE.2.1 Judging Criteria

Judges scores will account for 60% of a team's score. The other 40% of the score will be from the other 7 teams.

Team's will be graded not only on the content of the presentation but also on the quality of the content's delivery.

Judges scores will be averaged for a final score. Scoring by the other teams will be done based on a ranking system. Each team will rank the other school's presentations 1 through 7 (with 1 being the highest rank) and these rankings will be averaged from all teams and points assigned.

CDE.2.2 Score Sheet

The Design Judging Score Sheets are available at http://www.autodrivechallenge.com.

The organizing committee strongly urges all teams to read and study the score sheets and all other documents related to design judging that are available on the website.

CDE.2.3 Support Material

Teams are encouraged to bring with them to the Concept Design Event any of the following:

- Photographs
- Drawings
- Plans
- Data collections
- Computer results
- Charts
- Example components
- Other materials that they believe are needed to support the presentation of the vehicle and the discussion of their innovative concept
- Marketing materials

A projector/screen will be available to be used in an auditorium setting by all teams during their presentations. A projector will be provided for use, we can specify the type in the student handbook. Standard 120 V power outlets are also available. The vehicle will NOT be required at the presentation for Concept Design in Year 4.

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CDE.2.4 Judging Procedures - Onsite

- Teams will have up to 20 Minutes to present, following by a 10-minute Q/A which will be facilitated by the Design Event Lead.
- Questions for the Q/A section may be submitted by other teams or by judges. The Design Event Lead will choose the questions to ask based on the questions submitted.
- The presentation itself will not be interrupted by questions.
- Teams can select up to 6 student members (maximum of 2 graduate students and maximum of 2 undergraduate seniors) of the team to present
- Undergraduate students must give at least fifty percent of the presentation.
- Faculty and the GM Mentor are not permitted to present during the design event or answer questions for the team.
- There will be up to 10 judges grading each presentation. These judges will be volunteers from sponsor companies and be from various backgrounds in the Autonomous Vehicle industry.

CDE 2.6 Judging Process

Competition judges will observe and score the quality of student teams' responses to the challenge (paper and presentation). Judges will evaluate the performance of the participants per the standards and criteria provided. All decisions by judges are final and not subject to critique, challenge or reconsideration under any circumstances. Participants are not allowed to approach judges to solicit feedback or comments outside of what is provided by the competition process under any circumstances. Violation of this rule could result in being disqualified from the competition. A judge may abstain from

input or voting on a team or otherwise disqualify himself or herself if he or she feels his or her participation in the round of competition reflects a conflict of interest due to prior relationship (e.g., employment, academic, familial) with individual team's members or if participation will create an appearance of impropriety.

Article D3: Social Responsibility Report Year 4

SAE's vision: "SAE is the leader in connecting and educating mobility professionals to enable safe, clean and accessible mobility solutions" (SAE Website) and through engagement with industrial, technological, and societal leaders continues to champion efforts to bridge the existing gap for academia. Through our consistency with working toward mobility solutions, SAE's reputation of creating operational and safety standards ensure its vision is safeguarded.

Year 4 AutoDrive Challenge™ Social Responsibility is asking teams to help SAE bridge the academia gap in a partnership with the Office of Disability and Employment (ODEP) and write a 10-15-page white paper for application of their standard from Year 3, that focused on a topic in autonomous mobility that includes accessibility. Teams are tasked to present a white paper to standardize their best practice autonomous vehicle design that provides a safe and operationally user-friendly environment for the general public which includes disabled citizens.

SRR.1.1 White Paper Outline

AutoDrive Challenge™ Teams will apply their 2020 Year 3 Standard into a White Paper study of application for implementation into autonomous mobility. The paper should include the following sections:

A. **Project Description** – Provide a statement describing the specific product/technology proposed including its capabilities, using clear and concise terms. Include information on how this effort will fulfill accessibility needs.
B. **Approach** – Provide a description of the planned approach in achieving stated objective(s).
C. **Benefits to the Public** – Provide information of description capabilities, results, and differences offered by this technology as an operator/daily user.
D. **Funding/Cost**: Total estimated cost of the proposed implementation to a vehicle and or infrastructure.
E. **Program Plan**:
    a. Period of Performance: include technical reporting schedule
    b. Schedule: include description and milestones for major activities/efforts for technology/product development.
    c. Deliverables: Describe deliverables anticipated for the entire effort, including hardware, software prototypes if applicable. Include any technical data or computer software.
    d. Metrics/Measures of Success: describe criteria to measure progress vs. stated goals (i.e. interoperability against industry standard currently)
    e. Equipment: describe equipment necessary to accomplish proposed efforts.
    f. Risk: briefly describe anticipated risks and mitigation plan of implementation.
F. **Proposed Transition Plan**: include any restrictions on use, release, disclosure of technical data, component, or computer software presenting transition difficulty or increased risk/cost to consumer or manufacturing facilities to implement the design modification.

G. **Technology Readiness Level** (TRL): Determine your proposed solutions TRL Level and justify the rating based on results using data collection/simulation/prototype renderings.

