COLLEGIATE DESIGN SERIES

SAE CLEAN SNOWMOBILE CHALLENGE®

Rules 2022

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REVISION SUMMARY

*Provided as a courtesy. Not a complete list. See **GR.2.6***

1.0 The rules document has been completely updated, revised, and reformatted for 2022. Since this is a complete revision, changes in the document are not marked. Below are a few changes made in the rules (not a complete list):

- All Appendices have been removed from the rules and housed separately online competition website under Series Resources.
- Submissions/Scored Events removed:
  - MSRP
  - Lab Emissions
  - Brake Specific Fuel Consumption
  - Oral Design
  - Fuel Economy from Endurance
  - Acceleration Plus Load
  - CI Draw Bar Pull Test
  - Static Display Event
  - No-Maintenance Bonus
- Submissions/Scored Events introduced:
  - Value Benefit Analysis Presentation
  - Engineering Technical Presentation
  - Business/Sales Presentation
- Submissions/Scored Events remaining:
  - Abstract
  - Engineering Design Paper
  - In-Service Emissions
  - In-Service Fuel Economy
  - Endurance Event
  - Objective and Subjective Handling
  - Objective and Subjective Noise
  - Cold Start
  - Acceleration (for both classes)

GR - GENERAL REGULATIONS

GR.1 SAE CLEAN SNOWMOBILE CHALLENGE COMPETITION OBJECTIVE

GR.1.1 Collegiate Design Series

SAE International's Collegiate Design Series (CDS) programs prepare undergraduate and graduate engineering students in a variety of disciplines for future employment in mobility-related industries by challenging them with a real world, engineering application.

Through the Engineering Design Process, experiences may include but are not limited to:

- Project management, budgeting, communication, and resource management skills
- Team collaboration
- Applying industry rules and regulations
- Design, build, and test the performance of a real vehicle
- Interact and compete with other students from around the globe
- Develop and prepare technical documentation

Students also gain valuable exposure to and engagement with industry professionals to enhance 21st century learning skills, to build their own network and help prepare them for the workforce after graduation.

GR.1.2 SAE Clean Snowmobile Concept

The SAE International Clean Snowmobile Challenge (CSC) is an engineering design competition for undergraduate and graduate student members of SAE International. Their modified snowmobiles will compete in a variety of events including emissions and noise measurement, endurance, acceleration, handling, fuel economy and cold start plus students will make several presentations on technical design and value benefit analysis.

There are two categories in the SAE Clean Snowmobile Challenge, sleds driven by only one internal combustion spark ignited (SI) engine and sleds driven by only one internal combustion compression ignition (CI) engine.

GR.1.3 Competition Objective for Spark Ignited (SI) Engine Powered Snowmobiles

GR.1.3.1 The intent of the competition is to develop a snowmobile that is acceptable for use in environmentally sensitive areas such as our National Parks or other pristine areas; and designed to primarily be ridden on groomed snowmobile trails. National Parks have speed limit of 45 mph. Modern snowmobiles are engineered to meet the current standards for noise and emissions. Teams are expected to add innovative solutions for improving the performance of the base sled they start with. The modified snowmobiles are expected to be quiet and emit significantly less tailpipe emissions that current production machines. The modified snowmobiles are also expected to be cost-effective and comfortable for the operator to drive, as well as maintaining fun factor and performance.

GR.1.3.2 An additional objective of the competition is to improve fuel economy. Fuel consumption will be evaluated in the In-Service Emissions event.

GR.1.3.3 Minimum Performance Requirements

Snowmobiles competing in spark ignited class must have the following minimum performance:

- Range – 100 miles without refuelling
- Trail speed – 45 miles per hour on smooth trail

- Acceleration – Traverse 500 feet within 10 seconds from a standing start
- Designs that do not, in the sole opinion of the officials, have a responsible expectation of satisfying the minimum performance requirements as they will not be allowed to compete.

GR.1.4 Competition Objective for the Compression Ignition (CI) Engine Powered Snowmobiles

GR.1.4.1 The addition of a diesel class is in response to requests for university teams to have an opportunity to design and build a snowmobile around diesel technology. Diesel engines with their higher torque capability and lower operating speeds makes them less desirable compared to the higher performance snowmobiles on market. The intent of this class is for university teams to be challenged with designing a diesel snowmobile to be viable market option.

GR.1.4.2 The Compression Ignition class (CI) will still have the clean and quiet priorities of the SAE Clean Snowmobile Challenge.

GR.1.4.3 The noise test will be the steady state test consistent with SAE J1161 with a speed of 35 mph.

GR.1.4.4 Each of the four major snowmobile manufacturers has a snowmobile in the Utility category. None of them offer a diesel option. It is a requirement that the starting point for the CI class to be a snowmobile from one of these four manufacturers, that is no more than five years old, and the chassis is used in the Utility category. A list of approved models for this category is published online the SAE Clean Snowmobile Online Website. The gasoline engine must be replaced by a diesel engine. The horsepower rating of the replacement engine must not exceed 130hp, consistent with the traditional trail sled.

GR.1.4.5 Minimum Performance Requirements

Snowmobiles competing in the compression ignition class must have the following minimum performance:

- Range – 100 miles without refuelling
- Trail Speed – 45 miles per hour on a smooth trail
- Acceleration – there is no requirement
- Designs that do not, in the sole opinion of the officials have a responsible expectation of satisfying the minimum performance requirements as they will not be allowed to compete.

GR.1.5 Engineering Ethics

SAE Clean Snowmobile Challenge is an engineering design competition that requires performance demonstration of snowmobiles. It is not a race. Engineering ethics will apply. In all events, violation of the intent of the rules will be considered a violation of the rule.

GR.2 SAE CSC RULES AND ORGANIZER AUTHORITY

GR.2.1 Rules Authority

The SAE Clean Snowmobile Challenge Rules are the responsibility of the SAE Clean Snowmobile Challenge Rules Committee and are issued under the authority of the SAE International Collegiate Design Series.

GR.2.2 Rules Validity

GR.2.2.1 The SAE Clean Snowmobile Challenge Rules posted on the website and dated for the calendar year of the competition are the rules in effect for the competition.

GR.2.2.2 Rules appendices or supplements may be posted on the website and incorporated into the rules by reference.

GR.2.2.3 Additional guidance or reference documents may be posted on the website.

GR.2.2.4 Any rules, questions, or resolutions from previous years are not valid for the current competition year.

GR.2.3 Rules Alterations

GR.2.3.1 The SAE CSC rules may be revised, updated, or amended at any time during the competition season.

GR.2.3.2 Official designated announcements from the SAE CSC Rules Committee, SAE International or the other organizing bodies are to be considered part of, and have the same validity as, these rules.

GR.2.3.3 Draft rules or proposals may be issued for comments; however, they are a courtesy, are not valid for any competitions, and may or may not be implemented in whole or in part.

GR.2.4 Rules Compliance

GR.2.4.1 By entering the SAE CSC 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, these rules and all rule interpretations or procedures issued or announced by SAE International, the SAE CSC Rules Committee and the other organizing bodies.

GR.2.4.2 All participants must comply with the latest issue of the SAE CSC Rules. Refer to the SAE Clean Snowmobile Online Website to verify the current version.

GR.2.4.3 Teams and team members must comply with the general rules and any specific rules for each competition they enter.

GR.2.4.4 Any 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 SAE CSC Rules by reference. As examples, all competition site waiver requirements, speed limits, parking and facility use rules apply to SAE CSC participants.

GR.2.5 Violations on Intent

The violation of the intent of a rule will be considered a violation of the rule itself.

GR.2.6 Understanding the Rules

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

GR.2.7 Participating in the Competition

GR.2.7.1 Teams, individual team members, faculty advisors and other representatives of a registered university who are present onsite at a competition are “participating in the competition” from the time they arrive at the competition site until they depart the site at the conclusion of the competition or earlier by withdrawing.

GR.2.7.2 All team members, faculty advisors and other university representatives must cooperate with, and follow all instructions from, competition organizers, officials, and judges.

GR.2.8 Forfeit for Non-Appearance

GR.2.8.1 It is the responsibility of each team to be in the right place at the right time.

GR.2.8.2 If a team is not present and ready to compete at the scheduled time, they forfeit their attempt at that event.

GR.2.8.3 There are no makeups for missed appearances.

GR.2.9 Right to Impound

GR.2.9.1 SAE International and other competition organizing bodies may impound any onsite registered vehicle at any time during a competition.

GR.2.9.2 Team access to a vehicle in impound may be restricted.

GR.2.10 Problem Resolution

Any problems that arise during the competition will be resolved through the onsite organizers and the decision will be final.

GR.2.11 General Authority

SAE International and the competition organizing bodies 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 or the SAE Clean Snowmobile Challenge competition.

GR.2.12 SAE Technical Standards Access

A cooperative program of SAE International University Programs and Technical Standards Board is making some of SAE's Technical Standards available to teams registered for any SAE International hosted competition at no cost. A list of accessible standards can be found online www.saecleansnowmobile.com and accessed under the team's registration online www.sae.org.

GR.3 RULES OF CONDUCT

GR.3.1 Unsportsmanlike Conduct

If unsportsmanlike conduct occurs, the team will receive a warning from an official. Unsportsmanlike conduct is defined as detracting from the character of the event or how abuses, threatens or uses profane language to any participant.

A second violation will result in expulsion of the team from the competition.

GR.3.2 Arguments with Officials

Argument with, or disobedience of, any official may result in the team being eliminated from the competition.

All members of the team may be immediately escorted from the grounds.

GR.3.3 Drug and Alcohol Policy

GR.3.3.1 Alcohol, illegal drugs, weapons, or other illegal material are prohibited on the competition site during the entire competition.

GR.3.3.2 Any violation of this rule by any team member or faculty advisor will cause immediate disqualification and expulsion of the entire team.

GR.3.3.3 Any use of alcohol, illegal drugs, weapons, or other illegal material will be reported to the local authorities.

GR.3.4 Smoking – Prohibited

Smoking and e-cigarette use is prohibited in all competition areas.

GR.4 RULES FORMAT AND USE

GR.4.1 Definition of Terms

- **Must** - designates a requirement
- **Must NOT** - designates a prohibition or restriction
- **Should** - gives an expectation
- **May** - gives permission, not a requirement and not a recommendation

GR.4.2 Headings

The article, section and paragraph headings in these rules are provided only to facilitate reading: they do not affect the paragraph contents.

GR.4.3 Applicability

GR.4.3.1 Unless otherwise designated, all rules apply to all vehicles at all times

GR.4.3.2 Rules specific to vehicles based on their powertrain will be designated as such in the rule text:

- Spark Ignited "SI" or "SI Only"
- Compression Ignition "CI" or "CI Only"

GR.4.4 Change Identification

Any summary of changed rules and/or changed portions marked in the rules themselves are provided for courtesy and may or may not include all changes.

GR.5 RULES QUESTIONS

GR.5.1 Question Types

The Committee will answer questions that are not already answered in the rules or FAQs or that require new or novel rule interpretations.

Rules Questions may also be used to request approval, as designated in these rules.

GR.5.2 Question Format

GR.5.2.1 All Rules Questions must include:

- Full name and contact information of the person submitting the question
- University name – no abbreviations
- The specific competition your team has, or is planning to, enter.
- Number of the applicable rule(s)

GR.5.2.2 Response Time

- Please allow a minimum of two weeks for a response
- Do not resubmit questions

GR.5.2.3 Submission Addresses

Follow the link and instructions published on the SAE Clean Snowmobile Online Website to "Submit a Rules Question"

GR.5.3 Question Publication

Any submitted question and the official answer may be reproduced and freely distributed, in both complete and edited versions.

GR.5.4 Loopholes and Problems

GR.5.4.1 Any perceived loopholes, potential problems or suggestions for rules changes must reference the appropriate SAE CSC rule number, state the current wording of the rule, and contain a suggestion of how the rule should be changed. Information can be emailed to SAE via collegiatecompetitions@sae.org or submitted online using the Rules Inquiry at www.saecleansnowmobile.com.

GR.6 PROTESTS

GR.6.1 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.

GR.6.2 Preliminary Review – Required

Questions about scoring, judging, policies, or any official action must be brought to the attention of the organizer or SAE International staff for an informal preliminary review before a protest may be filed.

GR.6.3 Protest Format

- All protests must be filed in writing
- The completed protest must be presented to the organizer or SAE International staff by the team captain.
- Team video or data acquisition will not be reviewed as part of a protest.

