5 January 2004

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This version of the Grand Challenge Rules is updated to reflect changes required to ensure a safe and manageable event while meeting the constraints DARPA must adhere to. Thank you for your participation in making this event a safe and exciting milestone in the development of robotic technology.

Key Edits :

1. There is no longer a checkpoint on the route.

2. The start point departure will be sequential (vice simultaneous).

3. The Departure and Arrival Lines are now independent of the RDDF.

4. Challenge Teams will no longer be given time to repair their Vehicle if it does not leave the Departure Area when given the Departure Signal. Instead, Challenge Vehicles which experience technical difficulties will be given another opportunity to depart after other Vehicles have left the Departure Area.

5. The dates of the Qualification Inspection and Demonstration (QID) event will be 8 – 12 March 2004. Team arrival and check-in is scheduled for 7 March 04. If there are any changes to the team's technical paper submitted in Oct 2003, the team's updated technical paper must be received by DARPA by 1 March 04.

6. Challenge Teams are no longer required to attend DARPATech.

7. The RDDF format has been simplified.

8. More information has been given concerning the right-of-way of Challenge Vehicles for the purpose of collision avoidance.

9. The minimum audible alarm level required on Challenge Vehicles has been reduced to 85dB at 10ft.

10. The technical paper addendum submission process has been modified to require resubmissions of complete papers.

11. The section concerning Government Furnished Equipment has been expanded.

Four items were highlighted in the April revision of the Rules:

1. The maximum corrected time to receive the Grand Challenge Prize is now ten hours.
2. The participating teams are not required to provide a Safety Vehicle. DARPA will take responsibility for oversight of all vehicles on the Challenge Route.
3. The participating teams are not required to develop an Emergency-Stop system. DARPA will provide and operate the E-stop for all teams.
4. There is no specific requirement for general liability insurance for individual teams.

Please contact us if there are questions concerning these rules.

1. Introduction

1.1 Purpose of Challenge

DARPA is seeking to promote innovative technical approaches that will enable the autonomous operation of unmanned ground combat vehicles. In the future, such combat vehicles will operate over varied terrain without the benefit of road signs, pre-programmed routes, etc. Autonomous vehicles must navigate from point to point in an intelligent manner so as to avoid or accommodate obstacles and other impediments to the completion of their missions. For example, an extremely large vehicle that simply travels on a straight line between two points by climbing over or breaking through everything in its path (and destroying what cannot support that movement) is not the type of intelligent solution that is sought. Vehicles that cannot demonstrate intelligent autonomous behavior will not be accepted as Participants.

1.2 Date(s) of Challenge

The date of the Grand Challenge is March 13, 2004. If, for any reason, this Grand Challenge cannot be started on March 13, 2004, it will be rescheduled for March 14, 2004.

If the Grand Challenge has been started and, for any reason, it cannot be completed, DARPA will simultaneously stop and shut down all Challenge Vehicles that are on the Route and are not disqualified. The location of each Vehicle will be recorded, and the Vehicle may be re-positioned, depending on its location. The Vehicles will then resume the Challenge from their previous stopped position the following morning. This measure, if required, may require the Chief Judge to adjust the Rules in order to permit a fair continuation of the Challenge.

Should the event be stopped or disrupted, for whatever reason, in consultation with DARPA's Chief Judge, the activities to be accomplished will continue the following day until all the challenge vehicles have had an opportunity to complete the field exercise in less than 10 hours. (also see Section 9.1)

1.3 Place of Challenge

The Challenge Route will begin in the vicinity of Barstow, CA and finish near Las Vegas, NV.

1.4 Route Description

The Route will include surfaced and un-surfaced roads, trails, and off-road areas. Man-made and natural obstacles—both above and below the surface of the average terrain—are likely. Examples of obstacles include ditches, washboard, open water, rocks, underpasses, construction, power line towers, barbed wire fences, and other vehicles. All obstructions on the route can be either accommodated or avoided by a commercial 4X4 pick-up truck.

The Route consists of Waypoints and an Arrival Line.

Waypoints are two dimensional positions that, together with specified boundaries, define the corridor through which the Challenge Vehicles must travel.

1.5 General Procedures

Participant Teams will transport their Challenge Vehicles to the California Speedway, Fontana, CA, for the Qualification Inspection and Demonstration (QID) start that will occur on March 8 - 12, 2004. Team arrival and check-in is scheduled for 7 March 04.

On Friday, March 12, 2004, each Team will transport their Vehicle to the Grand Challenge Departure Area (currently near Barstow, CA) and prepare it for the Challenge. On the evening of March 12, DARPA will host a meeting with Teams to answer any questions prior to the first Departure Signal. The time and place for this meeting will be provided to qualifying Teams at the QID.

Prior to the first Departure Signal that will occur shortly after sunrise (approximately 0630) on March 13, 2004, each team will have positioned their Vehicle behind the designated point on the departure line. At the Departure Signal, DARPA will establish each E-Stop data link sequentially and the Vehicles will autonomously begin navigating the designated Challenge Route to near Las Vegas. More details concerning the Departure and QID, including the inter-Vehicle spacing or timing and the determination of starting order, will be provided to teams prior to the Challenge.

Once each Vehicle has cleared the Departure Area, and until it clears the Arrival Line, DARPA is responsible for its operation. DARPA will observe the Vehicles for safety and judging purposes, and will command any E-Stop that is necessary.

Teams may follow the progress of their vehicle at the departure and arrival areas, and they may periodically observe their Vehicle's operation at designated access points near the route. Except as approved by the Chief Judge (e.g. to recover a disqualified vehicle) teams may neither operate nor occupy any ground vehicle on the Challenge Route from two hours prior to the first Departure Signal until all Vehicles have either finished or been disqualified. Teams should be prepared to recover their Vehicle anywhere on the Route in the event that it does not arrive at the Arrival Area. No disabled or disqualified Challenge Vehicle may be recovered until all other Vehicles that are not disqualified have passed it.

1.6 Prize

DARPA will award one million U.S. dollars to the Team that completes the Route with the best corrected time at or under ten hours. Tax treatment of the Prize is the responsibility of the Winner. There are no other prizes.