SRR.1.2 White Paper Requirements

- White Paper will be no more than 10 pages of written text.
- Up to 5 pages can contain: drawings, data analysis, or other documents.
- Papers should be no longer than 15 pages total.

SRR.1.3 Paper Judging Process

Competition judges will observe and score the quality of student teams' responses to the paper Judges will evaluate the performance of the participants per the white paper and criteria provided above as an outline.

All decisions by judges are final and not subject to critique, challenge or reconsideration under any circumstances. Participants are not allowed to approach judges to solicit feedback or comments outside of what is provided by the competition process under any circumstances. Violation of this rule could result in being disqualified from the competition. A judge may abstain from input or voting on a team or otherwise disqualify himself or herself if he or she feels his or her participation in the round of competition reflects a conflict of interest due to prior relationship (e.g., employment, academic, familial) with individual team's members or if participation will create an appearance of impropriety.

SRR.1.4 Violation of Rules

The rules of ethics and academic integrity apply, meaning that plagiarism, using faculty in the writing of papers or presentations, and theft of other team's ideas will be considered a violation and the team eliminated from the competition. All sources for information, data, research and reports must be cited using MLA or AMA style of writing, format and citations. Any violation of these rules either intentionally or unintentionally will result in an appropriate sanction that includes assessment of a penalty, disqualification from the competition and/or the return of prize money. The imposition of sanctions is within the sole discretion of the Organizing Committee and is not subject to discussion, debate or challenge.

Article D4: Social Responsibility Event Year 4

SRE.1.1 Social Responsibility Presentation Format

Teams will present their white paper highlights in each category during a presentation. Teams will also showcase a modeled prototype and/or simulated user experience as part of their presentation

- Each team can structure the presentation based on their own needs and style but a formal presentation document (PowerPoint) is required.
- Up to 4 team members form the presentation group and will give the presentation to the judging panel (maximum of 2 graduate students and the rest undergraduate students) of the team to present during the presentation.
- All team members of the presentation group must be in the presentation area when the presentation starts and must be introduced and identified to the judges.
- Team members of this "presentation group" may answer the judge's questions even if they did not speak during the presentation itself.

- Presentations are limited to a maximum of thirty (30) minutes. The judges will stop any presentation exceeding thirty minutes. The presentation itself will not be interrupted by questions.
- Immediately following the presentation there will be a question and answer session of up to ten (10) minutes. Only judges may ask questions.

SRE.1.2 Evaluation Criteria

Presentations will be evaluated on content, organization, visual aids, delivery and the team's response to the judges' questions. The Social Responsibility Presentation Events total score is based on the average of the judges' scores.

SRE.1.3 Judging Process

Competition judges will observe and score the quality of student teams' responses to the presentation. Judges will evaluate the performance of the participants per the standards and criteria provided. All decisions by judges are final and not subject to critique, challenge or reconsideration under any circumstances. Participants are not allowed to approach judges to solicit feedback or comments outside of what is provided by the competition process under any circumstances. Violation of this rule could result in being disqualified from the competition. A judge may abstain from input or voting on a team or otherwise disqualify himself or herself if he or she feels his or her participation in the round of competition reflects a conflict of interest due to prior relationship (e.g., employment, academic, familial) with individual team's members or if participation will create an appearance of impropriety.

Article D5: MathWorks Simulation Challenge Year 4

MathWorks will be compiling a separate Simulation Challenges document detailing this year's Simulation Challenge to be released by November 2020 and will be hosting a dedicated Session in February 2021.

Technical Inspection

Article E1: Vehicle Requirements & Restrictions

TI.1.1 Technical Inspection

The following requirements and restrictions will be enforced through technical inspection. Noncompliance must be corrected, and the vehicle re-inspected before the vehicle can operate under power.

TI.1.2 Modifications and Repairs

The vehicle must maintain all required specifications throughout the competition as approved by their technical inspection passing. If any changes are made after practice periods an official competition Technical Inspector must approve and note these edits on the team's technical inspection sheet before they run their scored Challenges.

Once the vehicle is approved for competition, any damage to the vehicle that requires repair, (e.g. crash damage, electrical or mechanical damage, will void the Technical Inspection Approval. Upon the completion of the repair and before re-entering into any dynamic competition, the vehicle MUST be re-submitted to Technical Inspection for re-approval.

Article E2: AutoDrive Challenge™ Technical Inspection Pre-Competition Trainings & Documents

The AutoDrive Challenge™ Organizing Committee will offer the following pre-competition trainings for all those working on the vehicle or driving/operating the vehicle during planned workshops throughout the year.

RRAM.2.1 Roof Rack Mounting Design Pre-Check Form

Each team will need to submit a Roof Rack Mounting Design Pre-Check Form to show their antenna placement and design for the scoring team to be able to determine if this set up is an approved configuration for the OXTS installation of scoring equipment in your team's vehicle. Scoring antenna mounting requirements are listed in your Series Resources for download. The form can be downloaded from your series resources and uploaded in the approved space on www.autodrivechallenge.com

HV.2.2 High Voltage System Safety Training

All AutoDrive Challenge™ team members who will be working with the GM vehicle shall complete the GM High Voltage System Safety Training. This will be provided by General Motors, timing and delivery method will be announced in Q3 2020.