GR.6.4 Protest Point Bond

A team must post a 25-point protest bond which will be forfeited if their protest is rejected.

GR.6.5 Protest Period

Protests concerning any aspect of the competition must be filed in the protest period announced by the competition organizers or 30 minutes of the team's completion of the event to which the protest relates.

GR.6.6 Decision

The decision regarding any protest is final.

AD - ADMINISTRATIVE REGULATIONS

AD.1 OFFICIAL INFORMATION SOURCES

AD.1.1 Official Announcements and Competition Information

AD.1.1.1 Teams must read the published announcements by SAE International and the other organizing bodies and be familiar with all official announcements concerning the competitions and any released rules interpretations.

AD.1.1.2 Miscellaneous information on competition logistics and administration will be posted online www.saecleansnowmobile.com or emailed by SAE International to affiliated participants.

AD.1.2 Contacts

Contact collegiatecompetitions@sae.org with any problems/comments/withdrawals.

Consult the specific website for the other competitions requirements**.**

AD.1.3 Official Languages

The official language of the SAE CSC is English.

Document submissions, presentations and discussions in English are required.

AD.2 OFFICIAL SAE CLEAN SNOWMOBILE WEBSITES

The following websites are referenced in these rules. Refer to the websites for additional information and resources.

AD.2.1 Event Website

The Event Website for SAE Clean Snowmobile Challenge is specific to each competition, refer to:

www.sae.org/attend/student-events

AD.2.2 SAE CSC Online Website

The SAE CSC Online website is at: www.saecleansnowmobile.com

AD.2.2.1 Documents, forms, and information are accessed from the “Series Resources” link

AD.2.2.2 Each registered team must have an account on the FSAE Online Website.

AD.2.2.3 Each team must have one or more persons as Team Captain. The Team Captain must accept Team Members.

AD.2.2.4 Only persons designated Team Members or Team Captains can upload documents to the website and ask rules inquiries.

AD.3 INDIVIDUAL PARTICIPATION REQUIREMENTS

AD.3.1 Eligibility

AD.3.1.1 Team members must be enrolled as degree seeking undergraduate or graduate students in the college or university of the team with which they are participating.

AD.3.1.2 Team members who have graduated during the seven-month period prior to the competition remain eligible to participate.

AD.3.1.3 Teams which are formed with members from two or more universities are treated as a single team. A student at any university making up the team may compete at any competition where the team participates. The multiple universities are treated as one university with the same eligibility requirements.

AD.3.2 Age

Team members must be minimum 18 years of age.

AD.3.3 Driver's License

Team members who will drive a competition vehicle at any time during a competition must hold a valid, government issued driver's license.

AD.3.4 Society Membership

Team members must be members of SAE International. Proof of membership, such as membership card, is required at the competition.

AD.3.5 Medical Insurance

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

AD.3.6 Disabled Accessibility

Team members who require accessibility for areas outside of ADA Compliance must contact organizers at collegiatecompetitions@sae.org prior to start of competition.

AD.3.7 Visa Requests

Affiliated university team members will have the ability to print out a Registration Confirmation Letter for the competition they are attending under their registration page.

Please be advised that SAE International cannot intervene by calling or sending personal letters to the state departments, embassies or consulates of the United States or other governments on behalf of any meeting or event participant.

AD.4 INDIVIDUAL REGISTRATION REQUIREMENTS

AD.4.1 Preliminary Registration

AD.4.1.1 All students and faculty must be affiliated to your respective school /college/university on the Event Website by January 31 of the year of the competition.

AD.4.1.2 International student participants (or unaffiliated Faculty Advisors) who are not SAE International members must create a free customer account profile on www.sae.org. Upon completion, please email collegiatecompetitions@sae.org the assigned customer number also stating the event and university affiliation.

AD.4.2 Fast Track Registration Form

AD.4.2.1 Two weeks prior to competition the Fast-Track Registration Form found online www.sae.org will be locked for editing. Any student or faculty who have not affiliated or completed their required information will need to do so manually after the form is printed.

AD.4.2.2 This form is to be printed and brought to student team registration area onsite.

AD.4.3 Onsite Registration

AD.4.3.1 All team members and faculty advisors must complete online registration requirements of the Fast-Track Roster, print the file, and sign the liability waiver attached to the Fast-Track Roster document to bring to registration onsite at competition.

AD.4.3.2 All onsite participants, including students, faculty, and volunteers, must sign a liability waiver upon registering onsite.

AD.4.3.3 Onsite registration must be completed before the vehicle may be unloaded, uncrated or worked upon in any manner.

AD.5 TEAM ADVISORS

AD.5.1 Faculty Advisor

AD.5.1.1 Each team must have a Faculty Advisor appointed by their university.

AD.5.1.2 The Faculty Advisor should accompany the team to the competition and will be considered by the officials to be the official university representative.

AD.5.1.3 Faculty Advisors:

a. May advise their teams on general engineering and engineering project management theory.

b. Must not design, build, or repair any part of the vehicle.

c. Must not develop any documentation or presentation.

AD.6 REGISTRATION

AD.6.1 General Information

Registration for the SAE Clean Snowmobile Challenge competition must be completed on the Event Website. Online registration must be done by either (a) an SAE member or (b) the official faculty advisor connected with the registering university and recorded as such in the SAE database.

AD.6.2 Entries per University

Registration for the SAE Clean Snowmobile Challenge is limited to one vehicle per university in each of the two categories: Spark Ignited (SI) or Compression Ignition (CI).

AD.6.3 Registration Details

AD.6.3.1 Refer to the Event Website for specific registration requirements and details.

- Registration limits and Waitlist limits will be posted on the Event Website.
- Registration will open at the date and time posted on the Event Website.
- Registration(s) may have limitations

AD.6.3.2 Once a competition reaches the registration limit, a Waitlist will open.

AD.6.3.3 Beginning on the date and time posted on the Event Website, any remaining slots will be available to any team on a first come, first serve basis.

AD.6.3.4 Registration and the Waitlist will close at the date and time posted on the Event Website or when all available slots have been taken, whichever occurs first.

AD.6.4 Registration Fees

AD.6.4.1 Registration fees must be paid to the organizer by the deadline specified on the respective competition website.

AD.6.4.2 Registration fees are not refundable and not transferrable to any other competition.

AD.6.5 Waitlist

AD.6.5.1 Waitlisted teams must submit all documents by the same deadlines as registered teams to remain on the Waitlist.

AD.6.5.2 Once a team withdraws from the competition, the organizer will inform the next team on the Waitlist by email (the individual who registered the team to the Waitlist) that a spot on the registered list has opened.

AD.6.5.3 The team will then have 24 hours to accept or reject the position and an additional 24 hours to have the registration payment completed or in process.

AD.6.6 Withdrawals

Registered teams that will not attend the competition must inform the organizer to officially withdraw by notifying SAE at collegiatecompetitions@sae.org.

AD.7 COMPETITION SITE

AD.7.1 Personal Vehicles

Personal cars and trailers must be parked in designated areas only. Only authorized vehicles will be allowed in the track areas.

AD.7.2 Trash Clean-up

AD.7.2.1 Clean-up 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 a clean paddock

AD.7.2.2 Teams must remove all their material and trash when leaving the site at the end of the competition.

AD.7.2.3 Teams that abandon furniture, or that leave a paddock that requires special cleaning, will be billed for removal and/or clean-up costs.

DR - DOCUMENT REQUIREMENTS

DR.1 DOCUMENTATION

DR.1.1 Requirements

DR.1.1.1 The documents supporting the snowmobile must be submitted by the deadlines posted on the Event Website or otherwise published by the organizer.

DR.1.1.2 The procedures for submitting documents are published on the Event Website or otherwise identified by the organizer.

DR.1.2 Definitions

DR.1.2.1 Submission Date

The date and time of upload to the website

DR.1.2.2 Submission Deadline

The date and time by which the document must be uploaded or submitted

DR.1.2.3 No Submissions Accepted After

The last date and time that documents may be uploaded or submitted

DR.1.2.4 Late Submission

- Uploaded after the Submission Deadline and prior to No Submissions Accepted After
- Submitted largely incomplete prior to or after the Submission Deadline

DR.1.2.5 Not Submitted

- Not uploaded prior to No Submissions Accepted After
- Not in the specified form or format

DR.1.2.6 Amount Late

The number of days between the Submission Deadline and the Submission Date.

Any partial day is rounded up to a full day.

Examples: submitting a few minutes late would be one day penalty; submitting 25 hours late would be two days penalty

DR.1.2.7 Reviewer

A designated event official who is assigned to review and accept a Submission

DR.2 SUBMISSION DETAILS

DR.2.1 Submission Location

Teams must upload the required documents to the team account on the SAE CSC Online Website, see **AD.2.2**

DR.2.2 Submission Format Requirements

Refer to Table DR-1 Submission Information

DR.2.2.1 Template files with the required format must be used when specified in Table DR-1

DR.2.2.2 Template files are available on the SAE CSC Online Website, see **AD.2.2.1**

DR.2.2.3 Do Not alter the format of any provided template files

DR.2.2.4 Each submission must be one single file in the specified format (PDF - Portable Document File, XLSX - Microsoft Excel Worksheet File, etc.)

DR.3 SUBMISSION PENALTIES

DR.3.1.1 Each team is responsible for confirming that their documents have been properly uploaded or submitted and that the deadlines have been met.

DR.3.1.2 Prior to the Submission Deadline:

a. Documents may be uploaded at any time

b. Uploads may be replaced with new uploads without penalty

DR.3.1.3 If a Submitted Document revision is requested by the Reviewer, a new Submission Deadline for the revised document may apply

DR.3.1.4 Teams will not be notified if a document is submitted incorrectly.

DR.3.2 Penalty Detail

DR.3.2.1 Late Submissions will receive a point penalty as shown in Table DR-2, subject to official discretion.

DR.3.2.2 Additional penalties will apply if **Not Submitted**, subject to official discretion

DR.3.2.3 Penalties up to and including Removal of Team Entry may apply based on document reviews, subject to official discretion

DR.3.3 Removal of Team Entry

DR.3.3.1 SAE may remove the team entry when the:

a. Identified documents are **Not Submitted** in 5 days or less from the deadline. Removals will take place after each Document Submission deadline.

b. Team does not respond to Reviewer requests or organizer communications

DR.3.3.2 When a team entry will be removed:

a. The team will be notified prior to cancelling registration.

b. No refund of entry fees will be given.

DR.3.4 Specific Penalties

DR.3.4.1 Chassis Modification, Transmission Modification, or Data Sheet (DS)

a. There is no point penalty for late submissions of these documents.

b. Team must submit this document and be approved otherwise team will not be allowed to run their vehicle onsite.

DR.3.4.2 Program Submissions

Please submit material requested for the Event Program by the published deadlines.

Table DR-1 Submission Information

Submission	Refer to:	Required Format:	Submit in File Format:	Penalty Group
Abstract		see below	PDF	Overall
Technical Design Paper		see below	PDF	Design
Technical Design PPT Slide Deck		See below	PDF	Design
Chassis Modification		see below	PDF	Dynamic
Transmission Modification		see below	PDF	Dynamic
High Pressure Fuel Lines		see below	PDF	Dynamic
Safety Data Sheet (SDS)		see below	PDF	Dynamic
Presentation Pamphlet (if required)		see below	PDF	Present

Format: Use the template file or form available on the SAE CSC Online Website **AD.2.2.1**

Table DR-2 Submission Penalty Information

Penalty Group	Penalty Points per Day	Maximum Point Penalty	**Not Submitted** 5 Days after the Deadline
Abstract	-10	-50	Removal of Team Entry - see **DR.3.3**
Technical Design Paper	-10	-50	Removed from Design Event Score 0 points in Design Event
Technical Design PPT Slide Deck			Removed from Design Event Score 0 points in Design Event
Chassis Modification			Removed from Dynamic Events Score 0 points in Dynamic Events
Transmission Modification			Removed from Dynamic Events Score 0 points in Dynamic Events
High Pressure Fuel Lines			Removed from Dynamic Events Score 0 points in Dynamic Events
Safety Data Sheet (SDS)			Removed from Dynamic Events Score 0 points in Dynamic Events
Presentation Pamphlet (if required)	-10	-50	Removed from Presentation Event Score 0 points in Presentation Event

V - VEHICLE REQUIREMENTS – SNOWMOBILE MODIFICATION

V.1 BASELINE SNOWMOBILE

The intent of the competition is for student teams to modify an existing snowmobile to improve emissions and noise characteristics. Teams choosing to ignore this intent by entering a snowmobile made clean and quite by a manufacturer or aftermarket supplier will be disqualified. Competition organizers will be responsible for making this subjective determination, if necessary.