No government contract or other incentive is promised as a result of this Challenge.

1.7 Subsequent Prize Attempts

If there is no winner in the 2004 Challenge, subsequent Challenges will be held until the Prize is awarded or until Congressional authority for the Prize expires. The current Congressional authorization expires on September 30, 2007.

Any subsequent Challenge will permit the entry of new teams in addition to teams that participated in the first Grand Challenge.

2. Definitions

Definitions used in the Rules are capitalized when their definition is described below.

2.1 General Definitions

2.1.1 Rules

The Rules officially posted at www.darpa.mil/grandchallenge/rules.htm are the Rules of the 2004 DARPA Grand Challenge of Autonomous Ground Vehicles. The Chief Judge is the final authority on all rules.

2.1.2 Challenge Vehicle

A Challenge Vehicle is the fully autonomous ground vehicle system that has been entered for the Challenge.

2.1.3 Control Vehicle

A Control Vehicle is a vehicle that, for safety and judging purposes, carries a DARPA Field Judge in order to keep one or more Challenge Vehicles under direct visual observation at all times while any Challenge Vehicle is on the Challenge Route. Team Members do not occupy a Control Vehicle during the Grand Challenge. DARPA is responsible for the operation of Control Vehicles.

2.2 Personnel Definitions

2.2.1 Challenge Team

The Challenge Team consists of those and only those people who have been designated as such by the Team Leader in the entrance application and in any application addenda submitted to DARPA.

2.2.2 Chief Judge

The Chief Judge is the Official designated by DARPA as such. The Chief Judge is the final authority on all rules.

2.2.3 Entrant

An Entrant is an eligible entity (see section 3) that has submitted a completed Application Form to DARPA. An Entrant that does not become a Participant and attends the Challenge does so as a Spectator.

2.2.4 Field Judge

A Field Judge is an Official assigned by DARPA to observe Challenge Vehicles during the Challenge for safety and judging purposes.

2.2.5 Media Representative

A Media Representative is anyone who is accredited as such by DARPA.

2.2.6 Official

An Official is any person designated by DARPA for the purpose of administering or monitoring any aspect of the Grand Challenge.

2.2.7 Participant

A Participant is an Entrant that has completed the application process and whose technical paper has been accepted by DARPA.

2.2.8 Spectator

A Spectator is any person who is not a Participant, Official, or Media Representative.

2.2.9 Team Leader

A Team Leader is the eligible entity responsible for a team; and is the entity that will receive the prize if its team wins.

2.2.10 Winner

The Winner is the Participant whose Challenge vehicle has completed the prescribed Route in the least corrected time at or under ten hours.

2.3 Route Definitions

2.3.1 Arrival Area Parking Waypoint

Deleted.

2.3.2 Arrival Line

The Arrival Line is a line near the Arrival Waypoint that is independent of the RDDF, except that it will cross perpendicular to one of the final Track Lines. The Elapsed Time for a Vehicle is taken when the Vehicle has cleared the Arrival Line.

2.3.3 Arrival Waypoint

The Arrival Waypoint is the last Waypoint of the Challenge Route.

2.3.4 Challenge Area

The Challenge area includes the Departure Area, Departure Line, Challenge Route, Arrival Line, Arrival Area, and any other area that has been designated by DARPA for the purpose of conducting this Challenge. The specific boundaries of the Challenge Area will be provided to the Participants prior to the Challenge.

2.3.5 Challenge Route

The Challenge Route (sometimes referred to as the Route) is the area included within boundaries specified by DARPA in the Route Description Data File (RDDF). The Challenge Route does not include the Departure Area or the Arrival Area. It is on the Challenge Route that the performance of each Challenge Vehicle will be determined.

2.3.6 Checkpoint Area

Deleted.

2.3.7 Checkpoint Area Entry Waypoint

Deleted.

2.3.8 Checkpoint Area Exit Waypoint

Deleted.

2.3.9 Checkpoint Area Parking Waypoint

Deleted.

2.3.10 Departure Area

The Departure Area is that area behind the Departure Line, and within the boundaries designated for that purpose. The Departure Area is not part of the Challenge Route.

2.3.11 Departure Line

The Departure Line is a line near the first Waypoint that is independent of the RDDF, except that it will be perpendicular to one of the first Track Lines. It defines part of the boundary of the Departure Area.

2.3.12 Departure Waypoints

Deleted.

2.3.13 Departure Signal

The Departure Signal is the signal given sequentially to each Challenge Vehicle denoting the beginning of the Challenge. It will be given to each Challenge Vehicle by enabling it for operation via the normal mode of the wireless Emergency Stop (E-Stop) system.

2.3.14 Lateral Boundary Offset

The Lateral Boundary Offset (specified in feet) is the distance in any direction from the Track Line (including a radius at the end points) that defines the corridor in which Challenge Vehicles are permitted to travel. The width of this corridor will vary depending on safety and environmental limitations.

2.3.15 Maximum Crossing Time

The Maximum Crossing Time is the Pacific Standard Time associated with a Phase Line Waypoint, and is the time by which a Challenge Vehicle must pass that Phase Line Waypoint in order to remain in the Challenge.

2.3.16 Phase Line Waypoints

Phase Line Waypoints are those Waypoints that have been assigned a Maximum Crossing Time.

2.3.17 Route Definition Data File

The Route Definition Data File (RDDF) is the official Challenge Route. The RDDF is a comma delimited text file on a PC formatted CD-ROM. Data fields will include Waypoint number, Waypoint location (latitude in decimal degrees – seven decimal places, and longitude in decimal degrees– as seen below and referenced to the WGS 84 datum), Lateral Boundary offset (in feet), Speed Limit (in mph), and Maximum Crossing Time for Phase Line Waypoints (Pacific Standard Time in hours, minutes, and seconds, 24-hour clock). Null fields will be indicated by ####. Unlimited speed limits will be indicated by 999. The following are example lines:

NOTE: This data is for **format example only**. It does not represent points, separation, or parameters that are part of the actual event.