DT.2.3 Safety Driver Training

All AutoDrive Challenge™ Safety Drivers and operators who will be driving the Bolt EV shall complete a General Motors provided Safety Driving training class. The date for the Safety Driver training class will be announced in Q3 2020. ONLY trained Safety Drivers shall drive the vehicle. A list of trained Safety Drivers shall be maintained by each team.

Article E3: Systems Safety & Technical Reports Year 4

SSTR.3.1 Procedure

The goal throughout the competition is to ensure autonomous vehicle safety within a closed course competitive environment. This goal is accomplished two-fold:

1) "Design for Safety" AutoDrive Challenge™ teams shall understand the real risks autonomous technology introduces and how to reduce these risks in a systematic way.

Year 1) Goal is met through an introduction to functional systems safety principles through a Safety Concept, a Preliminary Hazard Analysis (that defines hazards and safety goals), and an Interface Analysis. Teams are expected to revisit and revise these analyses each year.
Year 2) Goal is met through providing requirements traceability to safety goals and through analysis of the system design through a DFMEA and Software Safety Analysis.
Year 3) Goal is met through formally defining the Operational Design Domain (ODD), Object, Event, Detection & Response (OEDR), and addressing Safety of the Intended Functionality (SOTIF).
Year 4) Goal is met through analyzing loss of GPS to SAE Level 4, identifying top 3 failures modes, and achieving level 4 automation per SAE's J3016 "Levels of Driving Automation."

2) "Formally Documenting Safety" AutoDrive Challenge™ teams shall be exposed to real world processes and deliverables through the compliance to the GM Development Vehicle Usage Level (DVUL) process and by creating a student version of the NHSTA Voluntary Safety Self-Assessment (VSSA) for Autonomous Vehicles

Year 1) Goal is met through drive logs, safety inspections, and maintaining DVUL 1 compliance

Year 2) Goal is met through working towards VSSA work products (AutoDrive Challenge™ Autonomous Vehicle Safety Assessment- Part 1) and working towards DVUL2-MM certification

Year 3) Goal is met through completing the VSSA work products (AutoDrive Challenge™ Autonomous Vehicle Safety Assessment- Part 2)

Year 4) Goal is met through submission of the final software safety analysis, VSSA, logbooks and the final safety video uploaded on www.autodrivechallenge.com in submission upload.

TD.3.2 Technical Document Deliverables for Year 4

- Each team must upload their overall and final Software Safety Analysis, VSSA, and logbooks – Pass/Fail
- Each team will create a safety video that highlights not only the safety features of your vehicle but how you built safety into your autonomous design process. This video should be creative and excite people to learn more about your work. It should be no more than 5 minutes long and will be uploaded on www.autodrivechallenge.com as a document submission
- Video content:
    - Unveiling your teams' safety features in a comprehensive and creative way
    - Get your audience (stakeholders, investors, general public, etc.) comfortable with autonomous and safety features
    - How will you prove to the public that autonomous vehicles should be trusted in general?
    - Road Map to how you got where you are and how did safety influence your design along the way?
    - What did your team do to mitigate risk?
    - It is okay to include setbacks but also include how they were resolved
    - Future road map
    - What's next for the safety of the vehicle (technology/features/development)? How will it improve?
    - How would your team make use of simulation to make a safer AV?
    - Judges score accounts for 100% of overall score (Creativity, Safety content, etc. will all be in consideration)

      Extra credit points will be given for top three teams who get the most "likes" on YouTube. Your videos will be uploaded to the SAE YouTube channel two weeks prior to the start of the competition.

      The top three teams will be determined by number of likes at the start of day 1 competition. **1st place (15 points), 2nd place (10 points), 3rd place (5 points)**

      Below are two examples of videos to help you get started. These are meant to help teams get an idea of what could be done, not meant to lock you into a specific format. We encourage you to be creative.

https://youtu.be/6_0eJGtXOis
https://youtu.be/1oKoGUKkkfA

Article E4: AutoDrive Challenge™ Development Vehicle Usage Level (DVUL - Safety Requirement)

The Chevy Bolt EV donated to teams will be a Level 1 DVUL. For Year 4 Competition, AutoDrive Challenge™ teams are expected to maintain DVUL 1 criteria to be part of the competition and target DVUL2 - Manual Mode (MM) certification (DVUL2-MM is optional if teams' benefit).

DVUL.4.1 DVUL Level 1 Definition (Vehicle Status at Delivery to Teams)

DVUL Level 1 vehicle rating allows usage on Controlled, Closed Course Usage Only by approved and trained Safety Drivers. This level allows a limited, highly knowledgeable set of trained drivers to operate the vehicle on a controlled, closed course, such as an access-controlled parking lot.