V.1.1 **SI Teams**

V.1.1.1 SI Teams are expected to provide their own snowmobile for modification.

V.1.1.2 The baseline snowmobile must be a stock qualified snowmobile, defined as a model that was produced in a quantity of at least 300 units.

V.1.1.3 The model year of the base snowmobile must be from the model years 2017 to 2022 inclusive from one of the four major snowmobile manufacturers (Arctic Cat, BRP/Ski Doo, Polaris, or Yamaha).

V.1.2 **CI Teams**

V.1.2.1 CI Teams must choose a snowmobile that is considered a “Utility” snowmobile.

V.1.2.2 The model years of the snowmobile must be from the model years 2017 to 2022 inclusive from one of the four major snowmobile manufacturers (Arctic Cat, BRP/Ski Doo, Polaris, or Yamaha).

V.1.2.3 An approved list is of sleds is provided online www.saecleansnowmobile.com under Series Resources.

V.2 ENGINE

V.2.1 **Permitted Modifications**

V.2.1.1 Modifications to the engine, including substitution of a different engine is allowed.

V.2.1.2 Two-stroke, four-stroke and rotary engines are allowed. There is no displacement limit.

V.2.2 **Permitted Fuel/Additives**

V.2.2.1 All fuel used at competition will be 91 octane, standard pump gas, with the potential of containing up to 10% ethanol.

V.2.2.2 All fuels will be supplied at the competition including fuels for emissions testing.

V.2.3 **Permitted Lubricating Oils**

V.2.3.1 Any type of oil may be used in the modified snowmobiles as long as the oil does not contain any oxygenates or other power boosting additives.

V.2.4 **Turbochargers/Superchargers**

V.2.4.1 The use of turbochargers and superchargers is allowed.

V.2.4.2 Teams must use commercially available turbochargers/superchargers if used.

V.2.4.3 Teams cannot build their own.

V.2.5 **Exhaust Systems**

V.2.5.1 The exhaust system may be modified.

V.2.5.2 Exhaust component should be guarded from human contact. Guards should protect the operator and bystanders from injury due to contact with piping.

V.2.5.3 The exhaust system, piping, and shields must NOT protrude more than three inches beyond the “outer envelope” of the snowmobile.

V.2.5.4 The “outer envelope” is defined for this rule as the outer surfaces of the hood, belly pan, side panels, running boards and bumpers.

V.2.6 **Throttle Requirements**

V.2.6.1 No modifications are allowed to an OEM thumb throttle control or handlebar grips.

V.2.6.2 OEM throttles from a different manufacturer may be used with no modifications. i.e., using a BRP ETC Control Lever on a non BRP Snowmobile.

V.2.7 **Fluid Containment**

V.2.7.1 Snowmobiles must not deposit fuel, coolant, or oil on the ground.

V.2.7.2 Containers chosen for use as reservoirs, overflow containers or as fluid plumbing of any kind must be of professional quality and meet the design requirements for material compatibility, temperature, and pressure. Crankcase/engine breather must be routed back into the engine intake system.

V.2.7.3 Food or beverage containers are NOT suitable or acceptable for this purpose.

V.3 BLOCK HEATERS

V.3.1.1 Block heaters, coolant heaters, or oil heaters are prohibited for any part of the competition.

V.4 DRIVE

V.4.1 **Chain Drive Oil Bath Requirement**

V.4.1.1 Solutions that utilize a chain to drive the primary clutch from the engine are permitted.

V.4.2 **Transmission**

V.4.2.1 Continuously Variable Transmissions (CVTs) are the common way of moving rotational energy from the engine to the track. If a team has an innovative way of moving this energy without use of a conventional CVT, the design must be submitted to the organizers for review prior to competition. This will give organizers time to review the design and bring up any concerns.

V.4.3 **Brake Performance Requirement**

V.4.3.1 All brake modifications are subject to retaining the braking performance of the original snowmobile. This will be tested during the technical inspection before snowmobiles can compete in any dynamic events.

V.4.3.2 All unmodified OEM brake components specific to chosen chassis are permitted.

V.4.3.3 The master cylinder, caliper and rotor assembly must be commercially available.

V.4.3.4 The “commercially available” stipulation can be accomplished.

a. Other brake systems, for example motorcycle, small tractors, and other off-road vehicles may use smaller diameter brakes. The concern is mainly one of the material specifications for the parts. Commercially available systems will most likely satisfy some quality standard for the caliper and rotor assembly regarding the durability of the parts.

V.4.3.5 Brake rotor on drive axle track shaft must be at least seven (7) inches minimum diameter. If the brake is on the jackshaft, the rotor may be smaller than seven (7) inches.

V.4.3.6 Additional brake assemblies may be added. Axle shaft may be lengthened to accommodate additional brakes.

V.4.3.7 Moving the brake to the track drive axle is allowed.

V.4.3.8 Replacement brake rotor of aluminium or carbon fiber is not allowed.

V.4.4 **Brake Control Handle**

The brake control handle must remain in the OEM location (front left side). Brakes must always be operative.

V.4.5 **Brake Rotor Shield**

V.4.5.1 If the brake system is standard as supplied by the manufacturer, no additional brake rotor shield is required.

V.4.6 **Rotor Contact Area**

The rotor pad contact surface area may not be reduced more than 15 percent (15%) of the original pad contact surface area.

V.4.7 **Belt Guard/Clutch Cover**

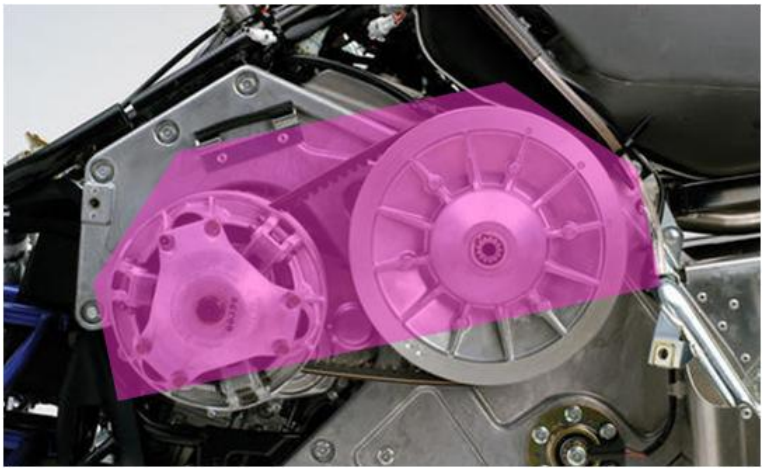
V.4.7.1 The stock belt guard is acceptable provided that both of the following conditions are met:

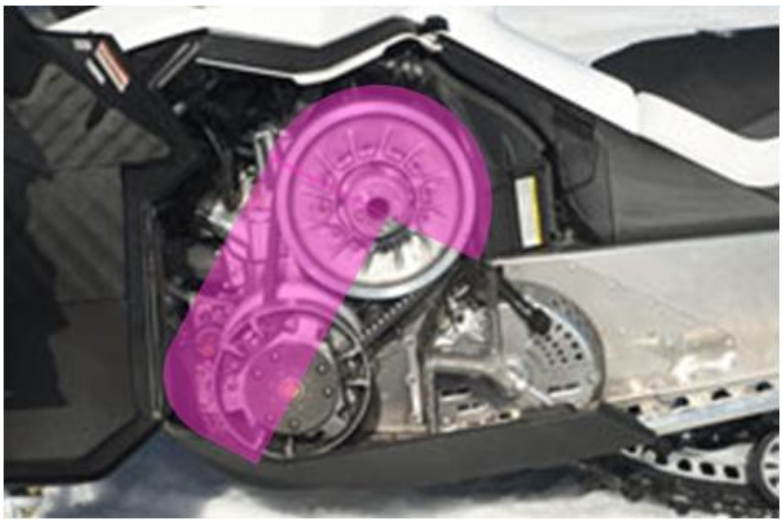
a. The engine has NOT been modified to exceed the manufacturer's recommended top rotational speed or horsepower.

b. The clutches and parts (excluding weights, springs and or ramps/helixes) are Original Equipment Manufacturer specific to the engine.

V.4.7.2 IN all other cases, the stock belt guard must be replaced with a clutch cover. Fabricated clutch covers must be made of 0.090 inch 6061 T6 aluminium or equivalent. The clutch cover must be separate of the cowl configuration and be removable. The clutch cover must shield the operator (including knees, shins, and feet) and bystanders from flying debris related to a belt/clutch failure. Specifically, straight-line paths (in the rotating place of the CVT assembly) to the operator must be interrupted by the combination of the clutch cover and the footrest/stirrup. The clutch cover must also extend below the mounting bolts of the clutch sheaves on the outboard side of the machine. There shall be no open areas wider than 0.5 inch or longer than 1.0 inch on the clutch cover or footrest.

Some examples of proper clutch coverage areas on several common chassis are shown below:





V.4.8 **Moving Parts Isolation**

V.4.8.1 Except for the Belt Guard and Clutch Cover mentioned in V.4.7.2 chains, pulleys and exposed moving parts will be isolated from the driver and other competitors by shields capable of retaining all accidental explosions and component impacts.

V.5 SKIS AND SKI SUSPENSION

V.5.1 **Ski Requirements**

V.5.1.1 Skis must be commercially available.

V.5.2 **Ski and Ski Suspension Modifications**

V.5.2.1 The snowmobile's skis and ski suspension may be modified. However, the snowmobile must remain ski steered.

V.5.3 **Ski Runners**

V.5.3.1 Carbide ski runners are allowed.

V.5.4 **Ski Suspension Requirements**

V.5.4.1 The following measurement procedure will be used to verify ski suspension travel:

a. With the driver in the seated position, a measuring stick will be placed at the front bumper of the snowmobile. This point on the measuring stick will be noted as "Point A".

b. With the driver still on the snowmobile, weight will be added to the snowmobile until the ski suspension is fully compressed. This point will be noted on the measuring stick as "Point B".

c. The ski suspension travel is the distance from "Point A" to "Point B". The ski suspension travel must be equal to or greater than three (3) inches.

d. Adjustments to the ski suspension (spring and damping) are allowed, provided the minimum ski suspension travel of three inches is maintained.

V.5.5 **Steering**

V.5.5.1 The Steering system must have a direct, mechanical link between the handlebars and steering assembly. Steer-by-wire is not allowed.

V.6 TRACK, TRACK SUSPENSION AND TRACTION DEVICES

V.6.1 Track and Suspension Modification

V.6.1.1 The snowmobile's track may be replaced with a different track.

V.6.1.2 The track must be a commercially available, one-piece, molded rubber snowmobile track. The selected, commercially available track may not be modified except for traction studs. The same track design must be used for all events.

V.6.1.3 Commercially available pre-studded tracks from Camso are allowed. If used, Rule V.6.3 does not apply.

V.6.1.4 Tracks specially modified by Camso will be allowed provided the part number and serial number from Camso are provided for verification at the competition. Tracks modified by any other individual or company will not be allowed.

V.6.2 Track Suspension Requirements

V.6.2.1 The following measurement procedure will be used to verify track suspension travel:

a. With driver in the seated position, a measuring stick will be placed at the rear bumper of the snowmobile. This point on the measuring stick will be noted as "Point C".

b. With the driver still on the snowmobile, weight will be added to the snowmobile until the track suspension is fully compressed. This point will be noted on the measuring stick as "Point D".

c. The track suspension travel is the distance from "Point C" to "Point D". The track suspension travel must be equal to or greater than three (3) inches.

d. Adjustments to the track suspension (spring and damping) are allowed, provided the minimum track suspension travel of three inches is maintained.

V.6.3 Traction Control Devices

V.6.3.1 The use of the traction control devices such as ice grousers, grass hooks, or paddles is not allowed.

V.6.3.2 The use of track studs is allowed.

V.6.3.3 Regardless of track length or width, the snowmobile is limited to two (2) commercially available studs per bar, 60-degree unsharpened, unmodified single point studs. See example below:

V.6.3.4 All component of the traction devices must be in the venter of the track between the inside edges of the two slide runners and a minimum 3.75 inches from the edge of the track.

