



The SAE Clean Snowmobile Challenge 2004 Rules

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2004 Clean Snowmobile Challenge Rules

1. BACKGROUND

1.1 Introduction

The Society of Automotive Engineers Clean Snowmobile Challenge 2004 (SAE CSC2004) is an engineering design competition for college and university student members of the Society of Automotive Engineers (SAE), organized and administered by the SAE and the Keweenaw Research Center (KRC). Competition organizers will allow up to twenty teams to compete in the SAE CSC2004. The modified snowmobiles will compete in a variety of events including emissions, noise, fuel economy/endurance, acceleration, handling, braking, static display, cold start and design.

1.2 Competition Objective

The intent of the competition is to develop a snowmobile that is acceptable for use in environmentally sensitive areas. The modified snowmobiles are expected to be quiet, emit significantly less unburned hydrocarbons and carbon monoxide than current production snowmobiles, without significantly increasing oxides of nitrogen emissions. The modified snowmobiles are also expected to be cost-effective. The intent of the competition is to design a touring snowmobile that will primarily be ridden on groomed snowmobile trails. The use of unreliable, expensive solutions is strongly discouraged!

2. COMPETITION ELIGIBILITY AND RULES

2.1 Team Eligibility

Registration into the 2004 Clean Snowmobile Challenge is limited to teams of undergraduate and graduate students from accredited universities. High school teams are prohibited.

2.2 Team Member Eligibility

Undergraduate participation is strongly encouraged. Graduate student participation is allowed, but limited to no more than 25% of the undergraduate participation on any individual team.

2.3 University Collaboration

Collaboration between schools will be accepted if both schools meet all requirements stated in these rules.

2.4 Entries per University - One

Registration into the 2004 Clean Snowmobile challenge is limited to one vehicle per university.

2.5 Registration Limit – 20 Vehicles

Registration into the 2004 Clean Snowmobile Challenge is limited to 20 vehicles.



2.6 Registration Deadline – December 15, 2003

Registrations will be accepted in the order in which they are received starting October 1, 2003 and ending at midnight, Eastern Standard Time, Sunday, December 15, 2003 **or** when 20 teams have registered, whichever occurs first.

The registration fee must be paid on-line by credit card at the time of registration. Registration fees may not be paid by any other means.

There is **no** late registration and there are **no exceptions** to this registration policy.

2.7 Individual Participant Requirements

Individual members of teams participating in this competition must satisfy the following requirements:

Student Status: Team members must be enrolled as degree seeking undergraduate or graduate students. Team members who have graduated during the seven (7) month period prior to the competition remain eligible to participate.

SAE Membership: Team members must be members of SAE. Proof of SAE membership is required at the event.

Comment: Students may join SAE online at:

http://www.sae.org/servlets/preLogin?REQUEST_TYPE=StudentApplication

Liability Waiver and Insurance: All on-site participants and faculty are required to sign a liability waiver upon registration. Individual medical and accident insurance coverage is the sole responsibility of the participant.

2.8 Driver Requirements and Limitations

All snowmobile drivers must be at least eighteen (18) years of age and have, and present proof of:

-A valid government issued highway driver's license and

-Medical and accident insurance coverage

2.9 Ringers Prohibited

In order to maintain the credibility of fair competition at SAE the Clean Snowmobile Challenge competitions, the Faculty Advisor must prohibit "ringers." A ringer is someone that has exceptional skills related to the competition who cannot be a legal member of the team.

2.10 Faculty Advisor

All teams entering the Clean Snowmobile Challenge competition must have a faculty advisor. The faculty advisor is encouraged to accompany the team to the competition. The faculty advisor will serve as a liaison between the team and the officials and oversee the team's conduct and responsibilities at all times. It is recommended that the faculty advisor also be an SAE member.



2.11 International Participation – U.S. Visa Letters

International teams requiring visa letters to enter the United States must fill out the on-line form a minimum of 3 weeks prior to the event in which they are competing at: <https://shop.sae.org/calendar/visaform.shtml>

2.12 International Participation – Vehicle Shipping/US Customs

SAE & the Clean Snowmobile Challenge Organizers strongly recommend that international teams ship their vehicle(s) early in order to allow enough time to compensate for any delays that may occur in clearing U.S. Customs. Please check with the United States Customs Service concerning the regulations governing the temporary importation of vehicles. You may want to consider using the services of a freight forwarder who is familiar with the international shipping of racing vehicles.

SAE staff and the Clean Snowmobile Challenge Event Organizers are not permitted to provide advice on U.S. Customs matters.

2.13 Rules Authority

The SAE Clean Snowmobile Challenge rules are issued under the authority of the SAE Student Activities Committee. Official bulletins from SAE and/or the organizer shall be considered a part of, and shall have the same validity as these rules.

In case of doubt or ambiguity as the wording or intent of these rules, the decision of the organizer shall prevail and will be binding on all parties concerned except as provided under the protest and appeal procedures specified herein.

Infractions of these rules can lead to point penalties and, in extreme cases, the prohibition of the team and vehicle from the competition. Safety and good sportsmanship will not be compromised.

Note: The 2004 rules are revised from previous year. These rules supersede all previous Clean Snowmobile Challenge rules.

2.14 Organizer Authority

SAE and the Organizers of the competition reserve the exclusive right to revise the schedule of the competition and/or to interpret or modify the competition rules at any time and in any manner which is, in their sole judgment, required for safety or efficient operation of the competition.

2.15 Rules Compliance

By entering the Clean Snowmobile Challenge competition the team, faculty advisor, and the members of the team as individuals agree to comply with, and be bound by, these rules and any procedures announced by the event organizers and SAE.

2.16 Participating in the Competition

Teams, team members and faculty advisors are considered to be “participating in the competition” from the time they arrive on-site until they depart at the conclusion of the Clean Snowmobile Challenge or otherwise withdraw from the event.



2.17 Violations of Intent



The violation of the intent of a rule will be considered a violation of the rule itself. Questions about the intent of a rule may be addressed to the organizer.

3. MEDICAL INSURANCE

All snowmobile drivers must present proof of medical insurance coverage that is valid in the United States.

4. SNOWMOBILE MODIFICATION

4.1 Baseline Snowmobile

SAE CSC2004 teams are expected to provide their own snowmobile for modification. The baseline snowmobile must be a stock qualified snowmobile, defined as a model that was produced in a quantity of at least 500 units.

The intent of the SAE CSC2004 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 quiet by a manufacturer or aftermarket supplier will be disqualified. Competition organizers will be responsible for making this subjective determination, if necessary.

4.2 Engine

4.2.1 Permitted Modifications

Modifications to the engine, including substitution of a different engine are allowed.

Two-stroke, four-stroke, and rotary engines are allowed. Engine displacement is limited to 600 cc or less for two-stroke and rotary engines, 960 cc or less for four-stroke engines.

4.2.2 Permitted Fuels/Additives

Snowmobiles must be fueled with a blend of 10% ethanol and 90% premium gasoline or 85% ethanol and 15% premium gasoline. Once a fuel has been selected the team must continue to use the same fuel for all events. Fuel additives (with the exception of commercial two-stroke oil) are not permitted. Fuel choices must be sent to organizers by January 30, 2004.

4.2.3 Permitted Lubricating Oils

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.

4.2.4 Turbochargers/Superchargers

The use of turbochargers and superchargers is allowed. All superchargers must have a restraint system to prevent them from being blown free of the engine; this includes a flexible blanket shield. Snowmobiles with an unshielded supercharger will not be allowed to compete in the SAE CSC2004.



4.2.5 Exhaust Systems

The exhaust system may be modified, but must meet or beat sound and emission standards detailed in SAE CSC2004 Rules 9.9 and 9.6. The exhaust system emission pipe must not protrude more than three (3) inches beyond the chassis or hood configuration.

4.2.6 Throttle Requirements

An adequate return spring on the throttle is required. The throttle must remain on the right side. The throttle will be operated with a direct mechanical operated thumb mechanism located on the handlebar to the rear of the machine (no twist grips).