The following Vehicle Control System functions are required to maintain DVUL Level 1 rating:

1. Self-Remediation by the system under certain hazardous failure conditions (Production validated), braking, steering, and propulsion control systems shall not be modified from delivered condition to the teams.
2. Driver Secured Remediation via E-Stop (or other AutoDrive Challenge™ approved back-up means) with verified capability to place the vehicle in a safe state when any hazardous failure conditions occur.
3. During automated driving operation, the vehicle speed shall be limited to 25 MPH, this will be the as delivered limit of the vehicle.
4. Verify that the vehicle contains a placard, which is very visible to the driver that contains detailed information on the state of the vehicle, what to do in case a hazard occurs and who to contact. A placard will be provided as an appendix to these rules.

DVUL.4.2 DVUL Level 2-Manual Mode Definition

DVUL 2-Manual Mode (MM) is optional for year 3. If you have obtained DVUL 2-MM in year 2 no action is required for year 3 unless changes were made to the year 2 applicable work products.

DVUL 2-MM grants limited public road usage in manual mode by trained and approved drivers (as well as closed controlled course in AV and Manual Mode).

Note that Autonomous mode shall only be enabled on a closed course regardless of DVUL level. For DVUL 2-MM teams are required to meet requirements per the table below before being issued the DVUL 2-MM placard.

Public road usage is expected for transporting the vehicle to a test site or to collect data. The driver cannot be responsible for any other task beyond driving (for example driver cannot operate a laptop, log data, etc.).

Driving off property is expected to be minimized, and teams must have plated and insured their vehicle based on their vehicle donation agreement document.

Activity	Deliverable
Safety Logs	Safety log for all driving operations (manual and autonomous)
Technical Inspection Check List	Mentor completed technical inspection list
Safety Analyses	Demonstration of plan for Year 3 Completion of deadlines and documents
Approved Driver Training List	List of approved drivers (licensed and trained)
Operating Routes	Map with routes of where vehicles will be driven identifying safety critical signs (such as traffic lights, speed limits, stop signs, school zones, etc.)

Autonomous Mode Isolation Switch Design and Usage Testing	Provide design schematics for isolation of autonomous commands to actuators either by physically disconnecting (from chassis bus / high speed bus) or by providing two inhibits, such as 1) insert and turn switch key, 2) depress switch. Provide a comprehensive test strategy that is approved by GM Safety to validate switch. A lockage/keyed switch is recommended.
Public Road Usage Checklist	New checklist which must include items such as: notifying faculty advisor of when off property usage will take place, description of route, who will be driving and who else is in the car and their function, test start and stop time, miles driven, issues encountered, what to do in case of an emergency (call 911)

The completed DVUL-Level 2 Manual Mode packet (the above chart deliverables) should be uploaded to the http://www.autodrivechallenge.com in the upload slot for this document in PDF form. Once submitted there will a two-week review process and a decision on the driving will be issued back to the team on the website. If accepted, then you will receive a sticker for validation and approval on the vehicle.

DVUL.4.3 Vehicle Usage Modes

Vehicle shall have a physical mode switch to allow usage in 1 of 2 distinct modes: (1) Manual Mode and (2) Autonomous Mode. Manual Mode shall be the default mode following full power down/up of the vehicle (by stopping and restarting vehicle through master Stop/Start switch in instrument panel) and re-entering the Autonomous Mode shall require a physical switch selection in addition to other control system initialization following restart. Physical switch selection and necessary operation is a key vehicle inspection item.

Manual Mode

Manual Mode is the default conventional driving mode with inherent safety and driving properties identical to the base production vehicle. The Manual Mode operation shall be as near to production configuration (as provided by GM) as possible. Manual Mode will be verified upon completion of all vehicle preparation steps and prior to first approval to drive GM-provided vehicle. The expectation is that any restart of the vehicle will put the vehicle in Manual mode and that Manual Mode configuration will remain unchanged such that DVUL2-MM usage by authorized drivers is always available to team members.

In Manual Mode, control system commanding or active assist of any actuator or other vehicle controls shall NOT be allowed. Teams shall demonstrate sufficient isolation of automated actuator controls in their design while in Manual Mode to ensure no unintended commands at any time. Drivers in Manual Mode shall keep hands on the wheel at all times and provide human control like any conventional vehicle. As such, all driver information or alerts required to drive the vehicle safely and per all applicable laws shall be functional.

Autonomous Mode

Autonomous Mode is the mode used for the AutoDrive Challenge™ Competition events and will be a driver-supervised fully automated driving mode with a human driver monitoring but not interfering with automation. The human monitor shall be able to intervene to control the vehicle at any time through takeover of either brake, steering, or propulsion. Driver supervision by trained human monitor is a significant enabler for safe evaluation of unproven automated vehicle control systems on closed or local road networks. Once activated, the Autonomous mode shall meet all automation and human monitor requirements stated in these rules.

The expectation is that Manual Mode is initially verified and will not change even as significant changes occur in the Autonomous controls system.