V.6.3.5 The stud may not protrude more than .375 inch above the highest point on the track.

V.6.3.6 Stud backing plate maximum size is 2 inches x 2.25 inches.

V.6.3.7 Backing plates may not extend beyond the height of the rib and must rest against the rib. Sharpening (vertically or horizontally) of the backing plate is not allowed.

V.6.4 **Slide Runner**

V.6.4.1 Slide runners may be drilled.

V.6.4.2 Any commercially available slide runners may be used as a replacement.

V.6.4.3 Inserts may be added to the slide runner.

V.6.4.4 Slide rail lubrication system (ice scratchers) are allowed. Only ice scratchers that do not have to be stowed when in reverse will be allowed.

V.6.5 **Maximum Track Lug Height**

The maximum height of track lugs is two (2) inches.

V.7 FRAME AND BODY

V.7.1 **Rear Snow Flap**

V.7.1.1 A Rear Snow Flap is required.

V.7.1.2 Approved/Accepted Rear Snow Flap:

a. If a team's base sled is a touring/rail/utility sled designed to travel on groomed snowmobile trails, then the stock rear snow flap as provided by the OEM manufacturer is acceptable.

b. Higher clearance snow flaps found on utility sleds with an articulating rear suspension are allowed. This is required for the snow flap to not contact the track when in reverse with the skid articulated up.

V.7.1.3 Not Approved/Not Accepted Rear Snow Flap:

a. Off road or "mountain" sleds typically have rear snow flaps deigned for that purpose and are much higher off the ground therefore are not acceptable.

V.7.1.4 Guidelines for an acceptable snow flap are as follows:

1) Be securely fastened to the tunnel or chassis (a snow flap that falls off or is inadequately held on to the snowmobile during competition will incur penalties for safety and repair).

2) Be wider than the track of the snowmobile. Tapered or shaped snow flaps are allowable provided that the narrowest point is wider than the track.

3) Be in proximity (one inch or less) to the ground when the lightest operator is on the machine.

4) Be adequately rigid (or massive) to remain in close proximity with the ground during high-speed operation.

5) Be adequately supported so that the flap does not get drawn into the track during reverse maneuvers if the snowmobile is equipped with reverse.

V.7.1.5 Snow flaps in question will be dynamically tested. Snow flaps that are deemed to not meet the above criteria will not be allowed.

V.7.1.6 Snow flaps from prior year competition do not necessarily meet the above requirements and are not "grandfathered in".

V.7.2 **Foot Stirrups/Pegs**

Foot Stirrups/foot pegs constructed of rigid materials may be installed.

V.7.3 **Seat**

All sleds will be equipped with an upholstered, padded seat with a minimum thickness of one (1) inch, a length of 24 inches, and a width of the tunnel.

V.7.4 **Front Bumper**

All snowmobiles must have a front bumper strong enough to support the snowmobile while suspended in mid-air (for ease of lifting).

V.7.5 **Chassis Modification**

V.7.5.1 Teams are not permitted to build their own chassis from the ground up. No modifications may be made to the snowmobile chassis that will reduce structural integrity.

a. Traditional snowmobiles have basic chassis consisting of bulkhead and tunnel.

b. Modern snowmobile chassis incorporates a triangle or pyramid to stiffen the bulkhead and tunnel.

V.7.5.2 Teams that modify their snowmobile chassis from stock form will be required to prove their modifications maintain or improve the original structural integrity of the original design. See S.2.3. Both design analysis and quality of fabrication will be considered before team can compete.

V.7.5.3 Modern snowmobiles have areas of the hood, body and side panels that allows for fingers, hands, and even arms to reach into the engine and powertrain areas. These areas must be redesigned so as not to allow any appendages access into the engine or body areas of the snowmobile.

a. The diameter of a finger for this purpose is defined as 12 mm in diameter and no finger shall be permitted to pass through the hole by more than 12 mm.

V.7.6 **Rear Hitch Requirement**

V.7.6.1 The factory rear bumper must be utilized. No custom-made rear bumpers will be allowed.

V.7.6.2 Both CI and SI sleds must have a rear hitch capable of a 0.375-inch pin connection (must have clearance for a 3/8- inch pin) providing at least +45 to -45 degrees of yaw rotation about the pin.

V.7.6.3 The hitch must have flap or pitch rotation of +45 or -45 degrees of rotation. Roll degree of freedom is not required.

V.7.6.4 The hitch must be rigid in fore-aft tension and compression and be capable of withstanding 800 pounds draw bar pull force. Pictured below are examples of snowmobile hitches which may be fabricated or purchased:

V.8 IGNITION AND ELECTRICAL

V.8.1 **Disconnect Tether**

V.8.1.1 All machines must be equipped with a disconnect tether that is always operable.

V.8.1.2 Disconnect tethers must be used and attached to the operator whenever the engine is running.

a. The tether must be connected around the operator's wrist (not to their glove or jacket).

b. No alligator clips are allowed.

c. Maximum tether cord length will be five (5) feet. Verification of the tether cord length will be determined at tether cord's fully extended length from multiple angles.

d. The tether switch will be securely mounted in a location on the snowmobile other than on the handlebars.

V.8.1.3 Battery operated electric fuel pumps and the ignition system must be connected to the tether switch. This includes electrically controlled fuel injection systems.

V.8.2 **Kill Switch**

V.8.2.1 All kill switches must be from a snowmobile manufacturer.

V.8.2.2 All snowmobiles must have a handlebar mounted button (on/off) kill switch on the right side within thumb reach (in addition to the tether switch).

V.8.2.3 Battery operated electric fuel pumps and the ignition system must be connected to the kill switch. This includes electrically controlled fuel injection systems.

V.8.3 **User Selection Switches**

Non-standard user selection switches must be identified.

V.8.4 **Battery Fuel Pumps**

Battery operated electric fuel pumps must be connected to the disconnect tether and kill switch. This includes electrically controlled fuel injection systems.

V.8.5 **Battery Requirements**

V.8.5.1 All batteries will be of a sealed, maintenance-free design.

V.8.5.2 Appropriate batteries include:

a. Valve-Regulated Lead Acid (VRLA) technology, such as gel or absorbed glass mat (AGM) types.

b. Lithium-Ion batteries provided they are 12V replacements intended for use in powersports machines.

V.8.5.3 Flooded/wet-cell batteries are NOT allowed.

V.8.5.4 If there is a question about the battery, teams will be required to present the data sheet and SDS for their battery upon judge's request.

V.8.6 **Battery Terminal Connections**

V.8.6.1 A single wire (4AWG or smaller gauge) is the only connection allowed to each battery terminal. Any power distribution that is required must be done downstream of the battery using a shielded/insulated terminal strip, connector, or fuse block.

V.8.6.2 The single wire connecting to the positive terminal of the battery must be fused upstream of the power distribution but does not need to be fused before connecting to the starter positive lug.

V.8.6.3 Fusing must be sized according to the wire gage used.

V.8.6.4 Circuit breakers or auto-resetting circuit protection such as power distribution modules (PDMs) are allowed.

V.8.6.5 Teams using PDMs must have concise wiring diagram with expected electrical loads to present during tech inspection. This ensures engineering judgement was used in selecting circuit breaking amperage settings, and any risks associated with the undersized wiring are reduced.

V.8.6.6 Both terminals of the battery and connected wiring must be shielded/insulated with a non-conductive boot.

V.8.6.7 The negative terminal of the battery must be grounded to the chassis.

V.8.6.8 A battery disconnect switch is required. This must be easily accessible from the outside of the snowmobile in the event of a fire or other emergency.

V.8.7 **Battery Box Requirements**

V.8.7.1 The battery must be securely held in place so that the battery does not shift or become dislodged in the event of an accident.

V.8.7.2 The battery may be contained in a box, if desired provided that it is vented and non-conductive.

V.8.7.3 Battery boxes do no by themselves satisfy the requirements of securing the battery and shielding/insulating the battery terminals.

V.8.8 **Head, Tail and Brake Light Requirement**

V.8.8.1 All snowmobiles are required to have functional head, tail, and brake lights.

V.8.8.2 Headlights should provide adequate lighting similar or better than OEM lighting

V.9 COMPONENT DELETION

V.9.1 No changes are allowed that would nullify compliance with federal, state, or provincial safety regulations. This includes removal or bypassing emissions components/systems required by the EPA.

V.10 SPEEDOMETER REQUIREMENTS

a. GPS-based
b. Readout in Miles Per Hour (MPH)
c. Minimum size on the readout (1” numeral height or larger)
d. Powered by the sled (not batteries)
e. Securely mounted in an area visible to the driver (no tape or Velcro)

V.11 DESIGN TO PREVENT THERMAL EVENTS

V.11.1 Any material added to the sled in a high temperature area, such as under the hood, near the engine, exhaust, or near the catalytic converter must be verified to withstand the

temperatures without melting, changing dimensions during the competition or catching on fire.

V.11.2 Materials added must be verified through submission of a Safety Data Sheet (DS) and thermal data taken near the area where the material was added.

V.11.2.1 Submit the Safety Data Sheet as described in section DR – Document Requirements.

V.11.3 The organizers reserve the right to question any potentially suspect design and request documentation that the design is properly engineered.

V.12 FUEL LINES

V.12.1 **Supply Side**

V.12.1.1 If the engine being used has high pressure (HP) fuel lines that are not original to the chassis, this must be revealed to the organizers at the time registration or as soon as the decision has been made by the team to use an engine with high pressure fuel lines.

V.12.1.2 High Pressure is defined as 200 psi or greater.

V.12.1.3 Teams must submit an explanation of how they will maintain the integrity of the high-pressure fuel line. Where possible, only production high pressure fuel lines along with their clamps and dampers should be used.

V.12.1.4 HP lines on engine must have shield/guard to prevent cracked line from allowing fuel direct line of sight to student competitors/volunteers.

V.12.1.5 All student lines should have vibration modal analysis performed on them to understand line natural frequency.

V.12.1.6 Clamping/dampers should be used to keep line vibration below 150-micron displacement.

V.12.2 **Return Side**

V.12.2.1 Fuel line used on return side must be metal or rubber line with SAE/ISO certification for 150C minimum.

V.12.2.2 If SAE/ISO certification line operation of 150C is not available present manufacturers certification for review by the rules committee.

V.13 FASTENERS

V.13.1 **Critical Fasteners**

A threaded fastener (bolt, screw) used in a location designated as such in the applicable rule.

V.13.2 **Critical Fastener Requirements**

V.13.2.1 Any Critical Fastener must meet at minimum one of the following:

a. SAE Grade 5
b. Metric Grade 8.8
c. AN/MS Specifications

V.13.2.2 All Critical Fasteners must be one of the following:

a. Hex head
b. Hexagonal recessed drive (Socket Head Cap Screws or Allen screws/bolts)
c. Hexalobular recessed drive (Torx Drive)

V.13.2.3 Some Critical Fastener application have additional requirements that are provided in the applicable section.

V.13.2.4 Critical Fasteners include but are NOT limited to:

a. All steering, suspension, brake system, engine mounting, powertrain accessories, power transmission components (including clutches, jackshaft, driveshaft, chain/belt case/transmission) and guarding components modified from stock.

b. All OEM applications where hardware with locking features is used must also have functioning locking features that are the same type as OEM.

V.13.3 **Securing Fasteners**

V.13.3.1 All Critical Fasteners must be secured from unintentional loosening by the use of the Positive Locking Mechanisms.

V.13.3.2 Positive Locking Mechanisms are defined as those which:

a. The technical inspectors (and team members) can see that the device/system is in place (visible) with the exception of blind hole applications where thread locking compound is required.

V.13.3.3 Technical inspection of fasteners will be done to the best of the ability of the inspectors during inspection of the snowmobile.

V.13.3.4 Fasteners that need to be corrected must be corrected before close of technical inspection, otherwise team will forfeit all dynamic events.

V.13.3.5 Fasteners that fail during an event will result in a Did Not Finish (DNF) and no points will be given.

V.14 IN-SERVICE EMISSIONS EVENT REQUIREMENT

V.14.1 If these requirements are not met during safety inspection, modification by the competing team will be required before they can participate in the In-Service Emissions event.

a. Rear hitch: the sled must have a tow hitch per Rule V.7.6

b. Emissions sample probe: each sled in the competition is required to have a removable exhaust gas-sampling probe and a permanent exhaust gas sample port.