4.2.7 Block heaters are prohibited for any part of the Challenge.

4.3 Drive

4.3.1 Chain Drive Oil Bath Requirement

Solutions that utilize a chain to drive the primary clutch from the engine are permitted. However, this design solution has historically created excessive temperatures and has been prone to failure. Therefore, if this type of drive system is selected, the chain must be enclosed in a case with a constant oil bath.

4.3.2 Transmission

The snowmobile must be propelled with a variable ratio belt transmission.

Exception: This requirement will be waived for electric drive designs.

4.3.3 Brake Performance Requirement

All brake modifications are subject to retaining the braking performance of the original snowmobile. This will be tested during the safety/tech inspection before snowmobiles are allowed to compete in the SAE CSC2004.

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

The "commercially available" stipulation can be accomplished two ways. Other brake systems, for example motor cycle, small tractors, and other off-road vehicles may use smaller diameter brakes. The concern is mainly one of 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.

The second way is to reduce the rotor diameter of a commercially available system. At least then you have started with parts that again satisfy some material standard. In stopping snowmobiles, usually the brakes lock up and the snowmobile slides on the snow, so there is plenty of clamping force available. A 15% reduction in surface area will probably not change this.

If the secondary brake is on the track shaft, the rotor may be smaller than 7". Additional brake assemblies may be added. Brake rotor on drive axle track shaft must be at least seven (7) inch minimum diameter. Axle shaft may be lengthened to accommodate additional brakes.



Moving the brake to the track drive axle is allowed. The brake components must be commercially available and the pad contact area cannot be reduced by more than 15%.

Replacement brake rotor of aluminum or carbon fiber is not allowed.

4.3.4 Brake Control Handle

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

4.3.5 Brake Rotor Shield

Brake rotor must be covered with a shield capable of retaining an accidental explosion.

4.3.6 Rotor Contact Area

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

4.3.7 Clutch Cover

Clutch cover must be separate of the cowl configuration and cover both clutches down to the center of the bolts or below. It must be made of 0.090 inch 6061 T6 aluminum or equivalent and be covered with 6-inch belting. Belting refers to woven nylon or Kevlar belting that is used as supplemental explosion containment on drag racing cars and various other vehicles. Similar material is also used for such things as automobile tow straps. A thinner, single ply version is also used for automobile seat belts.

Carbon fiber clutch covers are not permitted. Snowmobiles with removable side panels may bolt clutch cover guard to side panel to meet this requirement.

4.3.8 Moving Parts Isolation

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. No holes may be drilled in protective shields.

Chains that drive the primary clutch from the engine must be enclosed in a case with a constant oil bath per SAE CSC2004 Rule 4.3.1.

4.4 Skis and Ski Suspension

4.4.1 Ski Requirements

Skis must be commercially available.

4.4.2 Ski and Ski Suspension Modification

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

4.4.3 Ski Runners

Carbide ski runners will be allowed at the CSC2004 competition.

4.4.4 Suspension Requirements

Sleds must have a minimum of six (6) inches usable ski suspension. Usable means with rider on sled. Steel springs were required in previous years. Non-



steel springs will be allowed in CSC2004. Teams will be required to justify the durability and the practicality of the use of non-steel springs in their design presentations and papers.

4.5 Track, Track Suspension, and Traction

4.5.1 Track and Track Suspension Modification

The snowmobile's track may be replaced with a different track. The track must be a commercially available, one piece, molded rubber snowmobile track. The selected, commercially available track may not be modified. The same track design must be used for all events.

4.5.2 Track Suspension Requirements

The snowmobile's track suspension may be replaced and/or modified.

Sleds must have a minimum of six (6) inches travel in usable track suspension. Usable means with rider on sled. Steel springs were required in previous years. Non-steel-spring suspensions will be allowed in CSC2004. Teams will be required to justify the durability and the practicality of the use of non-steel-spring suspensions in their design presentations and papers.

4.5.3 Traction Control Devices

The use of traction control devices such as studs, ice grousers, or paddles is not allowed.

4.5.4 Slide Runner

Slide runners can be drilled. OEM type slide runners may be used as a replacement. Inserts may be added to the slide runner.

Slide rail lubrication systems are not allowed.

4.5.5 Maximum Track Lug Height

The maximum height of track lugs is 2 inches.

4.6 Frame and Body

4.6.1 Rear Snow Flap

A rear snow flap of sufficient material to restrain traction components if thrown from the track will be installed in a permanent manner and shall be held down so as to contain all mud, snow, rocks, water, etc., at all speeds. The snow flap must overlap from outside of tunnel to outside of tunnel, one (1) inch outside the widest part of the rear tunnel opening. The snow flap must be in contact with the course surface when the rider is on the sled.

4.6.2 Snow Flap: Twin Track

Two (2) separate flaps may be used on twin track sleds.

4.6.3 Snow Flaps: Fastening

The use of springs and/or elastic material for holding down and fastening snow flaps is not acceptable.

4.6.4 Foot Stirrups/Pegs

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



4.6.5 Seat

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

4.6.6 Body Modification

The snowmobile body may be modified. The hood must have top and side cowling and must contain at least one thousand three hundred (1300) square inches.

4.6.7 Front Bumper Requirement

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

4.6.8 Decal Space Requirement

Two hundred (200) square inches of space must be left free on the hood/tunnel of the snowmobile for sponsorship decals to be placed upon arrival to the competition.

4.6.9 Team Number

The team number must appear on both sides of the snowmobile hood. The number must be six (6) inches high, $\frac{3}{4}$ inches wide, and be displayed in contrasting colors. The team number must also be displayed in contrasting colors on both sides of tunnel, minimum of four (4) inches high.

Team numbers are automatically assigned upon completion of on-line registration. Team numbers can be found on the "Registered Teams" section of the CSC website.

4.6.10 Chassis Modification

The snowmobile chassis (bulkhead and tunnel) must be from a stock qualified snowmobile (a snowmobile that was produced in a quantity of at least 500 units). 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.

If a Team makes modifications to the snowmobile chassis, they will be required to explain to the Safety Inspector what steps (including computer modeling and analysis) were taken to ensure structural integrity and durability.

4.7 Ignition and Electrical

4.7.1 Safety Disconnect Tether

All machines must be equipped with a safety disconnect tether that is operable at all times. Safety disconnect tethers must be used and attached to the operator whenever the engine is running. The tether must be connected around the operator's wrist (not to his glove or jacket). No alligator clips are allowed. 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. The tether switch will be securely mounted in a location on the snowmobile other than on the handlebars.



4.7.2 Battery Fuel Pumps

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

4.7.3 Battery Box Requirements

All batteries, regardless of type, must be fully enclosed and sealed in a vented, non-conductive box. The purpose of this box is two-fold. First, for unsealed batteries, the box will prevent an acid spill in the event of an accident or "unusual attitude". And second, for all batteries, the non-conductive box will prevent the positive and negative terminals of the battery from contacting conductive material and/or sparking and start a fire (in case of an accident).

NOTE: Venting typically consists of a 1/8" rubber line vented out the bottom of the snowmobile. Battery boxes may be lined with non-conductive material...but the lining must be secure enough to serve its purpose in an accident and/or unusual attitude. Positive terminal must be shielded. Battery box must be securely held in place.

The stock battery box is acceptable if and only if it is modified to meet the above requirements.

No exceptions to this safety concern. If the safety inspectors are not satisfied that this modification has been made properly, the sled will not compete.

4.7.4 Head, Tail, and Brake Light Requirement

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

4.8 Component Deletion

No changes are allowed that would nullify compliance with federal, state, or provincial safety regulations.