Article E5: AutoDrive Challenge™ Technical Inspection Testing & Verification

TI.5.1 Pre-Driving Inspection Check List – (Download Technical Inspection Checklist for Explanation of Each Area)

1. Documentation
   a. DVUL Level Placard
   b. Approved Driver List (and verification of Driver's License for each competition driver) **All safety drivers must be present at inspection**
2. Exterior Light Operation
   a. Brake Lights
   b. Front Lamps
   c. Reverse Lamps
   d. Left & Right Turn Signals
   e. Hazard Lights
   f. Blue Autonomous Warning Light (See Section TI.4.3)
3. Drivability
   a. Battery Level/Range
   b. Telltales/Messages
   c. Interior Displays
   d. Tires
4. Sensors & Visibility
   a. Vision Sensor Set(s)
   b. Hood
   c. Trunk
5. Occupant Safety
   a. E-Stop
   b. Restraints
   c. Doors
   d. Seats
   e. In-vehicle equipment
6. Braking System
   a. Brake Pedal
   b. Park Brake
7. Steering System
   a. Steering Wheel
8. Software
   a. Software Version
   b. Controller (Brakes)
   c. Controller (Steering)
   d. Controller (Propulsion)
9. Other
   a. Vehicle Damage
   b. Under Hood
   c. Up to date logbook from testing (printed version)
   d. A Fire Extinguisher
      Should be rigidly clamped/secured inside of the vehicle.
      Should be easily accessible in the event you need to assist another vehicle
   e. Additional GPS Antennas and GNSS systems will not be permitted. The vehicle will be inspected to ensure this is followed so each team will be able to perform the Level 4 Challenge appropriately.

TI.5.2 Driving Test Inspection

1. Three people will be in the vehicle:
    a. a Safety Driver
    b. one additional team member
    c. an official Technical Inspector
2. Proper E-Stop usage will be shown during a short drive to ensure proper safety driver reaction. ALL drivers who will be participating in the competition must have taken the proper Driver Training at General Motors Proving Grounds, Milford, MI.
3. Teams will be asked to enter into autonomous mode, demonstrate that the Blue Autonomous Warning Lights activate automatically when autonomous mode is engaged. Then teams will be asked to disengage through their preferred method of takeover (braking or steering) and demonstrate that the vehicle is now in manual mode and the Blue Autonomous Warning lights automatically deactivate.

TI.5.3 Blue Autonomous Warning Light

The first light shall be on the exterior of the vehicle, mounted to the roof. The exterior blue light serves as a warning to others around the vehicle that Autonomous Mode is active. **The light must be visible in daylight conditions by an observer on all sides of the vehicle and from at least 200 Feet away**. Teams should select their own mounting design strategy. Teams must design into their autonomous control system the ability control the light. It is required that the control system turn on the light when entering Autonomous Mode and turn off the light when exiting Autonomous Mode for any reason, including when the Safety Driver performs a manual take over. **This functionality will be tested during Tech Inspection and if it does not automatically function in this manner it will need to be resolved before passing Tech Inspection and continuing in the Year 4 Competition**. As an example, teams may choose an exterior light similar to this:
https://www.amazon.com/MATCC-Emergency-Magnetic-Warning-Cigarette/dp/B01L94RC9W/ref=sr_1_9?ie=UTF8&qid=1489073844&sr=8-9&keywords=blue+strobe+light
The second light shall be on the interior of the vehicle, mounted on the dashboard. The interior blue light serves as an indicator to judges and passengers that autonomous mode is active. The light must be visible from any seat in the vehicle. The interior light should be turned on and off in sync with the exterior light.
As an example, teams may choose an interior light similar to this:
https://www.amazon.com/Alpinetech-Metal-Indicator-Pilot-Custom/dp/B00GNQXLQ0/ref=sr_1_13?ie=UTF8&qid=1490129247&sr=8-13&keywords=blue+led+indicator+light
The functionality of both lights will be checked during the Driving Test Inspection as described in section TI.4.2

NOTE: Teams must design to allow for 3 persons to fit in the car:

- A safety driver,
- 1 other team passenger
- An official during the challenges.
- Build envelope is one foot off the bumpers and one foot past the side view mirrors. Space for a judging DAC will be marked and cannot be encroached on.

Dynamic Event & Procedures

Article F1: Overview

AutoDrive Challenge™ Year 4 will have two Dynamic Challenges: The 99% Buy Off Ride (BOR) Challenge and the Level 4 Challenge.

The 99% BOR Challenge will be the cumulation of the previous year's challenges. The goal of this challenge is for teams to do a final demonstration showing that they have built a complete autonomous driving system that can successfully navigate a typical urban environment. In this challenge teams will be given several address points on the course and will be required to successfully navigate to each point navigating through a variety of dynamic and static obstacles while following all relevant traffic laws.