- The probe and port design and installation specification include:

1. The probe diameter should be either 1/4-inch or 3/8-inch OD stainless steel tube with 0.049-inch wall thickness. One end of the sampling probe is cut on a 45-degree angle and the open portion of the tube will face upstream in the exhaust pipe. Both ends of the tube must have a standard Nut-Ferrule set (Swagelok SS-400-NFSET for 1/4-inch OD tube, Swagelok SS-600-NFSET for 3/8-inch OD tube.).

2. The overall length and configuration (bends) of the probe is dependent on the engine/exhaust/sled. A heated sample line must connect to the end of the probe and its location and routing must be taken into consideration for the in-service event where the cowling is installed, and the heated sample line must run from the sleigh to the probe.

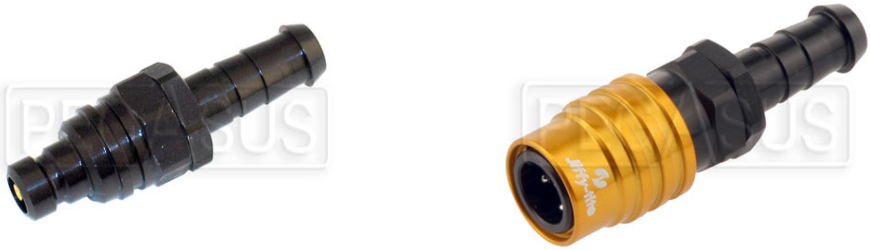
3. An adapter which mates the exhaust probe must be welded to the exhaust pipe to create the sample port. Swagelok fitting SS-400-1-4BT for 1/4-inch OD probe or Swagelok fitting SS-600-1-4BT for 3/8-inch OD probe shall be used as the sample port.

4. Swagelok Plug (SS-400-P for 1/4-inch, SS-600-P for 3/8-inch) is used to cap the port when the probe is not installed. Alternatively, a short probe can be left in place and capped (Swagelock SS-400-C for 1/4-inch for OD prove or Swagelock SS-600-C for 3/8-inch OD probe).
5. The adapter (sample port) must be welded to the exhaust to provide a leak-free joint. Do not use epoxy as shown in photo.

- Probe and sample port location requirements:
  1. For systems without after treatment, the probe must be placed after the point at which the exhaust from all cylinders is well mixed, a minimum of five (5) pipe diameters downstream of the last “Y” connection.
  2. For systems with air injection or after treatment, the probe must be placed a minimum of five (5) pipe diameters downstream of the converter outlet.
  3. For all systems, the probe must be placed a minimum of 12 inches upstream of the end of the exhaust pipe or seven diameters, whichever is greater.
- If the probe is placed in the actual muffler, the full exhaust stream must pass perpendicular to the probe. It may not be placed at a point where the exhaust stream has been separated into multiple streams for noise treatment purposes.
- Exhaust Extensions. Rule V.2.5 states the exhaust pipe must not protrude more than three (3) inches. In some cases, for the emission events an exhaust system extension is required to satisfy the 12 inch or seven (7) diameters upstream requirement for the sampling location. If an exhaust extension is to be used only for the emissions event, then the exhaust pipe connections must be made with a Marman V-band clamp and flanges. The Marman style joint is a leak-free connection while providing the structural integrity required to withstand the conditions encountered during the in-service event.

c. Fuel system connection:

- All competition snowmobiles must use Jiffy-tite 2000-series, fuel system couplers with fluorocarbon seals on supply and return (if equipped) lines. Fuel should flow out of the “plug” and into the “socket”.
- The fuel lines and couplers must be routed away from and exit the engine compartment away from the exhaust system components due to potential safety concerns. (i.e., fuel ignition).
- Removal of major components of the snowmobile, such as the seat, fuel tank, or exhaust system to access the fuel system couplers is unacceptable.
- All fuel lines must be labelled as “Supply” and “Return” near the fuel system couplers.



Jiffy-tite plug (left) and socket (right) fittings (for reference)

VE - VEHICLE AND DRIVER EQUIPMENT

VE.1 VEHICLE IDENTIFICATION

VE.1.1 Vehicle Number

VE.1.1.1 The assigned vehicle number must appear on the vehicle as follows:

a. Locations: in four (4) places, both sides of the hood and tunnel.

b. Size: Each number must be at least 4” tall and 1” wide

c. Color: Must be in contrasting colors.

VE.1.2 University Name

Each vehicle must clearly display the university name.

a. Locations: in two (2) places, both sides of the snowmobile.

b. Size: Each letter must be at least 4” tall and 1” wide.

VE.1.3 SAE Logo

The SAE International Logo must be displayed on the front and/or both sides of the vehicle in a prominent location.

VE.2 VEHICLE EQUIPMENT

VE.2.1 Fire Extinguisher

VE.2.1.1 Each team must have at least two fire extinguishers.

a. One must be mounted on the rear of the sled and be easily accessible by course workers.

b. One must be brought to technical inspection with mounting accessories; it will be used as replacement if needed.

Except for the initial inspection, one extinguisher must readily be available in the team’s paddock area, and the second must accompany the vehicle wherever the vehicle is moved. Both extinguishers must be presented with vehicle at Technical Inspection.

VE.2.1.2 Each fire extinguisher must meet the following:

a. Capacity: 0.9 kg (2 lbs)

b. ABC Dry chemical/dry powder or 1.75 liters Aqueous Film Forming Foam (AFFF)

c. Equipped with a manufacturer installed pressure/charge gauge indicating a full charge.

d. Extinguishers of larger capacity (higher numerical ratings) are acceptable.

VE.2.1.3 Fire extinguishers must be labelled with school name and vehicle number.

VE.2.1.4 Fire extinguisher mounted to rear of sled must be securely fastened to the vehicle frame and it must resist shaking loose in normal riding conditions including but not limited to small jumps and rough trail riding, while allowing course workers to remove it easily if necessary.

VE.2.1.5 If the fire extinguisher falls off the snowmobile during an event the team, the team will not be given a score resulting in a DNF, for that event

VE.2.1.6 The wall mount that comes with extinguisher is not sufficient. Fire extinguisher mounts should be quick release, robust and made for vehicle mounting. Below are examples of approved mounts:

- Drake FIREX-MNT-DOR or Drake FIREX-MNT-S-DOR

VE.2.2 Warm-up Stand

VE.2.2.1 Teams must have a warm-up stand in order to warm up snowmobile. No manual holding the track off the snow is allowed.

VE.2.2.2 The warm-up stand must meet these criteria:

a. Designed to catch and retain track, track cleats, traction components and other items that might be thrown by the track.

b. The stand must be no more than six (6) inches from the rear of the tunnel opening and no more than 12 inches from the track.

c. Will be constructed of metal equivalent to 6061T6 aluminium, 1/8-inch think.

d. Side panels are mandatory, and they must extend at least to the center of the rear axle.

e. Sides and back must be secured inside the framework.

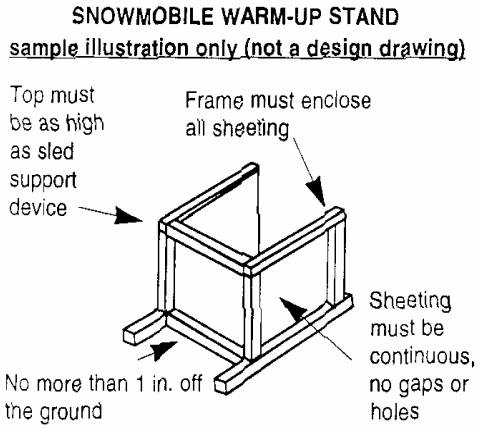
f. Vertical coverage must be no more than one (1) inch off the ice and as high as the snowmobile support device.

g. Coverage must be continuous (no lightening holes).

h. A plywood liner is recommended to help absorb impact.

i. Stand must maintain sufficient height to prevent track coming into contact with ground/ice surface.

A sample illustration of a snowmobile warm-up stand is provided below courtesy of International Snowmobile Racing Association.



VE.3 DRIVER PROTECTIVE EQUIPMENT

VE.3.1 General

VE.3.1.1 Any Driver Equipment:

a. Must be in good condition with no tears, rips, open seams, areas of significant wear, abrasions or stains which might compromise performance.

b. Must fit properly

c. May be inspected at any time

VE.3.1.2 Officials may impound any non-approved Driver Equipment until the end of the competition.

VE.3.2 Helmet

VE.3.2.1 Full coverage helmets that meet Snell 2015 or ECE Regulation 22, Rev 4 (or newer) are mandatory.

VE.3.2.2 Helmets must be worn and securely fastened by all drivers whenever operating a snowmobile.

VE.3.2.3 Helmets may be equipped with a chin or full-face guard that pivots or flips up for the rider's convenience. These structures are considered integral parts of the helmet and helmets equipped with them must always be used in their downward locked position, or in accordance with the instructions form the manufacturer.

VE.3.2.4 Eye protection is required.

VE.3.2.5 Helmet modifications (custom paint, decals, Mohawks, POV cameras, etc) are not allowed.

VE.3.3 Clothing and Boots

VE.3.3.1 Gloves and clothing, along with boots (above the ankle) are mandatory.

VE.3.3.2 The driver's jacket and pants must have an outer layer that is water and wind resistant.

VE.3.3.3 Cotton pants, blue jeans and other absorptive fabrics are prohibited.

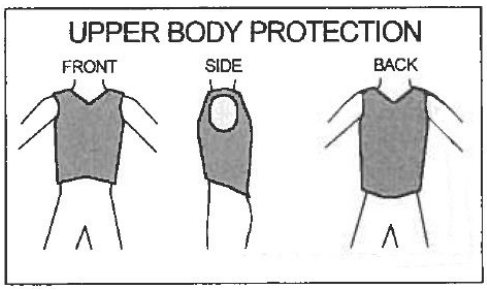
VE.3.4 Shin/Knee Guards

VE.3.4.1 Shin/Knee guards are mandatory and must be worn on both legs.

VE.3.4.2 Shin/knee guards must extend from the top of the boot to above kneecap and be constructed of an impenetrable material.

VE.3.5 Jacket/Vest

VE.3.5.1 A jacket or vest that conforms to International Snowmobile Racing guidelines must be worn by drivers in all competition events to protect the upper body. A sample illustration of approved upper body protection is provided below (courtesy of the International Snowmobile Racing Association):



VE.3.5.2 Typical motocross/ATV chest protectors do NOT satisfy this requirement.

VE.3.6 Penalties

VE.3.6.1 Twenty-five (25) penalty points will be assessed for each individual not wearing appropriate driver's gear each time the individual is observed to be in violation of the rule by a competition official.

VE.3.6.2 Appropriate driver's gear must be worn any time a snowmobile is in motion.

IN - CONDUCT OF THE EVENT

IN.1 SNOWMOBILE OPERATING REQUIREMENTS

IN.1.1 Team Responsibility

IN.1.1.1 Teams are responsible to confirm that their vehicle and the required equipment satisfies the requirements and restrictions of the SAE Clean Snowmobile Rules before Technical Inspection.

IN.1.1.2 Teams will fill out and sign their own technical inspection forms indicating they have checked all items prior to entering Technical Inspection.

IN.1.1.3 It is the responsibility of participating teams to arrive at competition prepared for inspection per event schedule.

IN.1.2 Disconnect Tether and Kills Switch

IN.1.2.1 Each snowmobile must be equipped with a disconnect tether and a separate kill switch as described in Rule V.8.1

IN.1.2.2 Twenty-five (25) penalty points will be assessed each time the tether is not properly utilized when the engine is on.

IN.1.3 Moving Snowmobiles and Test Drives/Practice

IN.1.3.1 When snowmobiles are driven anywhere but in practice areas, snowmobile trails or roadways they must be driven at a walking pace.

IN.1.3.2 During the performance events when the excitement is high, it is particularly important that the snowmobile is drive at a very slow pace.

IN.1.3.3 The walking rule will be enforced, and point penalties assessed for violations of this rule.

IN.1.3.4 Test drives may only be made:

a. After the sled has passed technical inspection

b. During scheduled practice periods

c. In practice areas designed by the organizers

IN.1.3.5 Teams operating their sled outside the hours and areas designated by the organizers will be disqualified from the competition.

IN.1.4 Support Snowmobiles

IN.1.4.1 The equipment listed in Rule V.3 must always be worn when any team member is on any snowmobile that is in motion.

IN.1.4.2 The same penalties described in V.3.5 will be applied to team support snowmobiles.