4.9 Regarding Electric and Hybrid Electric Designs

The electric snowmobile must compete in all events. Scoring for fuel economy and emissions will be at the discretion of the judges based on how well the team explains the difference between their design and the ethanol powered snowmobiles. For example, the team must calculate their fuel economy based on some measured criteria (state of charge, current consumed, etc.) and show how this compares to miles per gallon with and ethanol powered snowmobile. For the emissions score, the team must explain how their snowmobile is charged, where the energy comes from to charge, and what pollutants were generated in that process. The team must convert this information back to units used in the emissions test for the ethanol powered vehicles for comparison. Failure to do this will result in a zero score for emissions and fuel economy. Provisions for putting the electric snowmobile on the emissions dynamometer must be made, exactly the same as for the ethanol powered snowmobiles. The electric snowmobile will be tested for the same time period as the other snowmobiles on the emissions test stand. Power measurements will be made and used in the evaluation, along with the explanation of what pollutants are created in charging the electric snowmobile.

In other words, the burden is put on the electric team to explain how their design compares to ethanol powered snowmobiles. It is possible that an electric powered



snowmobile could win the challenge, provided it performs well in all aspects of the competition. Just because it does not emit HC, CO, and Nox during the competition will not guarantee that. Depending upon the performance and the explanation, the judges may decide to create a separate category or award for the electric snowmobile entries.

5. RULE QUESTIONS, DISCUSSION, AND COMMUNICATION

5.1 Question Submission

All SAE CSC2004 rule questions must be submitted via the Rule Questions folder in the SAE Clean Snowmobile Challenge Public Discussion Forum on the SAE Website. Questions must include the appropriate SAE CSC2004 Rule #. Organizers will answer questions in the CSC Forum as soon as the Rules Committee agrees upon answers. It is the responsibility of all SAE CSC2004 participants to monitor this forum to keep up to date on competition questions. Answers will not be distributed individually to teams. (http://forums.sae.org/access/dispatch.cgi/CLEAN_SNOWMOBILE)

5.2 Loopholes and Problems

Any perceived loopholes in or potential problems with the rules should be provided to organizers via the Rules Questions folder in the SAE Clean Snowmobile Challenge Public Discussion Forum on the SAE Website. Suggestions for rule changes must reference the appropriate SAE CSC2004 Rule #, state the current wording of the rule, and contain a suggestion of how the rule should be changed. (http://forums.sae.org/access/dispatch.cgi/CLEAN_SNOWMOBILE)

5.3 Engineering Ethics

The SAE Clean Snowmobile Challenge 2004 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 rule will be considered a violation of the rule.

5.4 Participants' Discussion

A Participants' Discussion folder has been provided in the SAE Clean Snowmobile Challenge Public Discussion Forum on the SAE Website. Participants are encouraged to use this folder to ask questions of and share information with other CSC2004 teams. (http://forums.sae.org/access/dispatch.cgi/CLEAN_SNOWMOBILE)

5.5 Competition Information

Miscellaneous information regarding competition logistics and administration will periodically be posted in the Competition Information folder in the SAE Clean Snowmobile Challenge Public Discussion Forum on the SAE Website and also on the Clean Snowmobile Challenge Website. It is the responsibility of all SAE CSC2004 participants to monitor both the forum and website and have the most recent competition information. (http://forums.sae.org/access/dispatch.cgi/CLEAN_SNOWMOBILE)

6. CONDUCT OF THE EVENT

6.1 Safety

The overriding emphasis of the SAE CSC2004 and all its events is on safety. Any unsafe behavior during the SAE CSC2004 will result in disqualification of the student team.



6.1.1 Safety/Technical Inspection

A safety/technical inspection of each snowmobile will be performed after it arrives to the competition. If safety or rule violations are found, the team will be promptly notified. The team must correct all safety issues and rule violations before the snowmobile is permitted to compete in any event.

It is the responsibility of participating teams to arrive at the competition prepared for the inspection.

Passing the safety/technical inspection does not imply that SAE, the SAE CSC2004, or any individuals acting on their behalf certify that the snowmobile is safe for use. It is the sole responsibility of participating teams to insure that their snowmobiles are safe for entry in the SAE CSC2004.

It is the intent of competition organizers to weigh snowmobiles during the safety/technical inspection. Snowmobiles will be weighed with full fuel. Snowmobile weights will be used for informational purposes only.

6.1.2 Safety Disconnect Tether

Each snowmobile must be equipped with a safety disconnect tether as described in SAE CSC2004 Rule 4.7.1. Twenty-five (25) penalty points will be assessed each time the safety tether is not properly utilized when the engine is on.

6.1.3 Moving Snowmobiles

When snowmobiles are driven anywhere but in practice areas, snowmobile trails, or roadways they must be driven at a walking pace. During the performance events when the excitement is high, it is particularly important that the snowmobile be driven at a very slow pace. The walking rule will be enforced and point penalties will be assessed for violations of this rule.

6.1.4 Support Snowmobiles

Support snowmobiles may be allowed during certain events. The safety equipment listed in SAE CSC2004 Rules 6.2.1 - 6.2.2 must be worn at all times any team member is on any snowmobile that is in motion. The same penalties described in SAE CSC2004 6.2.4 will be applied to support snowmobiles. Keweenaw Research Center Test Course guidelines (available upon request) apply to all support snowmobiles.

6.1.5 Warm up Stands

Snowmobiles may be warmed up before competing in events. However, this warm-up must take place with the snowmobile mounted in a snowmobile safety stand. You MAY NOT warm up the snowmobile by manually holding the track off of the snow. Twenty-five (25) penalty points will be assessed any time this rule is violated.

The warm-up stand must be designed to catch and retain track, track cleats, traction components and other items that might be thrown by the track. The stand must be no more than six (6) inches from the rear of the tunnel opening and no more than twelve (12) inches from the track. The safety stand will be constructed of metal equivalent to 6061T6 aluminum, 1/8 inch thick. Side panels are mandatory and they must extend at least to the center of the rear axle. The sides and back must be secured inside the framework. Vertical coverage must be

no more than one (1) inch off the ice and as high as the snowmobile support device. Coverage must be continuous (no lightening holes). A plywood liner is recommended to help absorb impact. Safety stand must maintain sufficient height to prevent track coming into contact with ground/ice surface. The stand must be used whenever the rear of a machine is raised to clean out the engine or track, and during warm-up.

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



6.2 Driver Protective Equipment

6.2.1 Helmet Requirement

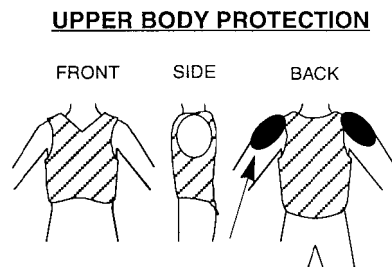
Full coverage helmets (Snell 95 or newer) are mandatory. The helmet must be securely fastened at all times. Eye protection is required.

6.2.2 Clothing and Boots

Gloves and clothing, along with at least above the ankle boots are mandatory.

6.2.3 Safety Jacket/Vest

A safety jacket/vest that conforms to International Snowmobile Racing guidelines as well as shin and knee guards made of an impenetrable material must be worn by drivers during all competition events. A sample illustration of approved upper body protection is provided below (courtesy of the International Snowmobile Racing Association).



6.2.4 Penalties

Twenty-five (25) penalty points will be assessed for each individual not wearing appropriate safety gear each time the individual is observed to be in violation of



the rule by a SAE CSC2004 official. Appropriate safety gear must be worn any time a snowmobile is in motion.

6.3 On Site Modifications Prohibited

No changes or modifications to snowmobiles will be allowed after safety/tech inspection except for:

- 1) Those required to fix safety issues.
- 2) Those required to return the snowmobiles to operating condition after a breakdown.
- 3) Those considered standard maintenance items as described in SAE CSC2004 Rule 6.4.

Hoods will be sealed and engine calibrations will be frozen at the beginning of emission testing. Accidental breakage of the seal must be reported immediately. No telemetry will be allowed. Teams are not allowed to remotely alter calibrations during events. No non-standard user input (other than power, ignition, starter and kill switches) is allowed to the powertrain (includes engine intake, base engine, engine exhaust, or drivetrain).