WP Number	WP LAT	WP LONG	LB	Speed Limit	Phase Line Hr	Phase Line Min	Phase Line Sec
10	38.2228914	-110.4790771	20	55	####	####	####
11	38.2224215	-110.4793187	20	55	09	45	00
12	38.2216479	-110.4799700	30	55	####	####	####

The above data would be formatted in the RDDF as:

10,38.2228914,-110.4790771,20,55,####,####,####
11,38.2224215,-110.4793187,20,55,9,45,0
12,38.2216479,-110.47997,30,55,####,####,####

NOTE: GPS data for the RDDF was collected using a NAVCOM StarFire™ GPS system that has a specified accuracy of <15 cm (or <6

inches) per the Tech Manual specs. The system provides seven (7) decimal place numerical output, which we provide in the RDDF. However, per the manual, the seventh decimal figure should not be confused as an additional degree of accuracy.

2.3.18 Track Line

The Track Line is a straight line from the center of a Waypoint to the center of the next sequential Waypoint.

2.3.19 Waypoints

Waypoints are two-dimensional locations (latitude, longitude) that, together with their related boundaries, define the Challenge Route. A Waypoint includes the area within a radius equal to the Lateral Boundary offset associated with that Waypoint.

2.4 Timing Definitions

2.4.1 Corrected Time

Corrected Time is the Elapsed Time for a Challenge Vehicle including any time adjustments as prescribed in the Rules. Corrected Time will not be maintained for disqualified Challenge Vehicles.

2.4.2 Elapsed Time

Elapsed Time is the uncorrected time for a Challenge Vehicle beginning at that Vehicle's Departure Signal and ending when that Vehicle has cleared the Arrival Line from the direction of the previous Waypoint. Elapsed Time will not be maintained for disqualified Challenge Vehicles.

2.4.3 Official Time

Official Time will be the time as kept by the Chief Judge.

3. Eligibility

3.1 Team Must Be U.S. Entity

The Challenge is open only to US entities. This includes U.S. corporations, U.S. non-profit organizations, U.S. universities, U.S. citizens, sole proprietors that are U.S. citizens or permanent residents, and partnerships of U.S. citizens or

permanent residents. The nationality of the team is determined by its Team Leader which may be a person or organization.

3.2 Federal Government Organizations Ineligible

U.S. Federal Government organizations, including U.S. Military Service Academies, are ineligible to lead a team or participate as a member of a team.

U.S. Federal employees may participate as private citizens as long as they do so on their own time and while using only non-Federal equipment and supplies. They must be a U.S. citizen to be a Team Leader.

3.3 Federally Funded Research and Development Centers (FFRDC)

A Federally Funded Research and Development Center (FFRDC) is eligible to lead or be a member of a team provided that no Federal funding is specifically used to prepare for or participate in the Challenge.

3.4 Foreign Participation

Foreign entities may participate only as members of a U.S.-led team.

3.5 Multiple Teams

A sponsor wishing to enter more than one vehicle shall assign unique names to each of its vehicle teams. DARPA shall treat such teams as separate teams for the purposes of administering this Challenge. Cooperation between Challenge Vehicles is strictly prohibited.

Any person may be a member of more than one team.

4. Entry Procedures

4.1 Entry Fee

There is no entry fee.

4.2 Application Period

The period of application begins on April 1, 2003 and ends on the application deadline at noon, Eastern Daylight Time, on October 14, 2003. Applications received after the deadline will not be considered, and will be destroyed.

4.3 Application Documents

A complete application consists of several documents that need not be submitted simultaneously. These documents include the application form, application addenda (if required), the technical paper, and technical paper addenda (if required).

4.3.1 Application Form

A completed application form must be received from any prospective Entrants on or before the application deadline. The application form is on the DARPA web site (www.darpa.mil/grandchallenge). Prospective Entrants also may request an application by calling 866 DARPA GC (866 327 7242) and leaving their mailing address or fax number, as desired. The application form must be submitted prior to, or along with, the other required documents.

4.3.2 Application Addenda

An application addendum accommodates the need for information items that are not expected to be available when the application form was completed. Examples of application addenda that will be required include updated Team roster, photographs of the Challenge Vehicles, and a photograph of the Challenge Team. The requirements for application addendum items will be sent only to Entrants and Participants.

4.3.3 Technical Paper

A technical paper describing the Challenge Vehicle must be received at DARPA on or before the application deadline. A description of the mandatory subjects to be addressed in this paper is on the DARPA Grand Challenge web site (www.darpa.mil/grandchallenge).

The technical paper will be reviewed by DARPA to ensure that the Challenge Vehicle design complies with the Rules. The panel also will judge the technical competence of the design and may not accept incomplete or ineffectual proposals. DARPA will respond to each technical paper within two weeks (14 days) of receiving it. Papers that are not accepted by DARPA may be re-submitted by Entrants until the application deadline.

DARPA will treat the technical papers as team proprietary information in their entirety until the conclusion of the 2004 Challenge, at which time the papers will be available to the public. If a technical paper contains an attachment of information that is designated by the Team as proprietary information, that attachment will not be made public with the technical paper.

Other than the required technical paper, and information already in the public domain, no public release of information regarding a team's technical approach will be made without the expressed permission of the Team Leader. DARPA

claims no intellectual property (IP) rights from Entrants, Participants, or the Winner. All trade secrets, copyrights, patent rights, and software rights will remain with the Team or other original holder.

4.3.4 Technical Paper Addenda

DARPA must be informed as soon as possible of any deviation in the technical approach described in a current technical paper. These technical paper addenda may be submitted to DARPA without penalty prior to the application deadline or any time after the initial technical paper has been approved as long as they are submitted at least 14 calendar days prior to the QID in order that DARPA will have time to review and approve the deviation.

The technical paper addenda are intended for minor modifications and refinement of the Challenge Vehicle design. The addition or improvement of code, sensors, suspension, or actuators on basically the same vehicle, for example, are appropriate for a technical paper addendum.