At each address teams will be required to stop and shift into park for a minimum of 5 seconds as if they were allowing passengers to enter or exit the vehicle before continuing onto the next address. Teams will be given two routes to complete for this challenge and will have one attempt to complete each route. The final address must be reached and successfully parked at to accumulate full points (400 points total, 200 points for each route).

The Level 4 Challenge. This is a new challenge that focuses on robustness of the vehicle. How tolerant is the system to a failure? Entropy is a real thing that fights systems constantly. Therefore, it is critical to design controls systems that can be tolerant to a single point of failure. In this challenge the Novatel GNSS and IMU communications will be cut to the vehicle after the challenge starts. Redundant GNSS and redundant IMUs are not allowed. The objective of this challenge is demonstrating fault tolerance to loss of comms from GNSS/IMU and continue through the course to arrive at the destination. Without GNSS/IMU, the control system must move from an absolute localization system (based on GNSS provided lat/longs) to a more relative localization method (utilizing LiDAR/Camera/RADARs to provide change in position inputs).

Points will be awarded for each intersection successfully completed. Safely pulling off the road, bringing the vehicle to a stop, and putting the vehicle into park is an acceptable Level 4 mitigation process for a failure. Therefore, a safety pull-off area will be provided that if reached and parked at will accumulate up to 50% of total points. However, the final address must be reached and successfully parked to accumulate full points (200 points max).

Article F2: Year 4 Dynamic Challenge Procedures and Definitions Applies to Both Challenges

The below is a list of high-level objectives that teams should expect to see in the Year 4 Dynamic Challenges. The full breakdown of metrics will be provided to teams in a supplementary document in your series resources to provide the breakdown of each dynamic route scoring. Including items such as drive quality metrics and individual object breakdowns.

- Teams will encounter completely closed roads or road sections and must avoid construction to re-route and navigate to the next address
- Teams may not perform U-Turns.
- Teams will encounter traffic signals that will require your vehicle to deal with red, yellow, and green light configurations including flashing (red) and directional arrows.
- Teams will encounter both white and yellow lines, dashed and solid.
- Teams will encounter stop signs with and without limit lines and will be required to stop within a certain distance specified in the metrics.
- Teams will encounter both static and dynamic objects throughout the challenge and will have to react appropriately.

- Teams will encounter traffic control signs and will be required to react appropriately.
- Teams will encounter intersections both controlled and uncontrolled.

The Year 4 challenges will have several different parts. The definitions include **Route**, **Segment**, and **Checkpoint.**

Route – The Year 4 competition will include 2 driving challenges. The BOR Challenge will contain 2 scored routes of address points that connect to form an optimal route using your HERE mapping data. Routes will be given to teams at least 30 days prior to competition. The Level 4 Challenge will contain only 1 scored route with 1 address.

Segment– Between each address points within the BOR Challenge will be segments that connect each address point to another. Routes will contain up to 8 segments / destination addresses. The Level 4 Challenge is only 1 segment.

Checkpoint – Checkpoints are obstacles or traffic controls encountered within each segment. These checkpoints are opportunities for teams to accumulate points.

Schedule - Teams will be given four days of practice/development time (non-sequential) in which they will each have 30-minute blocks of time twice a day (8 total sessions over the four days) to practice and test. Objects will be located throughout the course on some of the practice days to gain practice and testing on both dynamic and static objects, traffic signals, and traffic signs.

There will be 3 scored days (non-sequential) for the 2 challenges for total dynamic points. Each of the scored days will have 30 minutes non-scored practice in the morning using the same address points as the scored afternoon but will not contain dynamic/static objects, controlled traffic lights, blocked roads, or signs in the correct placement that will be present in the afternoon scored route. The afternoon scored route will have a 20-minute time limit.

Teams are encouraged to keep a continuous path of travel in autonomous mode throughout the entire route however, if you cannot complete a segment within the route you may move to the next segment but forfeit any potential points you could have earned in that segment.

Dynamic Day 1– Morning Practice - 30 minutes open practice

Afternoon Practice - 30-minute open practice

Dynamic Day 2– Morning BOR Route Practice - 30 minutes non-scored practice

Afternoon BOR Route Practice - 30-minute non-scored practice

Dynamic Day 3– Morning BOR Route Practice - 30 minutes non-scored practice

Afternoon BOR Route Practice - 30-minute non-scored practice

Dynamic Day 4 – Morning BOR Route 1 - 30 minutes non-scored practice

Afternoon BOR Route 1 - 20-minute scored run 200 points

Dynamic Day 5 – Morning BOR Route 2 - 30 minutes non-scored practice

Afternoon BOR Route 2 – 20-minute scored run for 200 points

Dynamic Day 6 – Morning Level 4 Route - 30 minutes non-scored practice

Afternoon Level 4 Route – 30-minute non-scored practice

Dynamic Day 7 – Morning Level 4 Route - 30 minutes non-scored practice

Afternoon Level 4 Route – 20-minute scored run for 200 points

Did Not Start (DNS)

Teams will receive a DNS for any route that they do not autonomously cross the route start. A DNS is given when your team does not attempt to autonomously drive a route.