Twenty-five (25) penalty points will be assessed for the hood seal being broken by anyone other than a liaison. Teams will be permitted to have a combination of 2 requests to break the seal for the purpose of fixing a safety issue or returning the snowmobile to working condition before penalty points are assessed (See 1&2 above). After the seal has been broken twice, (25) penalty points will be assessed to the team on each occurrence.

In the event that a snowmobile design strategy is “changed” during repairs made after emission testing, the team may continue to compete in SAE CSC2004 events. However, the team will not be eligible to receive any awards for events won after the strategy change.

6.4 Permitted Maintenance Items

The following maintenance items will be allowed throughout the SAE CSC2004 without penalty. Teams must notify and obtain permission from SAE CSC2004 officials before any permitted maintenance items are performed.

- Addition of any fluid – same fluid must be used throughout competition (NOTE: Adding significant amounts of coolant will not be considered standard maintenance)
- Suspension adjustment
- Track alignment and tension adjustment
- Drive belt/chain tension adjustment
- Headlight, taillight, brake light replacement
- Tightening of loose bolts: suspension mounting, suspension front limiter strap, ski saddle, and spindle.
- Lubrication of snowmobile parts.
- Tightening of rear idler wheel bolts and idler adjusting bolt jam nuts.
- Replacement of spark plugs (same plugs must be used as before...2 changes without penalty...then 5 point penalty per plug).
- Replacement of fuel injectors (same injectors must be used as before or design strategy will be considered to be “changed”...2 changes without penalty...then 5 point penalty per injector).
- Oil/fuel filter replacement



- Changing of the track is not in the list of permitted maintenance items. In other words, the average snowmobiler would not consider changing of the track a standard maintenance procedure.

Note: The intent of this rule is to allow 1000-mile maintenance items to be performed throughout the SAE CSC2004 without penalty. Organizers reserve the right to modify/add to this list as conditions demand.

6.5 Fuel at Competition

Teams are required to power their snowmobile with a blend of 10% ethanol and 90% premium gasoline or 85% ethanol and 15% premium gasoline. Fuel will be provided to all teams throughout the competition. Teams are required to use the provided fuel for all SAE CSC2004 events. Snowmobiles must arrive at the SAE CSC2004 with empty fuel tanks or must be driven to empty before being fueled for emissions testing.

6.6 Lubricating Oil at Competition

Competing teams are responsible for providing their own lubrication oil (two-stroke or four-stroke). Teams will not be allowed to switch the type of lubrication oil they are using once the competition has begun. Doing so without approval from a SAE CSC2004 official will result in disqualification. Oil must be added in the presence of a SAE CSC2004 official and must come from a factory sealed container.

6.7 Drafting Prohibited

Drafting of other snowmobiles will not be allowed during the Fuel economy/endurance event. Drafting is defined as following another vehicle closer than three snowmobile lengths at cruising speeds for sustained periods of time. Infractions of this rule may be reported by other competitors or by SAE CSC2004 officials. Penalties will be loss of points for the fuel economy/endurance event (25 points per occurrence).

6.8 Unsportsmanlike Conduct

Unsportsmanlike conduct will not be tolerated. Any driver, crew member, faculty advisor, or spectator who by their conduct detracts from the character of the event, or who abuses, threatens, or uses profane language to an official may be assessed a warning or penalty for unsportsmanlike conduct. A second violation may result in expulsion of the team from the competition. Warnings and penalties may be given by any official and will become record with the approval/concurrence of the organizers.

6.9 Drug and Alcohol Policy

If of legal drinking age, participants, guests, advisors, volunteers, and event staff may drink alcohol during meals and other social activities. However, participants, guests, advisors, volunteers, and event staff are prohibited from drinking alcoholic beverages or being under the influence of alcoholic beverages in any pit area or in any area where snowmobiles are operating or being worked on. There will be a zero-tolerance policy regarding the violation of this rule. Any participant, guest, or advisor violating this rule will cause the immediate disqualification of their team. Volunteers or event staff violating this rule will be dismissed.

There is also a zero-tolerance policy regarding the use of illegal drugs. Any participant, guest, or advisor observed using illegal drugs will cause the immediate disqualification of their team. Volunteers or event staff violating this rule will be dismissed.



6.10 Protests and Problems

(A) Required Review - Any team that intends to protest a rule, score, judge's decision or any other aspect of the competition, must present the issue to SAE staff or the event captain for discussion, and possible resolution before the protest is filed.

(B) Cause for Protest - If a faculty advisor or team captain feels a complaint about an official action or rules interpretation was not properly addressed by event officials, he/she may protest. Protests should be filed by the team steward.

(C) Protest Period - Protests must be filed within one (1) hour after the scores for the activity involving the protest subject are posted.

(D) Protest Format - All protests must be in writing and submitted to designated organizer. Protest forms may be obtained from the organizer.

(E) Protest Bond - The protesting team must post a twenty (20) point bond to be deducted from their score if the protest is denied.

(F) Decision - The decision of the judges or organizers regarding any protest is final.

6.11 Event Appearance and Forfeits

It is the responsibility of the teams to be in the right place at the right time. If a snowmobile is not ready to compete at the scheduled time, then the team forfeits the run of the event and will not be offered a late make-up. The driver for an event will be disqualified if he/she doesn't attend the driver meeting for the event.

7. DEADLINES

7.1 Registration

Registration Opens: October 1, 2003

Registration Closes: December 15, 2003

Student teams must register online at: <http://www.sae.org/students/snow.htm>

7.2 Fuel Choice

Student teams must supply fuel choice via e-mail to Jay Meldrum at jmeldrum@mtu.edu. Per rule 6.5, the fuel choices are E10 (10% ethanol/90% premium gasoline) or E85 (85% ethanol/15% gasoline)

7.3 Program Information (Due January 31, 2004)

Team program information may be submitted via e-mail directly to Jay Meldrum. The following is required:

Name of Faculty Advisor

Name(s) of Team Leader(s)



Names of Team Members

A brief write-up of the Design Strategy

Team Sponsors

Team Photograph – The photograph will be printed in the program on a page measuring 5.5 by 8.5 inches. The photograph will typically be 4 to 4.5 inches wide by 2 or 3 inches tall. The required resolution is 300 pixels per inch when printed on paper. Note: Pictures that look good on computer screens look different on paper. When in doubt, use the highest resolution the camera or scanner will allow.

7.4 March 8, 2004

See Rule 9.4 – “Engineering Design Paper”

One (1) copy in Microsoft Word and one (1) large print (16 point or) in Adobe Acrobat PDF format) of the final engineering design paper describing the modified snowmobile are due. The reports should be sent via e-mail to jmeldrum@mtu.edu.

NOTE: Late engineering design papers will receive 10 penalty points for each day that they are late, up to a maximum penalty equal to the team’s score for this event.

7.5 March 8, 2004

See Rule 9.5 – “Technology Implementation Cost Assessment”

One (1) electronic copy (MSExcel format) of the Technology Implementation Cost Assessment (TICA) is due. A copy of all supporting documentation is also due. The TICA information should be sent via e-mail to jmeldrum@mtu.edu.

NOTE: All teams will be required to update their TICA at the start of the SAE CSC2004 and have their snowmobile inspected to verify that their TICA is complete and accurate. Teams not submitting a complete and accurate TICA will be ineligible to receive the awards for Most Practical Solution and Best Value.

8. AWARDS

8.1 Award Criteria

Best Performance: Presented to the team receiving the highest total score in the acceleration, handling, and braking events that also passed the noise, acceleration and emission event.

Best Emissions: Presented to the team receiving the best score in the emissions event

Best Design: Presented to the team receiving the highest total score in the Engineering Design Paper, Oral Design Presentation, and Static Display Events that has also received passing scores in the emission, noise and acceleration events.