Addendums must be submitted as complete technical papers with the changes from the current technical paper marked. Alternately, these changes can be delineated in a separate document.

Challenge Vehicles presented for the Qualification Inspections and Demonstration (QID) that deviate substantially from the description in the approved technical paper (including approved addenda) will be disqualified. If there are any changes to the team's technical paper submitted in Oct 2003, the team's updated technical paper must be received by DARPA by 1 March 04.

4.4 Application Submission Procedures

Application documents may be submitted by using U.S. Postal Service, courier or delivery service, fax, or e-mail. The receipt of application documents will be promptly acknowledged by DARPA. Delivery information and official time of receipt will be as follows:

U.S. Postal Service, Courier or delivery service –
DARPA Grand Challenge
3701 North Fairfax Drive
Arlington, VA 22203-1714
(Time of receipt in DARPA mailroom)

Fax –
703 741 3892
(Time of receipt as recorded by DARPA)

E-mail –
grandchallenge@darpa.mil
(Time of receipt as recorded by the DARPA mail server)

4.5 List of Entrants and Participants

The names and contact information of Entrants and Participants will be posted on the Grand Challenge web site. Entrants that do not complete the application process by the application deadline will lose their designation as Entrants and will be removed from the list of Entrants.

5. General Rules

The Chief Judge has the right to modify the Rules at any time. As revolutionary thinking, engineering, and technology are desired, Entrants are invited to communicate directly with DARPA regarding any rule that restricts their ability to demonstrate technical achievement and innovative solutions to intelligent autonomous ground vehicle behavior in the Grand Challenge. Some potential reasons for Rules modifications include the clarification of issues raised by Entrants, the accommodation of promising but unexpected technical approaches that would have been prohibited by the Rules, and the exclusion of approaches that seek to win the prize without demonstrating the desired technical achievement in autonomous military behavior that is the purpose of the Challenge.

The Chief Judge reserves the right to revise the schedule of the Challenge and to change or provide interpretation of the Rules at any time and in any manner, which, in its sole judgment, is required. The Chief Judge's judgment regarding the Rules is based on safety, legal compliance, fairness, Challenge goals, and efficient operations.

5.1 Self-Sufficiency of Teams

Teams shall furnish all equipment and supplies used in entering and participating in the Grand Challenge.

5.1.1 Federal Resources Prohibited

No government-owned equipment or supplies may be used by a team in preparation for or during the Challenge except for equipment and supplies that have been offered to all Entrants.

5.1.2 Government-Furnished Equipment (GFE), Services, & Supplies

Some government-furnished equipment and supplies may be furnished or made available to all teams. A complete list of items to be provided will be transmitted to Participants well in advance of the Grand Challenge.

When GFE is issued for integration into the Challenge Vehicle, it is the sole responsibility of the Participant to properly install the GFE in their Challenge Vehicle. Limited technical assistance of this GFE will be available to the Participant from the manufacturer. However, DARPA shall not incur any liability from the Participant's use of this technical assistance. Use of this technical assistance is solely within the discretion of the participant.

Participants have five calendar days following receipt of the GFE to notify DARPA if the GFE is damaged or is otherwise not in working condition. After that period, the Participant assumes responsibility for the GFE and DARPA will not be responsible for repairs to the GFE or replacement of damaged GFE. The Participant's GFE must be fully functional for the Participant to be eligible to participate in the Grand Challenge. DARPA reserves the right, solely within its discretion and assuming equipment availability, to provide the Participant with replacement GFE if the Participant's GFE is not fully functional.

The Participant shall return GFE to DARPA within 24 hours from the date of any of the following events: when the Challenge Vehicle is disqualified from the Grand Challenge; when the Challenge Vehicle fails to complete the Grand Challenge course; or when the Challenge Vehicle is withdrawn or is otherwise eliminated from participation in the Grand Challenge.

During GFE testing by the teams, upgrades may be necessary to improve tracking system accuracy or e-stop capabilities. DARPA will coordinate timeframes with each team to ensure GFE upgrades are accomplished and the equipment is returned to the teams.

5.1.3 Sponsorship

The cost of developing, fielding, and insuring the vehicles is the sole responsibility of the teams. DARPA will not provide funding for the purpose of entering or participating in the Grand Challenge. Teams are allowed to obtain sponsorships and to display advertising so long as such advertisements are not considered offensive by the judges. DARPA will not endorse blanket sponsorships for teams.

The appearance of external advertising on Challenge Vehicles must be submitted to DARPA no later than 30 days prior to the Challenge.

5.1.4 Classified Data and Devices

No classified data or devices may be used by a team during or in preparation for this Challenge.

5.2 Publicity

Extensive media coverage of the Challenge is expected but cannot be guaranteed. Any Media Representative desiring to cover the Grand Challenge must register with DARPA in order to gain access to the Challenge Area. Media access may include a combination of DARPA provided data and video feeds, assigned airspace for aerial coverage, and designated fixed camera sites along the Challenge Route.

5.3 Security

5.3.1 Access Control

Grand Challenge Participants and DARPA-accredited Media Representatives will be issued access-control passes that are required for entry into controlled areas within the Grand Challenge Area.

5.3.2 Team Security

DARPA assumes no responsibility for the security of Team equipment and supplies. While DARPA will extend general control over Grand Challenge areas such as the Departure Area and Arrival Area, each team is responsible for providing any additional security for their equipment and property as desired.

5.3.3 E-Stopped Vehicle Security

DARPA will observe, for security purposes, any Challenge Vehicle that is stopped on the Route, including any that are E-Stopped because they failed to pass a Phase Line Waypoint on time. That observation will continue until either a Team Member for that Vehicle arrives, or for two hours after the last Vehicle has passed, whichever occurs first. A Team Member must display their DARPA-issued access badge in order to have access to the Vehicle.

5.4 General Safety

A Safety Standard Operating Procedures (SOP) Manual will be distributed to each Participant Team prior to the Grand Challenge. The SOP will provide specific instructions for the administration of activities associated with the Grand Challenge, as well as emergency contingency procedures. Compliance with the SOP is mandatory whenever the Team or its Vehicle is within DARPA-controlled areas.