Did Not Finish (DNF)

Exceeding the Challenge Time Limit

Teams will have a maximum of 20 minutes to complete the scored challenge each day. Timing begins once the Green Staging light is illuminated by the scoring officials at the Starting line of the Challenge. The Challenge timer will stop once the vehicle reaches the Finish line of the final segment of the route within the challenge. Any points earned up to that point are kept. Exceeding the challenge time limit ends your challenge attempt for that day.

Collisions

Colliding with any object will be considered a Collision DNF for that route. Any points earned up to that point are kept. Collisions end your challenge attempt for that day.

Off Course

An Off Course DNF occurs when the vehicle has all four (4) tires outside the course boundary indicated by yellow lines, solid white lines, or pavement edges, except for the designated safe pull off zone for the Level 4 Challenge. The vehicles that have gone off course must immediately be stopped and exit autonomous mode. Any points earned up to that point are kept and your challenge attempt for that day is ended.

Manual Overrides*

Any manual intervention by the Safety Driver or student passenger of the autonomous system will be considered a Manual Override DNF. Any points earned up to that point are kept and the following segments can still be attempted after manually proceeding to the next address. This includes driver interventions with any of the following;

1. Power button
2. Accel pedal
3. Brake pedal
4. E-stop
5. Steering wheel

Most manual overrides will be scored based on CAN messaging signals for Year 4. A full list of messages/signals will be published in your Series Resources.

Exceeding Speed Limit

The maximum vehicle speed limit is 25 mph. Exceeding this speed will result in a DNF. Any points earned up to that point are kept and your challenge attempt for that day is ended.

NOTE: Based on extenuating circumstances and investigation of a root cause(s), judges have the discretion to remediate the situation on any initially determined DNF if the situation arises. No protest can be made by teams on this issue and organizing authority will stand.

Starting Order

Starting order will determined by the organizing committee and posted in the Student Handbook prior to competition. The organizer will determine the allowable windows for each run and retains the right to adjust for weather or technical delays. Teams that have not run by the close of the event will receive 0 points for the Challenge.

Starting

Staging lights will be used to indicate the approval to begin. Once approval to begin is given, the teams are to activate Autonomous Mode for the vehicle to start. Timing begins once you are given the Green light from the staging lights regardless on if you cross the Challenge Start line. Once you arrive at the starting line no further driving or testing can be done (i.e. you cannot drive around to adjust your GPS at the starting line).

Article F3: Software and Calibration Changes

During the Dynamic Event days at any time software and calibration changes will be permitted, except during the dynamic event itself.

Article F4: Vehicle Integrity and Disqualification

During the Dynamic Events, the mechanical integrity of the vehicle must be maintained during all challenges. Any vehicle condition that could compromise vehicle integrity or could compromise the track safety or pose a potential hazard to participants, spectators, and volunteers will be a valid reason for exclusion by the official until the problem is rectified.

Article F5: Access to Dynamic Event Areas

The organizing committee will specify areas of the event such as the waiting area for dynamic events where only team members wearing official dynamic passes (3 will be given at registration) may gain access and the number of tools that may be used in this area may be restricted. Please refer to the student handbook to understand the specific restrictions on this competition.

Article F6: Weather Conditions

The organizing committee reserves the right to alter the conduct and scoring of the competition based on weather conditions to maintain safety of the participants and volunteers at any given time.

Article F7: Flags & Timing Lights

Each dynamic event will use staging lights to start the Challenge. Teams will pull up to the start line and receive a Green light to begin the Challenge. Staging lights will be used at beginning of each Course if a Challenge has multiple Courses. Flags will only be used in an emergency and only RED which will halt all operations.

RED FLAG – Immediate stopping of all activity, and vehicles.

Scoring & Protests

Article I1: Official Scores

All official AutoDrive Challenge™ scores will be posted on the official webpage, and on the AutoDrive Challenge™ App.

It is recognized that thousands of hours of work have gone into all aspects of the competition and teams are entitled to all the points they can earn. We also recognize that there can be differences in the interpretation of rules, the application of penalties and the understanding of procedures among volunteers and participants. The Organizing Committee will make every effort to fully review all questions and resolve problems and discrepancies.

P.1.1 Cause for Protest

A team may protest any rule interpretation, score or official action (unless specifically excluded from protest) which they feel has caused some actual, non-trivial, harm to their team, or has had a substantive effect on their score.

Teams may not protest rule interpretations, modifications, or actions that have not caused their own team any substantive damage. (i.e. on behalf of another team).

P.1.2 Protest Format and Forfeit

All protests must be filed in writing (form can be downloaded from www.autodrivechallenge.com) and presented to the SAE Competition Manager by the team's captain. The team captain must then meet with the Organizing Committee and verbally present the protest. The team captain may, at his or her discretion, bring one team faculty advisor and/or one other team member, but the team captain must present the protest and lead the discussion of any questions from the Organizing Committee.

To have a protest considered, a team must post bond of 25 points. These points will be subtracted from the team's overall score if the protest is rejected.