Best Fuel Economy: Presented to the team receiving the most points in the Fuel economy/endurance event.

Quietest Snowmobile: Presented to the team receiving the most noise points in the noise and acceleration event.

Most Practical Solution: Presented to team with the best balance between cost and measured noise and emission reduction. Winner will be the team



with the highest (Noise Points + Emission Points)/Technology Implementation Total Cost.

Best Value: Presented to team with the best balance between cost, fuel economy, and performance. Winner will be the team with the highest (Fuel Economy Points + Acceleration Points + Handling Points + Braking Points + Cold Start Points)/Technology Implementation Total Cost.

Founder's Trophy: Trophy awarded to the team recognized by other participants as being the most sportsmanlike.

8.2 Participation Plaque

Each school will receive a plaque commemorating its participation in the SAE CSC2004. Trophies will be given to the winners in each of the categories listed in Section 6.1 of the SAE CSC2004 rules.

9. Scoring

9.1 Overall Score

Overall scores will be determined, based on a maximum of 1400 points, according to the following schedule:

Event	Points for Passing Event	Maximum Additional Points for Relative Performance in Event
Engineering Design Paper	N/A	100
Cost Assessment	N/A	50
Emissions	100	200
2-stroke bonus	50	
Oral Presentation	N/A	100
Fuel Economy/Endurance	100	100
Acceleration	50	50
Handling	N/A	75
Cold Start	50	N/A
Braking	N/A	75
Static Display	N/A	50
Noise	100	200
All Events	450 points	1000 points



9.2 Event Points

With the exception of the subjective design events (engineering design paper, oral design presentation, and static display) and the emission event, the team having the best score in each of the events will be awarded the maximum possible points (if they have also passed the event). Teams finishing behind those leaders will be awarded proportionally fewer points according to the scoring schemes that appear at the end of the following items. No negative points other than as a result of penalties will be awarded.

9.3 Penalties

Penalties will result from violating SAE CSC2004 safety rules, performing prohibited maintenance on snowmobiles at any time after emission testing, drafting during the Fuel economy/endurance event, or failing to meet competition deadlines.

9.4 Engineering Design Paper

9.4.1 Engineering Design Paper Description

This event requires the team to submit an engineering design paper describing the snowmobile conversion concept, design, and implementation. The paper should explain why modifications were performed and the results of testing and development. The paper must address the durability, practicality, and increased cost of any modifications. An absolute limit of **fifteen (15) pages** will be strictly enforced, except as noted below for papers submitted in alternative accessible formats.

Late engineering design papers will receive 10 penalty points for each day that they are late, up to a maximum penalty equal to the team's score for this event. Hand written papers will not be accepted.

Papers must conform to the standard format for SAE technical papers. The format for SAE technical papers is available on-line through the SAE website at: www.sae.org/products/papers/paperinfo/prepare.htm.

9.4.2 Engineering Design Paper Scoring

This event is worth a maximum of 100 points. Engineering design paper judges will have a technical background. A sample engineering design paper judging form is located in the SAE CSC2004 Rules Appendix.

9.5 Technology Implementation Cost Assessment

9.5.1 Technology Implementation Cost Assessment Description

Each team is required to submit a Technology Implementation Cost Assessment (TICA) on their modified snowmobile. The TICA's purpose is to provide a standard method to compare the "manufacturer's cost" (cost TO the end snowmobile manufacturer) of each team's strategy for reducing emissions, noise, and fuel consumption. The TICA is not intended to evaluate the manufacturer's cost of "secondary" modifications such as suspension modifications or more comfortable seats.

It is the organizers' intent to make the completion of the TICA as simple as possible. Each team will be provided with an MSEXcel97 spreadsheet that contains three separate worksheets:



1. The first worksheet, the Cost Index Reference, is a read-only worksheet that contains the specific nominal cost for individual components or information on how to determine the cost of individual components. Teams **MUST SUBMIT** copies of all manufacturers' quotes per 5000, manufacturer specification sheets, and retail receipts that are used to determine the cost of individual components on their snowmobile.
2. The second worksheet, the Cost Subtotals Worksheet, is where teams are required to input specific information on their entry. Only those cells requiring input may be modified. The rest of the spreadsheet is "protected".
3. The third worksheet, The Cost Totals Form, is a read-only worksheet that automatically calculates the final Technology Implementation Total Cost (TITC).

If at any time you have questions about the completion of the TICA spreadsheet, or if it does not adequately "evaluate" a system on your snowmobile, please contact the organizers via the SAE CSC2004 Forum described in SAE CSC2004 Rule 5.1. Organizers are very willing to assist teams with the completion of the TICA and would like it to provide "useful" information

9.5.2 Technology Implementation Cost Assessment Scoring

Fifty (50) points will be awarded to the winner of this event. Other scores will be determined by the following:

$$YourScore = \frac{(TITC \text{ max}/TITC_{your})^2 - 1}{(TITC \text{ max}/TITC \text{ min})^2 - 1} \times 50$$

TITCs will also be used to determine the winners of the awards for Most Practical Solution and Best Value. Teams not submitting a complete and accurate TICA will be ineligible to receive the awards for Most Practical Solution and Best Value.

9.6 Emissions

9.6.1 Purpose of Emissions Event

The purpose of this event is to determine the emissions level generated by each snowmobile at predetermined operating conditions following guidelines currently issued by the EPA.

9.6.2 Emissions Event Description

Before being allowed to undergo SAE CSC2004 emission testing, snowmobiles will pass the safety/tech inspection. Teams that arrive unprepared or run into problems and are unable to complete the fuel economy/endurance event will lose their right to emission testing. Emissions of these teams may be tested, after all other teams that met competition deadlines, if and only if time permits.

For the 2004 CSC competition the endurance event is held before the emissions testing, therefore eliminating the need for a separate "catalyst break-in" event. If a team does not complete at least sixty miles during the endurance event they will be required to make up the difference on a closed course at KRC



before moving on to the emissions event, regardless if whether or not the sled design includes a catalytic converter.

Teams must provide the following information to event organizers before being permitted to participate in emission testing: 1) The engine rpm for their snowmobile at maximum steady engine speed in snowmobile operation (will be considered as 100% speed) and 2) The snowmobile engines maximum torque observed at 100% speed.

Brake-specific (g/Kw-hr) emissions will be measured using laboratory-grade instrumentation and a DYNO-mite direct couple dynamometer. The DYNO-mite mounts directly to the engine primary clutch shaft. The testing will follow five mode test procedure approved by EPA for snowmobile emissions measurement. Teams shall be prepared to test up to all five modes of the proposed test emissions test cycle. More information on the emissions testing process can be found by reviewing the methods proposed in SAE Paper No. 982017 and EPA 40 CFR Parts 89, 90 and 91.

Note: Hybrid electric or purely electric snowmobiles will not have their emissions tested.

Emission Event Equipment Requirements

Exhaust Gas Sampling Probe:

Each sled in the competition is required to be fitted with an exhaust gas-sampling probe in accordance with the following probe design and installation specifications.

- (1) The sample probe shall be a straight, closed end, stainless steel, multi-hole probe made from 1/4 in. OD stainless steel tubing. The wall thickness of the probe shall not be greater than 0.10 cm.
- (2) The probe shall have nine 1/16 in. holes. The spacing of the radial planes for each hole in the probe must be such that they cover approximately equal cross-sectional areas of the exhaust duct. The nine holes shall be drilled in a spiral pattern with an angular spacing between adjacent holes of approximately 120 degrees. This results in a spiral pattern with three triads of holes aligned along the length of the probe.

Required probe fittings: Stainless steel tubing - 0.25 in. OD, Swagelok cap - PN SS-400-C, Swagelok thermocouple fitting - PN SS-400-1-2BT.