IN.1.5 Warm-Up Stands

IN.1.5.1 Snowmobiles may be warmed up before competing in events. However, this warm-up must take place with the snowmobile mounted in a snowmobile stand only.

IN.1.5.2 Twenty-five (25) penalty points will be assessed each time this rule is violated.

IN.1.5.3 The stand must be used whenever the rear of a machine is raised to clean out the engine or track, and during warm-up.

IN.1.5.4 Teams may not run their snowmobile engine in the shop/pit area unless directed to do so by an organizer or judge.

IN.1.6 Drafting Prohibited

IN.1.6.1 Drafting is defined as following another vehicle closer than three (3) snowmobile lengths at cruising speeds for sustained periods of time.

IN.1.6.2 Infractions of this rule may be reported by other competitors or by competition officials.

IN.1.6.3 Drafting of other snowmobiles will not be allowed during Endurance event.

IN.1.6.4 Twenty-five (25) points per occurrence will be deducted for drafting if teams violate this rule.

IN.2 TECHNICAL INSPECTION

IN.2.1 Procedure

IN.2.1.1 Technical inspection will examine all items included on the tech inspection form plus any other items the inspectors may wish to examine to ensure conformance with the rules.

IN.2.1.2 The exact procedures and instruments employed for inspection and testing are entirely at the discretion of the Chief Technical Inspector(s).

IN.2.1.3 If any noncompliance is found, the team will be promptly notified. Teams must correct all noncompliance's before the snowmobile is permitted to compete in any event.

IN.2.1.4 Not passing technical inspection in timely manner could result in loss of participation in scored events.

IN.2.1.5 Both static and dynamic inspection will be performed on each sled. Sample forms for all technical inspection used can be found online the competition website under Series Resources.

IN.2.1.6 Passing inspection does not in any way imply that SAE, the CSC organizer, or any individuals acting on their behalf verify that the snowmobiles is safe for use. It is the sole responsibility of participating teams to ensure that their snowmobiles are safe for entry in the competition.

IN.2.2 Technical Inspection Authority

Decisions of the Chief Technical Inspector(s) and the organizing committee concerning vehicle compliance are final and may not be appealed.

IN.2.3 Re-inspection

Officials may reinspect any vehicle at any time during the competition.

IN.3 ONSITE MODIFICATION (PENALTIES)

IN.3.1.1 Hoods will be sealed, and engine calibrations will be frozen after the technical inspection with "serial numbered" strap. Teams must make appropriate modification to their hood to accommodate sealing with two 7-inch long 1/4-inch-wide tie straps.

IN.3.1.2 If data ports are not under the hood, they will be sealed, and engine calibrations will be frozen after the technical inspection with "serial numbered" label. Teams must provide a cap to block off data port and provide sufficient area around data port for label to be adhered.

IN.3.1.3 Accidental breakage of the seal must be reported immediately.

IN.3.1.4 No telemetry will be allowed. Teams are not allowed to remotely alter calibrations during events.

IN.3.1.5 No non-standard user input (other than power, ignition, starter and kill switches) is allowed to powertrain (includes engine intake, base engine, engine exhaust, or drivetrain).

IN.3.1.6 Twenty-five (25) penalty points will be assessed if the hood seal is broken by anyone other than a competition official.

IN.3.1.7 Once the hood seal is broken, the liaison or competition official will log the reason for the opening and supervise the modification. New hoods seals will be installed, and the serial number of the new seals will be recorded.

IN.3.1.8 Breaking of the seals will be supervised by competition officials at two specific times during the competition without penalty to inspect for rules compliance. Teams must wait for a competition official before breaking the seals to avoid penalty. These inspection times will be:

a. At the conclusion of the Endurance Event

b. At the beginning of the In-Service Emission Test for each sled.

IN.3.1.9 Additional hood openings may be requested to inspect engine area. No changes or modification to snowmobiles will be allowed after technical inspection except for:

a. Those required to fix compliance issues.

b. Those required to return the snowmobiles to operating condition after a breakdown.

c. Per Rule IN.5.2, penalty points may be applied.

IN.3.1.10 If any of the above modifications are to be made, the snowmobile must be serviced in the designated work area. The team may not return the snowmobile to its trailer to perform above maintenance items. Any team that violates this policy will be disqualified from the competition.

IN.4 LEAKS

The following information describes the different types/classes of leaks and how they affect the status of a vehicle. Class I and II leaks are considered minor leaks and operations can continue under these conditions. When operating with these types of leaks, fluid levels must be checked regularly. Class III leaks must be reported for corrective action.

IN.4.1 Class I Leaks

Class I leaks are identified by a wetness or discoloration not great enough to form drops. It is more of a seepage thank a leak.

IN.4.2 Class II Leaks

Class II leaks are identified by a flow of fluid great enough to form drops but not great enough to cause the drops to fall from the leak point.

IN.4.3 Class III Leaks

IN.4.3.1 Class III leaks are identified by a flow of fluid great enough to form drops that fall from the leak point.

IN.4.3.2 A Class III leak is unacceptable, regardless of the dipstick indicator and operation of the vehicle must cease.

IN.4.3.3 If the leak is repairable and repaired in time, then after repair the team could continue in the next events of the competition.

IN.5 PERMITED MAINTENANCE ITEMS

IN.5.1 No Penalty Maintenance

IN.5.1.1 Teams must notify and obtain permission from the competition officials before any permitted maintenance is performed.

IN.5.1.2 The following list of maintenance can be made without penalty.

a. Addition of any fluid – same fluid must be used throughout competition
b. Track alignment and tension adjustment
c. Drive belt/chain tension adjustment
d. Headlight bulbs, taillight bulbs, brake light bulb replacement or repair if not working
e. Tightening of loose bolts: suspension mounting, suspension front limiter strap, ski saddle, and spindle
f. Lubrication of snowmobile parts
g. Tightening of rear idler wheel bolts and idler adjusting bolt jam nuts.
h. Oil/fuel filter replacement

IN.5.1.3 Changes in suspension to accommodate rider weight will be allowed in Rule V.5.1.4 and V.6.2.

IN.5.2 Penalty Maintenance

IN.5.2.1 Teams may be allowed to replace engine parts during the competition.

IN.5.2.2 The penalty points for replacing engine parts are as follows providing the design of the engine compared to what was presented at technical inspection is not changed:

- Spark plug: 5 points per plug
- Fuel Injectors: 5 points per injector
- Piston: 10 points per piston
- Crankshaft: 50 points
- Crankcase: 50 points
- Connecting rods: 10 points
- Cylinder: 50 points
- Head gasket: 5 points
- Turbo charger: 20 points
- Total engine: 200 points

Items not listed will be individually evaluated.

Note: The intent of this rule is to allow 1000-mile maintenance items to be performed throughout the competition without penalty. Organizers reserve the right to modify and add to this list as conditions demand.

IN.6 FUEL AND LUBRICATING OIL AT COMPETITION

IN.6.1 Fuel

IN.6.1.1 Teams are required to power their snowmobile with the fuel provided throughout the competition by Gage Products, Inc.

IN.6.1.2 Teams are required to use the provided fuel for all events.

IN.6.1.3 Teams are not allowed to drain their tanks prior to or after any event.

IN.6.1.4 Organizers may decide to top off snowmobile fuel tanks before an event.

IN.6.2 Lubricating Oil

IN.6.2.1 Competing teams are responsible for providing their own lubrication oil.

IN.6.2.2 Teams will not be allowed to switch the type of lubrication oil they are using once the competition has begun.

IN.6.2.3 Oil must be added in the presence of an official and must come from a factory sealed container. Doing so without approval from a competition official will result in disqualification.

S - REQUIRED SUBMISSIONS AND SCORED EVENTS

S.1 SAFETY SUBMISSIONS

S.1.1 Chassis Modification

S.1.1.1 Only teams who are making modification to the chassis from its original OEM production state need to submit this requirement.

S.1.1.2 If your sled has been modified in previous year(s) it is the responsibility of the team to still submit this form for the current competition year.

S.1.1.3 Document submission should consist of detailed pictures, drawings and analysis results along with an explanation for why the team is modifying their chassis.

S.1.1.4 Organizers and judges will review and provide feedback to teams. Teams must be approved in order to compete onsite.

S.1.1.5 Chassis Modification does not have a template available, but teams should submit the document as described in section DR – Document Requirements.

S.1.2 Transmission Modification

S.1.2.1 Only teams who are making modification of their transmission from a conventional CVT need to submit this requirement.

S.1.2.2 Document submission should consist of detailed design plans and drawings of moving energy without conventional CVT.

S.1.2.3 Organizers and judges will review and provide feedback to teams. Teams must be approved in order to compete onsite.

S.1.2.4 Transmission Modification does not have a template available, but teams should submit the document as described in section DR – Document Requirements.

S.1.3 High Pressure Fuel Lines

S.1.3.1 Teams who are choosing to use an engine with high pressure fuel lines need to submit this requirement.

S.1.3.2 Document should provide detailed explanation of how the team will maintain the integrity of the high-pressure fuel line on their selected engine.

S.1.3.3 Organizers and judges will review and provide feedback to teams.

S.1.3.4 High Pressure Fuel Line does not have a template available, but teams should submit the document as described in section DR – Document Requirements.

S.1.4 Safety Data Sheet

S.1.4.1 Only teams choosing to add material in high temperature areas on their sled need to submit this requirement.

S.1.4.2 Teams must submit a Safety Data Sheet (SDS) on the material and thermal data taken near the area where the material was added.

S.1.4.3 Organizers and judges will review the information to verify the material will withstand the temperatures.

S.1.4.4 For this submission, teams should submit the document as described in section DR-Document Requirements.

S.2 SCORED SUBMISSIONS

S.2.1 Abstract

S.2.1.1 Each team must submit the standardized abstract template posted online the competition website.

S.2.1.2 The abstract is designed to clearly provide expectations for student teams prior to the competition and allow for quick evaluation by judges. Teams must strictly follow the template and are expected to complete every section appropriately.

S.2.1.3 Abstracts will be shared with competition organizers, design paper and technical presentation judges for them to evaluate how well a team was able to set and achieve goals for the competition year.

S.2.2 Engineering Design Paper

S.2.2.1 Each team must submit an engineering design paper.

S.2.2.2 The Engineering Design Paper should contain:

a. A brief description of the snowmobile with your team's design objectives.

b. Innovations. This section will be used to collect information regarding awards that key in on innovation. If it is not mentioned in this section, it will not be considered for an innovation award.

- For returning teams, this section must include all the changes and innovations made to the snowmobile compared to the previous year's entry. If the base snowmobile chassis or engine is different, state this in this section. Also label and include any part of the snowmobile that includes an innovative design approach or part.
- For first year teams, simply include innovative approaches and parts in our new entry.

c. Team Organization and Time Management. In this section, describe how the team was formed, who is in charge and of what and how timelines were set and monitored from start of project to the first day of competition.

- Include Gantt charts and organizational charts were appropriate. In appendices are fine.
- In addition to the actual project organization and timelines, include any outreach activities related to the team for fundraising, team building, or other educational purposes.

d. Accurate description of the build items of the competing snowmobile in the following order:

1. Chassis – Manufacturer, Model, year of production
2. Engine – Manufacturer, Fuel (Gasoline or Diesel), Model, 2 or 4-stroke, combustion volume in cubic centimeters, peak horsepower (note if horsepower is estimated from specifications or measured by the team)
3. Track – Manufacturer, style, supplier of traction studs if used
4. Muffler – Manufacturer or student designed
5. Catalytic Converter – Manufacturer, style
6. Skis – stock or aftermarket
7. Other significant additions to the snowmobile

e. Discussions on the design content of the snowmobile to address the major design objectives of clean, quiet and fuel efficient. The headings and the content are up to the authors discretion.

S.2.2.3 The Engineering Design Paper format:

a. Limit of 10 pages of content will be strictly enforced, but unlimited pages for resources/appendix/supporting data (Graphs, charts, tables)

b. Headings for each section must be **Bold, Times New Roman, size 11 font.**

c. Body content must be Times New Roman, size 9 font.

d. Paper must be in a two-column format.

Note: Teams may be requested to submit an additional copy of the Engineering Design Paper with entire content submitted in Times New Roman, size 16 font. Page limit will not apply to this submission if requested.

S.2.2.4 CSC Engineering Design Template is available online competition website under Series Resources.