5.5 Environmental Impact

Segments of the Grand Challenge Route and associated areas may lie within environmentally controlled areas. Therefore, any Vehicle or associated team activities that have an unacceptable impact on the environment will not be allowed. This includes overtly destructive vehicle systems or behavior, abnormally hazardous substances or materials, and generally reckless behavior. Any hazardous equipment or activities that are not indicated and approved in the technical paper are cause for disqualification of the Team.

5.6 Pre-Challenge Testing

Testing of Challenge Vehicles or components is the sole responsibility of each team. Any use of public lands for this purpose is at the team's own risk and must be in accordance with applicable local, state, and federal guidelines and be in accordance with the limits imposed by paragraph 8.3.

To validate the transfer of Grand Challenge route definition data, DARPA can provide a test RDDF to Participants for use in Vehicle testing. A request for a test RDDF must be accompanied by a complete data set (to include a maximum of 25 waypoint latitude and longitude pairs, lateral boundaries, speed limits, and Phase Line closing times that define a route specified by the Team. DARPA will encode these data into an RDDF and ship it to the requesting Team with no verification of the nature or safety of the defined route. The RDDF will be a comma delimited text file on CD-ROM, just as it will be distributed at the Challenge pre-brief.

6. Challenge Vehicle

Challenge Vehicles must be unmanned (no animals onboard) and fully autonomous. They may not be remotely driven while on the Challenge Route.

All computing and intelligence must be contained onboard while on the Route. Apart from the emergency stop feature, tracking signals from DARPA provided systems, and freely available navigation signals, no external communication is allowed. There is no size, weight, or propulsion power limit on the ground vehicle—the nature of the Route will dictate practical limits.

The entry must be a ground vehicle. That is, it must be propelled and steered principally by traction with the ground. The type of ground contact devices (such as tires, treads, legs, etc.) is not specified. The vehicles must not damage the environment or infrastructure in violation of restrictions specified by the applicable land-use permitting authority.

6.1 Autonomous Vehicle Behavior Required

Autonomous behavior and operation is required by a Challenge Vehicle whenever it is on the Challenge Route. No team may cause a signal of any kind (e.g. visual, RF, sonic) to be sent to a Challenge Vehicle, nor may any Challenge Vehicle receive a signal of any kind except those permitted by Section 6.7 while it is on the Challenge Route. Any remote control systems used for operation of the Challenge Vehicle prior to the Challenge must be removed from the Vehicle prior to the Departure Signal.

6.2 Tethered Vehicle Systems

Only single independent, un-tethered ground vehicles are eligible.

A technical approach using a single ground vehicle and one or more sub-systems (such as sensors) that are physically tethered to that ground vehicle is permitted as long as the tethered subsystems are not designed to be propelled or maneuver independently of the ground vehicle (as would, for example, an aircraft or steerable balloon or kite). Such tethered sub-systems that are permitted specifically include 1) sub-systems on a rigid, telescoping, or articulating mast, and 2) sub-systems such as balloons or kites that move only in response to relative wind and vehicle motion. Tethered sub-systems that are designed to extend more than 10 feet above the surface must be painted so as to enhance their visibility to helicopter pilots that may need to land near a Challenge Vehicle. Entrants are advised that the Federal Aviation Administration, particularly in 14 CFR 101, regulates the operation of moored (tethered) balloons.

Entrants are advised that the Challenge Route may be adjacent to utility and power structures, and high-voltage power lines. A description of the ability to safely operate any tethered system is required in the technical paper.

6.3 Vehicle Identification Number

Prior to the Challenge, each Challenge Vehicle will be assigned a unique identification number that shall be displayed at least 12 inches in height on its sides, front, back, and top (as large as possible is preferred). The number shall be either black or white and shall have a solid background either in white or black, respectively, extending at least three inches larger than the number. A vehicle that can operate when flipped over also shall have the number displayed on its bottom.

6.4 Vehicle Safety

Notwithstanding any Rule, or the acceptance by DARPA of any technical paper, or any inspection or demonstration required as a condition of participating in the Grand Challenge, DARPA makes no representation as to the safety of any Vehicle entered in the Grand Challenge.

6.4.1 Radiated Energy Safety Standards

6.4.1.1 Laser Safety Standards

All participants are directed to OSHA 29 CFR 1926.54 and OSHA Technical Manual (TED 1-0.15A), Section III - Chapter 6 (1999, January 20) for relevant laser safety standards. Challenge Vehicles must comply with all applicable local, state, and federal laser safety regulations.

6.4.1.2 RF Radiation Standards

All participants are directed to OSHA 29 CFR 1910.97 (Non-ionizing Radiation) and Department of Defense Instruction 6055.11 (1995, February 21) for relevant RF safety standards. Challenge Vehicles must comply with all applicable local, state, and federal RF safety regulations.

6.4.1.3 Acoustic Safety Standards

All participants are directed to OSHA 29 CFR 1910.95 (Occupational Noise Control) and OSHA Technical Manual (TED 1-0.15A), Section III - Chapter 5 (1999, January 20) for relevant acoustic safety standards. Challenge Vehicles must comply with all applicable local, state, and federal acoustic safety regulations.

6.4.2 Warning Devices

6.4.2.1 Audible Warning–Vehicle Operating

Each Challenge Vehicle shall produce an intermittent warning sound when, and only when, the Vehicle is enabled for operation (i.e. including when it has autonomously stopped, but is computing a path in preparation for movement). The warning sound shall not operate after the Vehicle has come to a stop following an E-Stop. The Challenge Vehicle may not commence movement unless the warning sound has been in operation for at least five seconds.

The warning sound shall produce at least 85dB at ten feet in front of the Vehicle, and shall not produce sounds that can be confused with those of public-safety vehicles such as law-enforcement, fire, or ambulance.