The probe is to be installed in the engine exhaust system, using the above fittings. A 1/4 in. diameter hole is to be drilled in the common exhaust pipe at the selected location (see requirements below). A 1/8 in. NPT internally-threaded close bushing is to be welded or brazed onto the exhaust pipe over the hole. The Swagelok thermocouple fitting is screwed into the bushing, and the probe is inserted through the thermocouple fitting so that it crosses the full diameter of the exhaust pipe, perpendicular to the direction of exhaust flow. The Swagelok cap compression fitting is installed at the end of the probe. For emission sampling, the cap will be removed for connection of the heated sample line. The probe may be bent, as needed, to provide a straight-on connection for the heated sample line.

Probe 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 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 pipe diameters downstream of the converter outlet.
- (3) For all systems, the probe must be placed a minimum of 12 in. upstream of the end of the exhaust pipe.

The reason the exhaust probe needs to be at least 12 inches from the point in which the exhaust exits into the atmosphere is to prevent back pulses reaching the sample probe. When the probe is located too close to the end of the exhaust air pulses propagating back into the exhaust may actually reach the probe and dilute the sample. So, if the probe is located before or in the muffler there are no problems. As long as there is, at least, 12 inches of exhaust travel before it exits the system into the atmosphere there will be no problems. Note: 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

Fuel Flow Measurement

Accurate fuel flow data are required to make brake-specific emissions measurements. The emissions testers will supply the apparatus for measuring fuel used during the emissions testing. Teams will be responsible for setting up their fuel lines for quick disconnection from their on-board fuel system. Specifications for the connectors and connection diagrams will be provided at a later date.

Supplemental Engine Cooling System

Supplemental cooling will be required for snowmobile engine operation using the direct connect dynamometer described above. Fan-cooled engines will be tested with two cooling fans directed onto the engine with the cover open. For liquid-cooled engines, an external heat exchanger system consisting of a small automotive radiator with an electric fan will be provided. Liquid-cooled sleds are to be configured with cooling systems supply and return lines for connection to the external system. Specifications for the connectors and a connection diagram will be provided at a later date.

Fuel and lubricants

For CSC2004, each team will have the choice of using one of two fuels to be provided by the organizers, either E10 or E85. The E10 will be a premium grade blend of 10% ethanol and 90% unleaded gasoline. The E85 will be a blend of 85% ethanol and 15% unleaded gasoline. Once a fuel is specified for the participant, the participant must use that fuel for all CSC testing. E85 may provide improved emissions but fuel consumption may suffer. To be fair, if a participant chooses to use E85 for emissions they must use it for all other events.

Pretest Inspection, Required Information

Prior to emission testing, each sled will be inspected for proper installation of required equipment and fittings. Installations will be checked against provided specifications. Additionally, the engine, drivetrain, and related systems will be



safety-inspected. Sleds that have not passed the safety/tech inspection prior to their scheduled emission test forfeit their right to undergo emission testing. If the team's sled does not complete the fuel economy/endurance event, they will be given credit for the distance traveled. The remainder will be completed on a closed course to fulfill the requirements for the emissions event. Their snowmobile will be rotated to the back of the schedule, and the next available sled will proceed with testing.

Teams need to provide the following pretest information to the emissions staff: the sled's maximum steady speed (engine rpm) at WOT and maximum steady engine torque at WOT. A pretest information form will be provided prior to the competition.

9.6.3 Emission Testing

Teams should be prepared to test the complete 5-mode emission test cycle currently under consideration by the EPA and discussed in SAE Paper No. 982017. This cycle is shown below for reference.

Mode	1	2	3	4	5
Speed, %	100	85	75	65	Idle
Torque, %	100	51	33	19	0
Wt. Factor, %	12	27	25	31	5

The emissions staff reserves the right to minimize the number of cycles run at the time of emissions testing, i.e., only three may be run but to be fair to all participants, the specific modes will not be identified until the time of emissions testing. Test modes will be run in order, from highest to lowest speed. One hundred percent engine speed is defined at the maximum steady engine speed in snowmobile operation. Torque values are specified as a percent of maximum wide open throttle torque observed at 100 percent speed in Mode 1.

If a sled develops a problem during emission testing, a maximum of 20 minutes may be allowed for repairs. If a sled cannot be repaired in 20 minutes, the DYNO-Mite will be removed from the sled and installed on the next sled. No adjustments to the sled's calibration will be allowed after safety/tech inspection or during maintenance or repairs. This repair allowance is not provided to allow re-engineering of a sled deficiency.

9.6.4 Emissions Testing Safety

Snowmobile engines are operated at high power levels during emission testing. Engines and powertrain systems must be sufficiently robust to be safely operated at WOT-rated speed for as much as 15 minutes.

Teams should incorporate rev limiters in their design, but this is not a requirement.

Only the team captain or another single designated individual will be allowed to stand near the sled during testing. This individual will serve principally as a safety observer.



Unsafe or hazardous conditions may result in the immediate disqualification of the sled under test. This determination will be at the sole discretion of emission testing staff. Examples of unsafe conditions include:

- Broken motor mounts
- Fuel leak
- Fire or appearance of smoke
- Excessive vibration

This list provides a number of examples, but is by no means intended as an exhaustive or complete list of every possible ground for disqualification. In all such cases, **sled operation will be immediately discontinued** if the emissions staff feels an unsafe or hazardous operating condition is present. It is the responsibility of each team to design their sled and drivetrain with these requirements in mind. Unsafe or questionable designs have no place in this competition.

At the risk of overstating this point, if your sled has **any** weak points in its engine, they **will show up** in emission testing. If you cannot complete emission testing, you cannot win the competition. **Do not underestimate the difficulty of surviving this event.**

9.6.5 Emissions Event Scoring

A 4-stroke snowmobile representative of a typical touring snowmobile will be tested as part of the SAE CSC2004 emission tests. The emission levels measured from this snowmobile will serve as baseline values. The Control Snowmobile will be an Arctic Cat 660 non-turbo, 2-seater.

Sleds that use a 2-stroke engine will be given a 50 point bonus provided the emission level is equal to or less than the emissions of the control sled.

Snowmobiles must have HC + NO_x and CO levels that are equal to or less than the emissions of the baseline snowmobile to receive points for this event. Points for snowmobiles that pass this event will be awarded according to the following equation:

$$\text{Your Score} = 100 + 133 \left(\frac{(HC + NOx)_{ref} - (HC + NOx)_{your}}{(HC + NOx)_{ref} - (HC + NOx)_{min}} \right) + 67 \left(\frac{CO_{ref} - CO_{your}}{CO_{ref} - CO_{min}} \right)$$

9.7 Oral Design Presentation

9.7.1 Oral Design Presentation Description

A 10-minute oral presentation of the rationale and approach to the conversion is required, followed by a five-minute question and answer period. The presentation should state clearly how your modified snowmobile addresses the needs of snowmobilers (performance), environmentalists/land managers/regulatory agencies (noise and emissions), and snowmobile dealers/outfitters (cost, durability, re-sale value). Your presentation should focus on how your snowmobile will economically and practically reduce the impact that snowmobiles have on the environment. The presentation will be judged on content, format, and delivery. All statements must be backed up with test results and science...this is a marketing delivery that must be based on FACTS.



Each team is required to submit an electronic copy of their oral design presentation to competition organizers at the end of the presentation. Electronic copies may be submitted on 1.4" floppies, a zip disk, or a CD (no email). Teams failing to provide an electronic copy of their oral presentation will receive 0 points for this event. **THIS REQUIREMENT WILL BE STRICTLY ENFORCED!**

9.7.2 Oral Design Presentation Scoring

This event is worth a maximum of 100 points. Oral design presentation judges will include snowmobilers, environmentalists, land managers, and engineers. A sample oral design presentation judging form is located in the SAE CSC2004 Rules Appendix.

9.8 Fuel Economy/Endurance Event

9.8.1 Purpose of Fuel Economy/Endurance Event

The purpose of this event is to evaluate the endurance and durability of the competition snowmobile in conjunction with its energy efficiency.