S.2.2.5 CSC Engineering Design Scoring Rubric is available online competition website under Series Resources. The weighting of points in each category is noted on the form.

S.2.2.6 Engineering Design Paper Scoring will be comprised of the judges' score average. The minimum requirement to receive points in this event will be to submit a paper according to the rules. If the judges' average score is less than five points, the team will receive five points.

S.2.2.7 Any paper that shows overlap of 20%+ uncited work with content from previous year submission will result in organizers authority to assign zero (0) points for design event.

S.2.2.8 Submit the Engineering Design Report as described in section DR – Document Requirements.

S.3 PRESENTATION EVENTS

S.3.1 Presentation Event Logistics

S.3.1.1 Presentations may be conducted onsite or in virtual environment prior to competition.

S.3.1.2 Teams will be notified via website announcements and posted deadlines.

S.3.1.3 Teams will be assigned a specific time slot closer to the competition and be notified typically within two weeks of the onsite or virtual event.

S.3.2 Engineering Technical Presentation

S.3.2.1 The goal of this event is to evaluate the knowledge of the presenters related to the projects and the rationale used by the team in project selection.

S.3.2.2 A 60-minute time slot will be assigned for team oral presentation to describe and defend the improvements made to the snowmobile intended for a highly technical audience. Please anticipate questions throughout the presentation that may require extensive explanation.

S.3.2.3 The goal of the presentation is to allow the team adequate time to deep dive into the projects they selected. Major talking points in this presentation should include, but are not limited to:

a. Initial project selection

b. Background/research into the project

c. Prototyping

d. Implementation

e. Testing/data analysis and results

S.3.2.4 Teams are expected to focus on projects that are newly implemented for the current year's competition. Historical projects can be assumed to be understood by judges and should not be discussed in detail unless there are marked improvements.

S.3.2.5 This is not a marketing presentation. This is intended for a highly technical audience and should be treated as such.

S.3.2.6 These presentations will be less formal than marketing presentations. Teams may use other reference documentation outside of the presentation slides, if necessary, i.e., an example could include additive manufacturing proto parts.

S.3.2.7 Each team is required to submit an electronic version of the oral technical presentation to competition organizers via. Teams that do not submit presentations will be assessed a score of zero points.

S.3.2.8 Technical presentation scoring will be conducted by judges who will primarily consist of engineers but may include some non-technical personnel. Scores will be averaged across all judges scores for the team final score.

S.3.2.9 Technical Presentation Scoring Rubric can be found online competition website.

S.3.3 Value Benefit Analysis Presentation

S.3.3.1 The intent of this event is to allow teams to present their new innovations and evaluate their feasibility in mass production; not to penalize teams for bringing expensive improvements or innovation that cannot scale to mass production.

S.3.3.2 Teams are required to create a presentation focusing on two major improvements that have been to the snowmobile for the current year's vehicle and evaluate the improvement from a value/benefit perspective.

S.3.3.3 A 20-minute oral presentation describing the improvements made to the snowmobile intended for a technical audience is required. There will be 10 minutes allocated for questions and answers at the end.

S.3.3.4 Team's presentations must include, but are not limited to:

a. General overview of the component being analyzed

b. Prototype development

c. Testing and data analysis

d. Mass production analysis

e. Value evaluation

S.3.3.5 At least one component must fall under a major category of clean, quiet or fuel efficient.

S.3.3.6 The second component may also address those categories or could alternatively be targeted at rideability, ergonomics, performance, etc.

S.3.3.7 For a mass production evaluation, teams may assume a fleet size of 50,000 snowmobiles annually and a four-year implementation period for their innovation. Any deviation outside of these numbers is allowed but will require adequate explanation as to why it was altered.

S.3.3.8 Teams will not be evaluated on the total cost of the components but rather the team's evaluation of the systems. No points will be allocated based on the overall cost of the system, nor its impacts on various events throughout the competition.

S.3.3.9 Scoring will be conducted by judges who will primarily consist of engineers but may include some non-technical personnel. Scores will be averaged across all judges scores for the team final score.

S.3.3.10 Value Benefit Analysis Presentation Scoring Rubric can be found on the competition website.

S.3.4 Sales Presentation

S.3.4.1 The objective of the sales presentation event is to evaluate the team's ability to develop and deliver a comprehensive business case that will convince outside interests to invest in the team's concept that can be profitably manufactured and marketed.

S.3.4.2 The comprehensive business case may have a logistical, production or technical focus.

S.3.4.3 The sales presentation should include high level technical data (HP, mpg, weight, etc), customer feedback, market comparison and any other sections the teams feel would help with the presentation.

S.3.4.4 Teams should assume that judges represent different areas, including engineering, production, marketing, and finance, and may not all be engineers.

S.3.4.5 Presentation will be evaluated on content, organization, visual aids, delivery, and the team's response to the judges' questions.

S.3.4.6 Scores will be averaged across all judges scores for the team final score.

S.3.4.7 Business Presentation Scoring Rubric can be found on the competition website.

S.3.4.8 Presentations are limited to a maximum of ten (10) minutes. The judges will stop any presentation exceeding the limit.

S.3.4.9 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.

S.3.4.10 Only judges may ask questions. Only team members who are part of the "presentation group" may answer the judges' questions.

S.3.4.11 All team members who will give any part of the presentation, or who will respond to the judges' questions, must be in the presentation area when the presentation starts and must be introduced and identified to the judges.

S.3.4.12 Teams planning to use data projectors, visual display devices (tablets, computers, etc.) or other communication means as part of their presentation are responsible for bringing, or otherwise arranging for their own projection equipment.

S.4 ENDURANCE EVENT

S.4.1 Purpose of Endurance Event

S.4.1.1 To evaluate the endurance and durability of the competition snowmobile.

S.4.2 Endurance Event Description

S.4.2.1 Teams will travel approximately 100 miles (trail section dependent on snow conditions) to the finish point.

S.4.2.2 Teams must plan for at least 100 miles of travel without refueling.

S.4.2.3 Both SI and CI sleds will run the endurance event.

S.4.3 Endurance Rules

S.4.3.1 The fuel tanks will be filled to within three (3) inches of the top of the filler spout.

S.4.3.2 A trail judge will maintain a speed consistent with trail conditions following all trail signs and rules.

S.4.3.3 The snowmobile and driver's ability must be capable of safely driving at steady speeds up to 45 mph.

S.4.3.4 If a snowmobile cannot maintain progress with the trail judge, they will fail the event.

S.4.3.5 If the trail judge determines the snowmobile cannot maintain progress as a result of means other than mechanical failure, for example not enough power, veering off trail, etc. the snowmobile will fail the event.

S.4.3.6 During the Endurance Run, any failure of the snowmobile, parts falling off (including fire extinguisher), fire or other significant thermal event will result in "Did Not Finish" (DNF) from the event.

S.4.4 Endurance Scoring

S.4.4.1 Teams that complete the endurance event will receive 100 "passing points".

S.4.4.2 The minimum performance level on this event is traveling 500 feet. Teams will be awarded five (5) points if the sled travels 500 feet.

S.5 OBJECTIVE AND SUBJECTIVE NOISE

S.5.1 Purpose of the Noise Event

S.5.1.1 To determine the peak A-weighted sound pressure level generated by each snowmobile during a steady state pass-by test.

S.5.1.2 In additional, the subjective noise performance (sound quality) of each snowmobile at a bystander location will be evaluated.

S.5.2 Sound Description

S.5.2.1 The current sound requirements for SSCC Snowmobile Certification (Requirements of all production snowmobiles) are to meet SAE J192: Maximum Exterior Sound Level for Snowmobiles & SAE J1161: Operational Sound Level Measurement Procedure for Snowmobiles.

S.5.2.2 The SAE J192 is a wide-open throttle test and was implemented as a qualifying gate for access to the scored 35 mph BAT sound test.

S.5.2.3 The SAE J1161 is a steady state 15 mph pass by test and will not be performed at competition.

S.5.2.4 SAE J192 Pass-by-Sound -Qualifying Gate

To pass this test, the snowmobile must have a sound pressure level equal or less than a control sled provided by the organizers that has been certified to pass the J192 test requirements. Sound pressure is dependent on many factors including snow conditions, wind, temperature, and barometric pressure. Therefore, a control sled that has passed the test will be used and we assume the sound pressure measured on that sled is affected to the same degree as team sleds. This assumption is not perfect as the J192 is very sensitive to traction and vehicle power, therefore the control sled will be of typical performance (110-130 hp). This means that the environmental and ground conditions should affect the control led to a similar degree as it does the team sleds. Teams' sound pressure level will be compared against the most recent control sled run (closet in time and most similar in conditions). All J192 tests will be conducted in a four (4) hour time period to minimize changing weather conditions. The test course will be moved to maintain consistent results at the discretion of the event judges. If the

team passes the J192 test, they can proceed to the next tests, BAT (Modified J1161) and Sound Quality detailed below.

S.5.3 BAT Objective Sound – Scored Event

S.5.3.1 The requirements used in this event mirror the test used for snowmobile operation in Yellowstone National Park. This test is the National Park Service Best Available Technology (NPS BAT).

S.5.3.2 Note that the current BAT test procedure is the same as J1161 with the exception of operating speed and sound pressure requirements. BAT tests were initially based on SAE J192 standard (WOT) but changed to the 35-mph test in 2015 when NEW BAT was implemented. Since then, a more stringent standard has been released, EBAT, and it consists of a reduction in permissible sound level.

S.5.3.3 Since CSC scoring is a relative scale, the sound pressure limit listed in either BAT requirement (2015 + NEW BAT or EBAT) is not meaningful to CSC. Event scoring is detailed in a later section.

S.5.3.4 This group of tests will be conducted in a four (4) hour time period to minimize the influence of changing weather conditions. The test course will be moved to maintain consistent results at the discretion of the event judges.

S.5.3.5 Environmental factors and snowpack conditions are known to greatly affect the results obtained using the sound pressure tests. A control sled will be used for the NPS BAT pass-by scored event to understand the influence of conditions. This will allow for a fair comparison of the competition sleds as changes in the control sled sound pressure can be used as offset on competition sleds in an attempt to remove the effect of conditions from the results. This action will be taken at the discretion of event judges once control sled run-to-run variation has been found.

S.5.3.6 The control sled will be a production unit provided by an OEM and certified to meet SSCC sound requirements: SAE J192 & SAE J1161. Effort will be made to use a control sled that has been New BAT certified, but is not guaranteed, and is irrelevant to scoring Team's performance. There will be no pass/fail criteria for the BAT test. The control sled will only be used to understand how test course & environmental conditions are affecting the results.

S.5.3.7 Each snowmobile will be driven at 35 mph by a competition judge according to the published procedure SAE J1161 Recommended Practice.

S.5.3.8 Every reasonable effort will be made to provide a test site that conforms to SAE J1161 specifications; however, this cannot be guaranteed due to changing weather conditions.

S.5.3.9 A binaural recording system will be placed on one side of the vehicle acceleration lane, also at a distance of 50 feet, for the recording of subjective noise playback files. The side on which the recording system is placed will be chosen by the event staff immediately before the noise event.

Note on Dependence of Snowmobile Pass-by Sound Testing on Weather & Surface Conditions

S.5.3.10 The event timing is subject to change depending on weather conditions. Once the test is scheduled, all available participants must be tested in the time window of the event since there is no good way to compare sound pressures taken under different conditions.

S.5.3.11 There will be no makeup sound tests.

S.5.4 Objective Noise Scoring for SI Sleds

S.5.4.1 Teams will receive a maximum of 200 points on an exponential scale consistent with sound pressure versus loudness.

S.5.4.2 Four runs will be performed per machine, with measurements taken on both sides, the three most consistent runs per side will be averaged.

S.5.4.3 The louder side of the vehicle will be reported and will be rounded to the nearest half-dBA.