6.4.2.2 Visual Warning–Vehicle Operating

Each Challenge Vehicle shall display one or more flashing yellow or amber warning lights, the combination of which results in visibility 360 degrees horizontally around the Vehicle. The warning light shall operate when, and only when, the Vehicle is enabled for operation (i.e. including when it has autonomously stopped, but is computing a path in preparation for movement). The warning light shall not operate after the Vehicle has come to a stop following an E-Stop. The Challenge Vehicle may not commence movement unless the warning light has been in operation for at least five seconds. The warning light(s) shall comply with SAE Class 1 standards for warning lights, and shall not produce light(s) than can be confused with those of public-safety vehicles such as law-enforcement, fire, or ambulance.

6.4.2.3 Visual Warning–Vehicle Brake

Each Challenge Vehicle shall display two or more steadily illuminated red warning light(s) on the rear of the Vehicle and visible within a 90-degree cone that illuminates when and only when the Vehicle's dynamic braking system (not a parking brake) is being activated. The purpose of this light is to indicate that the Vehicle is braking. The placement of this light should be mounted high and sufficiently distant from the amber lights so as to permit its rapid recognition.

6.4.3 Emergency Stop (E-Stop)

The Emergency Stop (E-Stop) system has two modes; a normal E-Stop mode, and a disable E-Stop mode. The normal mode brings the Vehicle to a prompt stop under control of the onboard processing system, and keeps all systems energized and able to resume navigation when the normal mode stop signal is removed. The disable mode brings the Vehicle to a prompt stop when the normal E-Stop mode has failed, or the Vehicle has been disqualified. The disable mode disables the main propulsion unit and as many Vehicle systems as necessary (e.g. fuel pump, electrical bus) to positively ensure that the Vehicle shuts completely down.

The E-Stop system shall be capable of being activated manually and remotely as described below. Activation of the disable-mode E-Stop is anticipated only when the Vehicle is disqualified.

6.4.3.1 Manual E-Stop (disable mode)

Each Challenge Vehicle must be equipped with an externally actuated, manual E-Stop capability. Activating the manual E-Stop must promptly bring the vehicle to a complete halt in the disable mode. At least one actuator and its labeling must be easily visible and accessible by an average human standing anywhere around the vehicle. The E-Stop must be easy to identify and activate safely, even if the

vehicle is moving at a walking pace. The operation instructions for manual E-Stop actuators must be clearly labeled in English and in Spanish, and the labeling must not be interfered with by any other labeling or advertising. A demonstration of the manual E-stop capability will be required as part of the pre-Challenge Qualification Inspection and Demonstration.

6.4.3.2 Wireless E-Stop (normal and disable modes)

DARPA will temporarily transfer custody of one set of government-owned E-Stop equipment, consisting of a controller and a Vehicle receiver, to each Participant for the purpose of integration and testing with the Challenge Vehicle. This transfer will occur after the application deadline. The E-Stop systems will remain the property of the U.S. Government and must be returned to DARPA immediately following the 2004 Grand Challenge. While insurance is not explicitly required to cover the E-stop equipment, the equipment, or its full cost to the government, must be returned to DARPA immediately following the 2004 Grand Challenge. Each Challenge Vehicle must be equipped with the DARPA-furnished wireless remote E-Stop capability (see paragraph 5.1.2).

The wireless E-Stop receiver (Vehicle component) will furnish two binary outputs—one for the normal mode and one for the disable mode. Specifications regarding size, weight, power, output voltage, current, connectors, etc. have been furnished to Participants. The preferred implementation of the E-Stop system is that the normal mode can be cycled on or off in order that the Vehicle can be stopped and re-started during the Challenge, and that the disable mode is latched so that its state cannot be changed after initiation. Provisions for a manual disable-mode unlatch switch on the vehicle are, of course, acceptable.

A demonstration of the wireless E-stop capability (both modes) will be required as part of the pre-Challenge QID.

Vehicles that do not exhibit mobility within 10 minutes of re-establishing the normal-mode E-Stop link may be considered disabled for the purposes of physically moving them to avoid obstructing Challenge or Control Vehicles from passing.

6.5 Neutral Gear

Challenge Vehicles must have the capability to be easily put into a neutral gear. The mechanism for placing the vehicle into a neutral gear must be readily accessible and clearly marked. This is to allow disabled Challenge Vehicles to be moved aside if they are impeding other Challenge Vehicles behind them.

6.6 Electrical Provisions for DARPA Equipment

Challenge Vehicles will need to accommodate the E-Stop receiver described in paragraph 6.4.3.2 and a tracking beacon, both provided by DARPA, along with associated antennas. The E-Stop receiver will require a nominal 12 VDC power input which can range from a minimum of 10 VDC to a maximum of 20 VDC. The tracking beacon will receive power from the E-Stop receiver. The combined power requirement will be less than 30W. Any mounting plates or interfacing connections for DARPA equipment will be supplied to all Participants well in advance of the Challenge.

6.7 Position-Determination Equipment

Challenge Vehicles may be equipped to receive and process electronic position-determination signals (such as GPS) that are freely available to all teams. Teams desiring to utilize position-determination signals that are not freely available (such as subscription services) must make that request in the technical paper no later than the application deadline. The use of position-determination devices (such as beacons, etc.) that are developed or placed specifically for Route navigation is prohibited.

GPS alone will not provide adequate navigation information to a Challenge Vehicle. Prospective Entrants also are advised that there could be dust, smoke, or other visual obscurants on the Route, and that visual spectrum only sensing may not permit sufficient speed if those situations are encountered (such as when following another vehicle).

6.8 Telemetry

This Section does not apply to the E-Stop system or to any DARPA-supplied system.

No telemetry from a Challenge Vehicle is permitted without the approval of DARPA. Requests for approval shall be submitted with the required technical paper. Telemetry that requires sending any signal to the Challenge Vehicle will not be approved.

7. QUALIFICATION INSPECTION & DEMONSTRATION (QID)

A qualification inspection & demonstration (QID) shall be conducted and must be passed as a prerequisite to starting the Challenge. The QID will be held during the week prior to the Challenge start (March 8 – 12, 2004).