P.1.3 Protest Period

Protests concerning any aspect of the competition must be filed within the protest period which is one-half hour (30 minutes) after the posting of the scores of the event to which the protest relates.

P.1.4 Decision

The decision of the competition Organizing Committee regarding any protest is final.

APPENDIX

SAE Standards Available to Teams

AutoDrive Challenge™

J3016 – Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems
J3018 - Guidelines for Safe On-Road Testing of SAE Level 3, 4, and 5 Prototype Automated Driving Systems (ADS)
J3063 - Active Safety Systems Terms & Definitions

Baja SAE

J586 - Stop Lamps for Use on Motor Vehicles Less Than 2032 mm in Overall Width
J759 - Lighting Identification Code
J994 - Alarm - Backup – Electric Laboratory Tests
J1741 - Discriminating Back-Up Alarm Standard

Clean Snowmobile Challenge

J192 - Maximum Exterior Sound Level for Snowmobiles
J1161 - Sound Measurement – Off-Road Self-Propelled Work Machines Operator-Work Cycle

Formula SAE Hybrid

J1318 - Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance and Service Vehicles
J1673 - High Voltage Automotive Wiring Assembly Design

Formula SAE

SAE 4130 steel is referenced but no specific standard is identified
SAE Grade 5 bolts are required but no specific standard is identified

Supermileage

J586 - Stop Lamps for Use on Motor Vehicles Less Than 2032 mm in Overall Width

SAE Technical Standards for Supplemental Use

Standards Relevant to Baja SAE

J98 – Personal Protection for General Purpose Industrial Machines – Standard
J183 – Engine Oil Performance and Engine Service Classification - Standard
J306 – Automotive Gear Lubricant Viscosity Classification - Standard
J429 – Mechanical and Material Requirements for Externally Threaded Fasteners – Standard
J512 – Automotive Tube Fittings - Standard
J517 – Hydraulic Hose - Standard
J1166 – Sound Measurement – Off-Road Self-Propelled Work Machines Operator-Work Cycle
J1194 – Rollover Protective Structures (ROPS) for Wheeled Agricultural Tractors
J1362 – Graphical Symbols for Operator Controls and Displays on Off-Road Self-Propelled Work Machines - Standard
J1614 – Wiring Distribution Systems for Construction, Agricultural and Off-Road Work Machines
J1703 - Motor Vehicle Brake Fluid - Standard
J2030 – Heavy Duty Electrical Connector Performance Standard
J2402 – Road Vehicles – Symbols for Controls, Indicators and Tell-Tales – Standard

Standards Relevant to Clean Snowmobile Challenge

J44 – Service Brake System Performance Requirements – Snowmobiles - Recommended Practice

J45 – Brake System Test Procedure – Snowmobiles – Recommended Practice
J68 – Tests for Snowmobile Switching Devices and Components - Recommended Practice
J89 – Dynamic Cushioning Performance Criteria for Snowmobile Seats - Recommended Practice
J92 – Snowmobile Throttle Control Systems – Recommended Practice
J192 – Maximum Exterior Sound Level for Snowmobiles - Recommended Practice
J288 – Snowmobile Fuel Tanks - Recommended Practice
J1161 – Operational Sound Level Measurement Procedure for Snowmobiles - Recommended Practice
J1222 – Speed Control Assurance for Snowmobiles - Recommended Practice
J1279 – Snowmobile Drive Mechanisms - Recommended Practice
J1282 – Snowmobile Brake Control Systems - Recommended Practice
J2567 – Measurement of Exhaust Sound Levels of Stationary Snowmobiles - Recommended Practice

Standards Relevant to Formula SAE
J183 – Engine Oil Performance and Engine Service Classification - Standard
J306 – Automotive Gear Lubricant Viscosity Classification - Standard
J429 – Mechanical and Material Requirements for Externally Threaded Fasteners – Standard
J452 - General Information – Chemical Compositions, Mechanical and Physical Properties of SAE Aluminum Casting Alloys – Information Report
J512 – Automotive Tube Fittings - Standard
J517 – Hydraulic Hose - Standard
J637 – Automotive V-Belt Drives – Recommended Practice
J829 – Fuel Tank Filler Cap and Cap Retainer
J1153 - Hydraulic Cylinders for Motor Vehicle Brakes – Test Procedure
J1154 – Hydraulic Master Cylinders for Motor Vehicle Brakes - Performance Requirements - Standard
J1703 - Motor Vehicle Brake Fluid - Standard
J2045 – Performance Requirements for Fuel System Tubing Assemblies - Standard
J2053 – Brake Master Cylinder Plastic Reservoir Assembly for Road Vehicles – Standard

Standard Relevant to Formula Hybrid
J1772 – SAE Electric Vehicle and Plug in Hybrid Conductive Charge Coupler

Standard Relevant to all CDS Competitions
J1739 – Potential Failure Mode and Effects Analysis in Design (Design FMEA) Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA) and Potential Failure Mode and Effects Analysis for Machinery (Machinery FMEA)