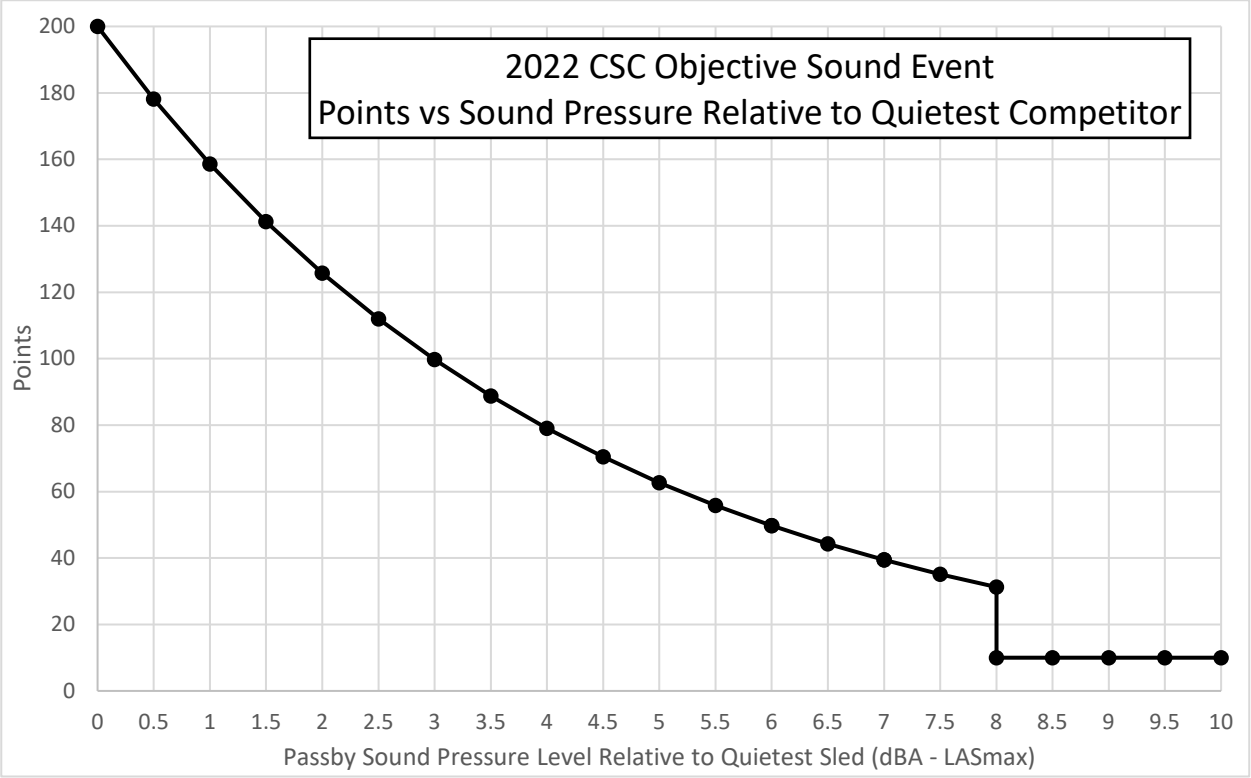
S.5.4.4 A 3dBA increase in sound pressure level over the quietest competition sled will result in a reduction of points by one half.

S.5.4.5 Similarly, a 6dBA increase in sound pressure level will result in a reduction of points by about three-fourths.

S.5.4.6 Teams that are more than 8dBA higher than the quietest competition sled will receive a flat rate of 10 points.

S.5.4.7 Points scaling is defined independently by the following table and curve for each class:

x (dBA over Quietest Competition Sled)	y (Points)
$0 \leq x \leq 8$	$e^{-.232x}$
$x > 8$	10



S.5.5 Subjective Noise Scoring

S.5.5.1 Data from the above BAT Objective Sound Event will be recorded for playback to a "blind jury". The jury will consist of attendees to the SAE CSC competition.

S.5.5.2 Jury members will be screened to determine their ability to discern the noise playback files. Acceptable jury members will evaluate and grade the playback files. Jury members will not be given the team's name of the sound file.

S.5.5.3 Scoring will be based on a linear relationship from worst to best. The scale will be 100 points.

S.6 ACCELERATION TESTING EVENT

S.6.1 Purpose of the Acceleration Testing Event

S.6.1.1 To determine the acceleration performance of each snowmobile.

S.6.2 Acceleration Testing Event Description

S.6.2.1 Each snowmobile will be drive by a student participant during this event. The snowmobile will be accelerated from a standing stop to the maximum speed it can achieve in 500 feet.

S.6.2.2 The snowmobile will be timed from start to finish, the lower the time the better.

S.6.2.3 Teams will have two times to run this event and the best time will be used for scoring.

S.6.2.4 To pass this event, the elapsed time must be equal to or less than 10 seconds.

S.6.2.5 All drivers must wear the proper safety gear as instructed per the rules.

S.6.3 Acceleration Testing Event Scoring

S.6.3.1 The team with the lowest time to reach 500 feet (best of two runs) will receive 50 points.

S.6.3.2 The minimum performance level will be to reach 500 feet in 10 seconds for SI sleds

S.6.3.3 Any team that passes the event by reaching 500 feet in 10 seconds or less will receive the minimum performance level of 2.5 points.

S.6.3.4 The remaining sleds will receive additional points on a linear scale from the fastest measured time (50 points) to the slowest allowable time (10 seconds).

S.7 OBJECTIVE HANDLING & DRIVABILITY EVENT

S.7.1 Purpose of Objective Handling & Drivability Event

S.7.1.1 To objectively evaluate the agility and maneuverability of each competition snowmobile.

S.7.2 Objective Handling & Drivability Event Description

S.7.2.1 A student driver from each team will be allowed to complete two (2) consecutive individually timed laps on a slalom style course.

S.7.2.2 The fastest lap time will be recorded for scoring.

S.7.2.3 No adjustments to the snowmobile will be allowed between laps.

S.7.2.4 A one (1) second penalty will be assessed for each cone or flag hit.

S.7.2.5 A five (5) second penalty will be assessed if the entire sled does not stop within the designated stopping area.

S.7.3 Objective Handling & Drivability Rules

S.7.3.1 The handling event will consist of a course designed to challenge the snowmobiles in the areas concerned with handling.

S.7.3.2 The snowmobiles will be driven by a student team member. This team member must wear the proper safety gear to be eligible for this event.

S.7.4 Objective Handling & Drivability Scoring

S.7.4.1 The scoring for the event will be based on a linear scale from the fastest time (75 points) to the slowest time which will receive 3.75 points.

S.7.4.2 The minimum performance level will be to complete one lap of the course.

S.8 SUBJECTIVE HANDLING & DRIVABILITY EVENT

S.8.1 Purpose of the Subjective Handling & Drivability Event

S.8.1.1 To subjectively evaluate the agility and maneuverability of the competition snowmobile.

S.8.2 Subjective Handling & Drivability Event Description

S.8.2.1 Judges will drive each competition snowmobile through a course designed to evaluate handling and drivability.

S.8.2.2 Lap times will not be recorded. Rather, the judges will evaluate ride quality based on criteria on the Subjective Handling & Drivability Event Judging Form located online competition website under Series Resources.

S.8.3 Subjective Handling & Drivability Rules

S.8.3.1 The handling event will consist of a course designed to challenge the snowmobiles in the areas concerned with handling and overall drivability.

S.8.3.2 The snowmobiles will be driven by competition judges.

S.8.4 Subjective Handling & Drivability Scoring

S.8.4.1 The scoring for the event will be based on the judge's ranking of each snowmobile according to the scoring rubric.

S.8.4.2 Points will be awarded based on the average of the judges' scores.

S.8.4.3 The minimum performance level is allowing the judges to evaluate the subjective ride of the sled.

S.8.4.4 If the judges' scores average below 2.5, the team will receive 2.5 points.

S.9 COLD START EVENT

S.9.1 Purpose of Cold Start Event

S.9.1.1 To test the snowmobiles' ability to start its engine when it is cold, relative to its normal operating temperature after being cold soaked overnight.

S.9.1.2 Teams will have exactly 20 seconds to start their snowmobile; the use of external help such as ether is not allowed. Use of external help will disqualify a team.

S.9.1.3 To pass the event, the snowmobile must start in 20 seconds and then move forward without stalling 100 feet within 120 seconds.

S.9.1.4 The minimum performance level of the event is starting within 20 seconds.

S.9.2 Cold Start Event Scoring

S.9.2.1 If a snowmobile does not start within 20 seconds, the team will fail the event and receive zero (0) points.

S.9.2.2 If a snowmobiles' engine stalls during the 100 feet movement, the team will fail and receive zero (0) points.

S.9.2.3 Snowmobiles that start within 20 seconds but fail to move 100 feet in 120 seconds will receive a minimum performance level of 2.5 points.

S.9.2.4 Snowmobiles that start within 20 seconds and move 100 feet in 120 seconds will receive 50 points.

S.10 IN-SERVICE EMISSION EVENT

S.10.1 Purpose of the In-Service Emission Test

S.10.1.1 Measure the rate of gaseous emissions emitted and fuel consumed from each snowmobile over a range of operating conditions, while operating on snow.

S.10.2 In-Service Emission Event Description

S.10.2.1 Both SI and CI vehicles will vary from 20 mph to 45 mph to simulate actual vehicle operations on a snowmobile trail.

S.10.2.2 Carbon monoxide (CO), nitrogen oxide (NO), and total hydrocarbon (THC) emissions as well as fuel consumption will be measured while the snowmobile is operated by the event coordinator around a pre-defined test course.

S.10.2.3 If your snowmobile cannot pull the sleigh at 45 mph, you will not get any points for this event. The in-service sleigh weighs approximately 350 lbf.

Figure 1. In-Service emissions sleigh being pulled by competition snowmobile

S.10.3 In-Service Emission Test Procedure

S.10.3.1 Sled will be driven by a competition organizer on a closed course.

S.10.3.2 Every effort will be made to drive the sleds in an identical and consistent manner to create a fair comparison of design. No excessive acceleration, steering, or braking maneuvers will be conducted.

a. The first lap is to warm up the snowmobile and to familiarize the driver with the operation of the snowmobile.

b. Gaseous emissions and fuel consumption will be measured for laps 2, 3, and 4 on a second-by-second basis.

c. The emissions components (CO, NO, and THC) will be converted to grams and summed for laps 2, 3, and 4 (not averaged). The sum of emissions will be divided by the total distance travelled to compute g/mile.

d. Fuel economy (miles/gallon) will be computed knowing total fuel consumption and the distance travelled for the three laps.

e. THE RAW DATA WILL BE GIVEN TO TEAMS IN .CSV FORMAT WITH AT LEAST THE FOLLOWING MEASURED:

- Vehicle Speed (miles/h)
- GPS coordinates
- Fuel Consumption rate (kg/hr)
- Exhaust Air Fuel Ratio (AFR or Lambda? Depends on method…)
- Exhaust emissions gasses in PPM as well as g/hr
- Other?
- Exhaust gases will be measured and scored on g/mile with equal weighting.
- HC + NOx and CO

S.10.4 Scoring

S.10.4.1 The minimum performance level for this event will be to pull the sleigh at the required speed of the event. For this the team will receive 2.5 points.

S.10.4.2 A team will receive 200 points if their combined emissions (CO+NO+THC) is 0g/mile.

S.10.4.3 A SI team will receive 2.5 points if their combined emissions (CO+NO+THC) exceeds 100g/mile.

S.10.4.4 The following linear interpolation assigns points based on the 0 g/mile and 100 g/mile limits.

a. SI In-Service Emissions Points = -1.975*[(CO+NO+THC (g/mile)] +200

S.10.4.5 A CI team will receive 2.5 points if their combined emissions (CO+NO+THC) exceeds 5 g/mile.

S.10.4.6 The following linear interpolation assigns points based on the 0 g/mile and 5 g/mile limits.

a. CI In-Service Emissions Points = -39.5*[(CO+NO+THC (g/mile)]+200

S.10.4.7 The minimum fuel economy to receive any points for SI sleds is 5 PMG. The minimum fuel economy to receive any points for CI sleds is 10 MPG.

S.10.4.8 Fuel economy (miles/gallon) scores between zero (0) and 200 points will be awarded according to a linear scale.

a. SI Fuel Economy Points = 8*[MPG] – 40

b. CI Fuel Economy Points = 6.67*[MPG] – 66.7

S.11 POINT DISTRIBUTION

S.11.1 Overall Scores

S.11.1.1 Overall scores will be determined based on maximum points according to the following:

Abstract	50 points
Engineering Design Paper	100 points
Engineering Technical Presentation	100 points
Value Benefit Analysis Presentation	50 points
Sales Presentation	150 points
In-service Emissions	200 points
In-service Fuel Economy	200 points
Endurance Event	100 points
Acceleration Event	150 points
Objective Handling Event	100 points
Subjective Handling Event	50 points
Objective Noise Event	200 points
Subjective Noise Event	100 points
Cold Start	50 points
Total Points	1500 points