7.1 Technical Inspection

The first phase of the QID will be a static technical inspection of all Challenge Vehicles. The purpose of this inspection will be to ensure compliance with all Rules, ensure compliance with the technical paper and all approved Technical

addenda, and to ensure the general safety of the Challenge Vehicle. Any deviations will be identified to the Team for immediate action to bring the vehicle into compliance. If a vehicle cannot conform to the Rules and technical paper description, it will be disqualified. If there are any changes to the team's technical paper submitted in Oct 2003, the team's updated technical paper must be received by DARPA by 1 March 04.

7.2 Demonstration

The second phase of the QID will be a required demonstration of intelligent autonomous behavior and safety features around a short demonstration course. The purpose of the demonstration is to verify that all Challenge Vehicles exhibit basic autonomous adherence to defined route parameters while negotiating minor obstacles. The demonstration course obstacles will be significantly less demanding than those on the Challenge Route, and will be designed to minimize the risk of damage to the Challenge Vehicles. The demonstration course will be defined by a QID RDDF in the same format as the Challenge Route.

The QID demonstration will contain a competitive element for the purpose of eliminating teams. Twenty-five teams are invited to the QID, but only 20 teams will be invited to the field event on March 13, 2004..

8. Route Rules

8.1 Challenge Route

All Challenge Vehicles must remain within the Challenge Route from the time they leave the Departure Area until the time they reach the Arrival Waypoint. If a vehicle is immobile for longer than 10 minutes, it may be disqualified.

8.1.1 Waypoints

GPS reception at Waypoints is not guaranteed.

The Waypoints, together with their related Lateral Boundary Offsets, define the corridor through which the Challenge Vehicles are required to travel. For portions of the Route, the Boundaries may be narrower than the accuracy of some radio-positioning systems; and intelligent sensing and behavior will be required for the Vehicle to remain on the Route.

Vehicles must pass Phase Line Waypoints by the time designated in the RDDF. Failure to pass a Phase Line Waypoint before the specified time results in disqualification.

8.1.2 Route Boundaries

The Lateral Boundary Offsets of the Route will be specified in feet from any point on a Track Line. Challenge Vehicles are free to traverse any area within the corridor thus defined. The width of the corridor defined by the Boundaries will vary but will be no less than ten feet. When the width of the Boundaries is less than the accuracy of radio-positioning, other sensors will be required to keep the Challenge Vehicle on the Route. In areas of particular safety or environmental concern where the Route edges may not be sufficiently clear, the Boundaries may be marked with concrete barriers, plastic snow fencing, or other similar material. Any Challenge Vehicle that crosses a Lateral Boundary will be immediately E-stopped and disqualified from the Challenge.

8.1.3 Speed Limits

Speed limits will be mandatory for certain segments of the Challenge Route for safety and environmental reasons. Speed limits will be specified in the RDDF in miles per hour, and will apply for the Route segment defined by the associated Waypoint to the next sequential Waypoint. In the area where two Route segments overlap, the least restrictive (i.e. higher) speed limit will apply. A specified speed limit does not imply that it has been tested or that it is a safe or achievable speed. Exceeding a speed limit may be a cause for disqualification.

8.1.4 Route Definition Data File (RDDF)

The RDDF will be given to all Participants approximately two hours prior to the first Departure Signal at a pre-Challenge brief.

8.1.5 Underpasses

Where the Boundaries constrain the Route to pass through an underpass or other feature, all Challenge Vehicles must pass through the underpass or feature. No underpass will be smaller than ten feet wide and nine feet high.

8.2 Unintended Obstacles

DARPA intends to clear the Challenge Route of non-Challenge traffic and obstacles, but can not guarantee that there will be no non-Challenge traffic, obstacles, or humans on the Challenge Route. Technical approaches for Challenge Vehicles that rely on brute force to accommodate (e.g. crush, damage, or push aside) obstacles will not be permitted. Sensing and processing designs must be able to avoid collisions with any obstacle, moving or static, that may exist on the route.

8.3 Pre-Running the Route

Pre-running or surveying the route is prohibited within two hours of the scheduled departure signal..

8.4 Departure Procedure

The Departure procedure will involve a sequential start of all Challenge Vehicles. Vehicles will be positioned behind the Departure Line. For each Challenge Vehicle, DARPA will establish each E-Stop data link sequentially and it will autonomously begin navigating the Challenge Route. If a Challenge Vehicle fails to depart due to technical difficulties, it will be given another opportunity after all other Challenge Vehicles have left the Departure Area. More details concerning the Departure, including the inter-Vehicle spacing or timing and the determination of departure order, will be provided to teams prior to the Challenge.

A Team that fails to report to its assigned starting position at the designated time as provided at the March 12 Team meeting, may be disqualified.

8.4.1 Departure Line Time Limit

Deleted.

8.5 Interference

8.5.1 Intentional

Intentional interference with other Challenge Vehicles is strictly prohibited. Interference is defined as any physical action or emission with the purpose of degrading another Challenge Vehicle's ability to compete. If such interference is observed, the offending vehicle will be disqualified. Identification and enforcement of interference is at the discretion of the DARPA Chief Judge.

8.5.2 Un-intentional

Minor or unavoidable interaction between Challenge Vehicles shall not be penalized. Classification of such contact is the decision of the DARPA Chief Judge.

8.5.3 Damaging Non-Team Property

8.5.3.1 Intentional

Except for minor and unavoidable damage as determined by the DARPA Chief Judge, any team responsible for the intentional damage of property that does not belong to that team shall be disqualified. Intentional damage includes damage that occurs as a result of failure to prevent damage that could have been foreseen. Minor damage does not include damage that, as determined by the Chief Judge, adversely affects the performance of another team.

8.5.3.2 Un-intentional

Minor and unavoidable damage shall not be penalized. Un-intentional damage to another Team's property that, in the opinion of the Chief Judge, adversely affects the performance of the other Team shall be disqualifying.

8.5.4 Human Interaction Prohibited

8.5.4.1 Physical Contact With Own Challenge Vehicle

No Team Member may make, or cause to be made, physical contact with that Team's Challenge Vehicle after it has started the Challenge and before it has finished the Challenge (including the post-Route inspection). Physical contact includes indirect contact such as with tools, etc., as well as human-commanded contact such as by using remotely controlled equipment. Minor and inadvertent contact with a team's own Challenge Vehicle may be accepted based on the judgment of the Chief Judge. Violation of this rule shall result in disqualification.