9.8.2 Fuel Economy/Endurance Event Description

The snowmobiles will be filled with fuel and paired with a trail judge before being allowed to enter the trail section. The teams will travel approximately 100 miles (trail section dependent on snow conditions) to the finish point. Teams must plan for at least 100 miles of travel without refueling. At the final destination, the snowmobiles will be refilled with fuel and their fuel consumption recorded. After the previously arranged photo shoot and dinner teams will be responsible for hauling their respected snowmobiles back to KRC. (Road maps will be provided to the teams.) The planned route is from Twin Lakes to Copper Harbor. Trail conditions may result in a change to this plan on the day of the competition.

9.8.3 Fuel Economy/Endurance Rules

The fuel tanks will be filled to within 3 inches of the top of the filler spout. The trail judge will maintain a speed consistent with trail conditions following all trail signs and rules. If a snowmobile cannot maintain progress with the trail judge they will fail the event. 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 of trail, etc. the snowmobile will fail event. When this happens, the trail judge will tow or direct the snowmobile to the nearest road crossing and will then radio to a pickup trailer. The competition snowmobile will then be hauled to the event finish area or back to KRC.

9.8.4 Fuel Economy/Endurance Scoring

If the teams complete the endurance event they will receive 100 points. They will then receive additional points for their energy consumption compared to the rest of the field based on the following equation:

$$\text{Your Score} = 100 \times \frac{(G_{\text{max}}/G_{\text{your}})^2 - 1}{(G_{\text{max}}/G_{\text{min}})^2 - 1}$$

G = number of gallons of fuel consumed.



Note: This event will be scored based on energy efficiency if any entries are hybrid electric snowmobile or electric snowmobiles.

9.9 Noise Event

9.9.1 Purpose of Event

The purpose of this event is to determine the noise level generated by each snowmobile at a steady state operating condition.

9.9.2 Event Description

The noise created by the sled must be equal to or less than that of the control sled to pass this event.

The snowmobile will be driven by a competition judge at a constant speed between 35 and 55 mph through a sound power-measuring hemisphere, the snowmobile will be driven through this course 2 times. The average sound power from the two runs will be used to determine the noise performance of each snowmobile. The exact test speed will be chosen on the day of the competition to ensure that snowmobiles are not optimized for noise at a specific speed. This hemisphere will consist of 6 microphone locations, 2 overhead, and 2 on each side of the snowmobile. The microphones will measure A-weighted sound pressure. The basics of this measurement technique are discussed in the International Standard ISO4872 and the SAE standard J2104. A stationary radar gun will also be used to verify this speed. Teams are encouraged to have and accurate speed measuring device such as GPS to monitor their speed.

9.9.3 Event Scoring

If Team average sound power is less than control sled average sound power by .5 dBA, then.

$$YourScore = 100 + \frac{(dBA_{ref} / dBA_{your})^2 - 1}{(dBA_{ref} / dBA_{min})^2 - 1} \times 100$$

where dBA_{ref} = the sound power of the control sled rounded to the nearest dBA and then two runs are averaged. The resultant number will have a resolution of .5dBA (the average of two integers).

If your snowmobile's average sound power is greater than the control sled, you will receive zero points.

If your snowmobile's average sound power is equal to the control sled, you will receive zero points in this event.

If your snowmobile's average sound power is less than the control sled by .5 dBA, you will receive points according to the formula.

Available event points = 200 points



9.10 Acceleration Testing Event

9.10.1 Purpose of Event

The purpose of this event is to determine the acceleration performance of each snowmobile.

9.10.2 Event Description

Each snowmobile will be driven by a student participant during this event. The snowmobile will be accelerated from a standing stop to the maximum speed that it can achieve in 500 feet. The snowmobile will be timed from start to finish, the lower the time the better. This event will be completed two times and the best time will be the time used for scoring. To pass this event your elapsed time must be equal to or less than 12 seconds. All drivers must wear the proper safety gear as specified in section 5.2.

9.10.3 Event Scoring

The team with the least time to reach 500 feet (best of two runs) will receive 100 points.

Teams reaching 500 feet in exactly 12 seconds will receive 50 points.

A team that passes the event by reaching 500 feet in 12 seconds or less will receive points according to the following formula:

$$YourScore = 50 + \frac{(T_{max}/T_{your})^2 - 1}{(T_{max}/T_{min})^2 - 1} \times 50$$

T_{max} is equal to or less than 12 seconds.

T_{min} = minimum time to reach the designated distance.

T_{your} = the time it takes your sled to reach the designated distance.

Your score = number of points your snowmobile will receive.

Available event points = 100 points

9.11 Handling/Drivability Event

9.11.1 Purpose of Handling/Drivability Event

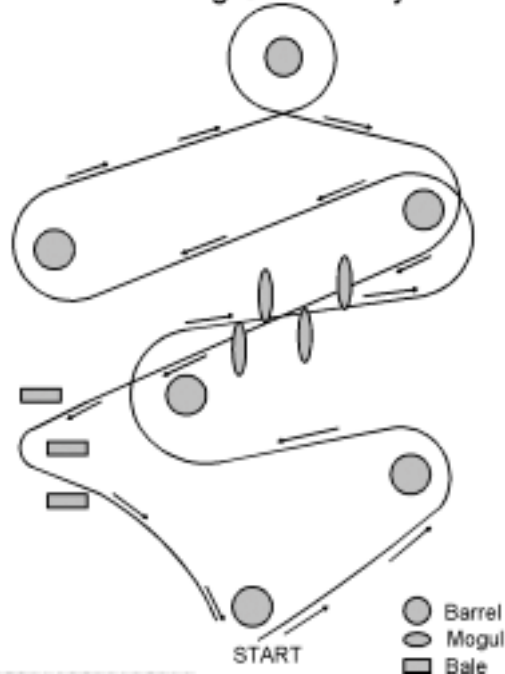
The purpose of this event is to evaluate the agility and maneuverability of the competition snowmobile.

9.11.2 Handling/Drivability Event Description

Each team will be allowed to complete 2; consecutive individually timed laps on a slalom style course (course example below). The fastest lap time will be recorded. No adjustments to the snowmobile will be allowed between laps. One

second penalty will be assessed for each cone, barrel, or bale hit. Five seconds will be assessed if the entire sled does not stop within the designated stopping area.

Handling Course Layout



Example course layout
Not to scale.

9.11.3 Handling/Drivability Rules

The handling event will consist of a course designed to challenge the snowmobiles in the areas concerned with handling. The horsepower of the snowmobile will have very little influence on how well the snowmobile performs in this event. 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 as specified in section 5.2

9.11.4 Handling/Drivability Scoring

The scoring for the event will be a comparative ranking based on the equation below.

$$\text{Your Score} = (75 \text{ points}) \times \frac{(T_{\text{max}}/T_{\text{your}})^2 - 1}{(T_{\text{max}}/T_{\text{min}})^2 - 1}$$

T = minimum lap time.

9.12 Cold Start Event

9.12.1 Cold Start Event Description

Snowmobiles will be cold-soaked overnight. Teams will have exactly twenty seconds to start their snowmobile. The use of ether is not allowed.



9.12.2 Cold Start Event Scoring

Snowmobiles that do not start within 20 seconds will fail the cold start event and will receive 0 points. Snowmobiles that start within 20 seconds will receive 50 points.

9.13 Brake Testing Event

9.13.1 Purpose of Brake Testing Event

The purpose of this event is to determine the braking performance of each snowmobile.