8.5.4.2 Physical Contact With Other Challenge Vehicle

No Team Member may make, or cause to be made physical contact with any other Team's Challenge Vehicle after that Vehicle has started the Challenge and before it has finished the Challenge unless that Challenge Vehicle is disqualified. Minor and inadvertent contact with another team's Challenge Vehicle may be accepted based on the judgment of the Chief Judge. Violation of this rule shall result in disqualification of the member's Team.

8.6 Jettisoning Material on the Challenge Route

Except for normal by-products of power generation, the intentional jettison of any material from the Challenge Vehicle is prohibited and shall result in disqualification. If a portion of a Challenge Vehicle unintentionally falls from the vehicle while on the Route, DARPA will notify that Team, and the Team is responsible to recover such debris once all qualified Challenge Vehicles have cleared the affected area.

A smokescreen or any other obscurant intentionally discharged from a Challenge Vehicle is specifically prohibited.

8.7 Passing

No Vehicle may intentionally operate to hinder another Vehicle that is trying to pass it.

Passing is permitted as long as the passing Vehicle does not cross a Boundary of the Route. The burden of responsibility for collision avoidance shall fall primarily on the Vehicle that is attempting to pass.

If the width of a Route segment is insufficient for passing, and the impeding Vehicle is moving, the passing Vehicle must wait until there is sufficient room to pass. Time credit will be given to the following Vehicle(s) at the discretion of the Chief Judge.

If the width of a Route segment is insufficient for passing and a Challenge Vehicle is immobile and blocking the route such that no other vehicles can pass, any other approaching Challenge Vehicles will be E-stopped (normal mode). If the immobile vehicle has not moved within10 minutes, it may be disqualified and shall be removed from the Route. Once the route is clear, waiting vehicles will be reactivated, and time spent waiting to pass the immobile Challenge Vehicle shall be credited to the passing Challenge Vehicle's Corrected Time.

At the discretion of the Chief Judge, a slow moving Challenge Vehicle may be stopped in areas wide enough to allow a faster Challenge Vehicle to pass with its associated Control Vehicle. The time stopped will not count against the Corrected Time for slow moving Challenge Vehicle.

8.8 Checkpoint Area

Deleted.

8.9 Collision Avoidance

Challenge Vehicles should attempt to avoid collisions with stationary objects and other vehicles. To assist in vehicular collision avoidance, Challenge Vehicles should adhere to the following guidelines concerning right-of-way:

- For the purpose of this section, a vehicle that has the right-of-way is also be referred to as the "stand-on" vehicle and a vehicle that does not have the right-of way is also referred to as the "give-way" vehicle. A give-way vehicle should yield to a stand-on vehicle.
- In a crossing situation, the vehicle on the right has the right-of-way and is therefore the stand-on vehicle.
- In a crossing situation, if the give-way vehicle must turn to avoid the stand-on vehicle, that turn should be to the right.
- In a head-on situation, both vehicles are considered give-way vehicles and should veer right to avoid a collision.
- In an overtaking situation, the vehicle being overtaken is the stand-on vehicle (in accordance with paragraph 8.7).

8.10 Arrival Area

After a Challenge Vehicle has crossed the Arrival Line it shall be impounded for a post-Route inspection. Teams may not interact with their Challenge Vehicle until released from this impound by a Field Judge.

8.11 Maximum Corrected Time

The Maximum Corrected Time is ten hours. A Challenge Vehicle must have a Corrected Time of ten hours or less to be eligible for the Prize.

9. Challenge Judging

9.1 Judging Decisions are Final

Decisions of the DARPA Chief Judge are final.

9.2 E-Stop

A Field Judge may, without penalty, E-stop (normal mode) any Challenge Vehicle for safety reasons not related to the undesired behavior of the Challenge Vehicle. After the safety issue is resolved, the Challenge Vehicle may continue with the Challenge, and the time of the stop will be credited to the Corrected Time of the Challenge Vehicle.

If an E-stop is performed because of a loss of visual contact or loss of wireless link between the Challenge Vehicle and a Field Judge, the Challenge Vehicle may resume the Challenge when the E-Stop link is re-established; and the time of the stop will be credited to the Corrected Time of the Challenge Vehicle.

If the E-stop is performed to prevent undesired behavior (such as driving off a bridge or out of bounds) by the Challenge Vehicle, the team may be disqualified.

DARPA reserves the right to take any measures necessary to stop a Challenge Vehicle that does not respond to an E-Stop. These measures may result in damage to the Challenge Vehicle.

9.3 Time Corrections

No time corrections are applicable to any Challenge Vehicle that does not enter the Arrival Area at or before ten hours Corrected Time since their starting signal. Time credits will be applied to the Elapsed Time of a Challenge Vehicle as follows:

- E-Stop because visual contact or wireless link with the Challenge Vehicle was lost
- E-Stop because of safety concern not a fault of the Challenge Vehicle

- E-Stop or other halt caused because the route is blocked and is too narrow to permit passing
- E-Stop to of a Challenge Vehicle to allow another to pass
- Any other situation, in the opinion of the Chief Judge, in which the Challenge Vehicle was unfairly disadvantaged while exhibiting reasonable autonomous behavior

9.4 Disqualification

A disqualified Challenge Vehicle may not continue on the Challenge Route. The location(s) of any disqualified Challenge Vehicle(s) will be maintained in the local DARPA Operations Center. Section 5.3.3 also applies.

10. Receiving the Prize

The winning Team, in order to receive the Prize, shall be required to certify to the U.S. Government that the Team complied with all Rules. Therefore, it is prudent for Teams to ask for clarifications of Rules, or whether a questionable action is permitted, well enough in advance of the Challenge to accommodate DARPA's decisions and interpretations of the Rules. DARPA will keep questions that have been designated as team proprietary from the other Teams.