9.13.2 Brake Testing Event Description

A student participant will drive their snowmobile during this event. The snowmobile will be decelerated from a speed of at least 20 miles per hour to a standing stop. The distance traveled for the snowmobile to come to a complete stop will be measured, the shorter the distance the better. This test will be performed by requiring that the snowmobile to be traveling at least 20 mph at the point that the snowmobile reaches a cone signaling the start of braking. Braking distance will be measured from this cone. The snowmobile's speed will be verified through the use of radar, if the snowmobile is traveling less than the designated 20 mph at the time the snowmobile reaches the cone the run will be disqualified. For this reason it is recommended that the driver have an accurate device to measure their speed over ground at the time of the start of braking, a GPS unit is recommended. The snowmobile must remain within a 6-foot wide lane. The team will not receive points for the event if they travel outside of the lane. This event will be completed two times and the stopping distance averaged from the two runs. If a braking run is disqualified due to the speed of the snowmobile being too low, the snowmobile will be assigned the longest valid braking distance measured during the event by a snowmobile for that run.

The order in which the snowmobiles are evaluated will be determined by a random drawing the day of the event.

9.13.3 Brake Testing Event Scoring

The scoring for this event will be as follows:

The team with the minimum braking distance will receive 75 points.

The other teams will receive points based on the formula presented below:

$$\text{Your score} = (\text{available event points}) \times \frac{(BD_{max} / BD_{your})^2 - 1}{(BD_{max} / BD_{min})^2 - 1}$$

where:

BD_{max} = largest average braking distance of a snowmobile (worst brake performance)



BD_{min} = minimum average braking distance of a snowmobile (best brake performance)

BD_{your} = average braking distance obtained by your snowmobile

Your score = number of points your snowmobile will receive

Available event points = 75 points

9.14 **Static Display Event**

9.14.1 Static Display Description

Each school will place their snowmobile on display. An outdoor area will be provided for your snowmobile and display. The display is intended to serve as a marketing/promotional display that will encourage snowmobilers and outfitters to use/purchase your snowmobile. Teams are encouraged to put up signs, hand out flyers, and use any other marketing techniques to attract attention to your prototype snowmobile.

9.14.2 Static Display Scoring

This is a judged event worth a maximum of 50 points. Static display judges will have a technical background, be active snowmobilers, and/or be concerned about the impact of snowmobiles on the environment. A sample static display judging form is located in the SAE CSC2004 Rules Appendix.

10. **ORGANIZER AUTHORITY**

The organizers of the competition reserve the exclusive right to revise the schedule of the competition and/or to interpret the competition rules at any time and in any manner which is, in their sole judgment, required for efficient operation or safety of the competition.



APPENDIX

SAE CSC2004 Engineering Design Paper Judging Form

Score the following categories, giving each points ranging from 0 (very bad) to the maximum points available for the category (excellent). The maximum points available for each category are listed in parenthesis.

When evaluating the papers, please keep in mind that the papers should be high-quality, technical papers that meet the rigorous standards required for publication in scholarly journals.

_____ **CONTENT – PERFORMANCE (15):** Does the paper describe the challenges of maintaining/improving snowmobile performance (while reducing emissions and noise)? Does the paper describe the strategy the team selected to maintain/improve performance? Are adequate technical details given? Are adequate results given?

_____ **CONTENT – EMISSION CONTROL (15):** Does the paper describe the challenges of improving snowmobile emissions? Does the paper describe the strategy team selected to improve emissions? Are adequate technical details given? Are adequate results given?

_____ **CONTENT – NOISE (15):** Does the paper describe the challenges of reducing snowmobile noise? Does the paper describe the strategy team selected to reduce noise? Are adequate technical details given? Are adequate results given?

_____ **CONTENT – MISCELLANEOUS (10)** Does the paper describe other features of the snowmobile? How will the modifications affect the cost of the snowmobile? Will the snowmobile be durable? Will the snowmobile be energy efficient? Will the snowmobile be comfortable and safe to ride?

_____ **RESULTS/DATA – (15)** Does the paper contain valid numerical data? Are results described based upon testing?

_____ **ORGANIZATION (10)** Was the paper format logical and organized? Did it contain an introduction/overview as well as conclusion/summary? Did the paper conform to the SAE standard format for technical papers?

_____ **USE OF GRAPHICS – TABLES/GRAPHS/PICTURES (10)** - Were graphics used in the paper? Were they clearly explained in the text? Were they legible? Were they effective?

_____ **REFERENCES (10)** Were references cited whenever appropriate? Were the references from high-quality sources?

_____ **TOTAL = ENGINEERING DESIGN PAPER POINTS (100 Points maximum)**

COMMENTS: _____



SAE CSC2004 Oral Presentation Judging Form

Score the following categories on the basis of 0-12.5 points each according to the following scale (any number or fraction along this scale may be used).

- 0 = inadequate or no attempt
2.5 = attempted but below expectation
5 = average or expected
7.5 = above average but still lacking
10 = excellent, meets intent
12.5 = extraordinary, far exceeds expectations

CONTENT (SNOWMOBILE OPERATOR PERSPECTIVE): Does the presentation describe how the design will appeal to snowmobilers? Will the snowmobile maintain/improve performance and handling? Is enough detail given about how? Are there other factors that make this design more attractive to snowmobile operators?

CONTENT (SNOWMOBILE DEALER/OUTFITTER PERSPECTIVE): Does the presentation describe how the design will meet the needs of snowmobile outfitters? Is the cost reasonable? Is the design durable and easy to maintain? Does the design allow operation by a novice snowmobiler? Is enough detail given about how these goals are met? Are there other factors that make this design more attractive to snowmobile dealers/outfitters?

CONTENT (ENVIRONMENTAL PERSPECTIVE): Does the presentation describe how the design will minimize the environmental impacts of the snowmobile? Are emissions reduced significantly? How much? Is the snowmobile quiet enough? How quiet? Is enough detail given about how these goals are met? Are there other factors that make this design more attractive from an environmental perspective?

CONTENT (TEST RESULTS/SCIENCE): Are test results given for all of the "claims" made about the modified snowmobile? Is the presentation based on "good science" (as opposed to a slick sales job)? Is data provided to support all conclusions?

ORGANIZATION: Were the concepts presented in a logical order progressing from basic concept and showing how the engineering accomplished the concept? Was it clear to the audience what was to be presented and what was coming next? Were distinct introduction and overviews as well as summary and conclusions given?

VISUAL AIDS: Were visual aids used? Was the text readable? Were illustrations, graphs, and tables clearly explained? Were the visual aids effective?

DELIVERY: Did the presenter speak in a clear voice? Did the presenter show enthusiasm and promote confidence in the technical aspects? Did he/she maintain eye contact?

QUESTIONS: Did the answer illustrate that the team fully understood the question? Is there doubt that the team understood the answer? Did the team promote complete confidence in their response to the questions?

TOTAL = PRESENTATION POINTS (100 Points maximum)

COMMENTS: [Three horizontal lines for handwritten notes]



SAE CSC2004 Static Display Judging Form

Score the following categories on the basis of 0-12.5 points each according to the following scale (any number or fraction along this scale may be used).

- 0 = inadequate or no attempt
- 2.5 = attempted but below expectation
- 5 = average or expected
- 7.5 = above average but still lacking
- 10 = excellent, meets intent
- 12.5 = extraordinary, far exceeds expectations

When evaluating the snowmobile and its static display, please keep in mind that the intent of this event is to encourage the student designs to be appealing to snowmobilers and snowmobile tour operators.

_____ **AESTHETICS:** Does the snowmobile look attractive? Does it have a high performance appearance? Does have a quality appearance? Does it look fun to ride?

_____ **STUDENTS:** Were the students present? Were they outgoing? Did they offer to tell you about their snowmobile? Did they seem knowledgeable? Were they able to answer your questions?

_____ **DISPLAY/INFORMATION:** Are marketing-type materials provided (pamphlets, standing posters, etc.)? Are they informative? Would you be able to learn anything about the snowmobile if there weren't any students around?

_____ **OVERALL IMPRESSION:** Were you convinced that the snowmobile would have enough power to be fun to ride on groomed trails? Were you convinced that a tour operator could use a fleet of these snowmobiles and still make money? Do you think this snowmobile is environmentally friendly? Would you buy one?

_____ **TOTAL = STATIC DISPLAY POINTS (50 Points maximum)**

COMMENTS: _____

