



DARPA Grand Challenge 2005

National Qualification Event

August 8, 2005

Defense Advanced Research Projects Agency

3701 North Fairfax Drive
Arlington, VA 22203-1714

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National Qualification Event (NQE)

This document provides initial instructions for operations at the National Qualification Event (NQE). Teams are required to comply with the guidance in this document.

The NQE gives teams the opportunity to demonstrate their vehicles on a challenging test course. The evaluation and ranking of teams is based on demonstrated vehicle capabilities and cumulative performance after multiple course attempts. The NQE results will determine the teams that will advance to the Grand Challenge Event on October 8, 2005. Results of the NQE will be announced October 5, 2005.

General The NQE will take place at the California Speedway in Fontana, California. Teams should be on-site with vehicles ready to run every day of NQE, from the opening ceremony on September 28 to the closing ceremony on October 5. All autonomous vehicles should be fully integrated and tested prior to NQE and should be robust enough to perform reliably over multiple runs on the course.

Attendance is required at a number of events during NQE:

- Team vehicles must arrive during the arrival period specified below.
- Team leaders must attend the Team Leader Welcome Meeting at 5:00 PM on September 27.
- Team vehicles and team leaders must be present and participate in the opening ceremony on September 28.
- Vehicles must undergo static and dynamic inspection on September 28. Vehicles must pass inspection to participate in NQE.
- Team leaders must be present and participate in the closing ceremony on October 5.

Disqualified teams must forfeit their garage area credentials and remove their vehicles from the garage area as directed by DARPA officials.



Notional NQE test course layout at the California Speedway

The NQE course is within the infield area of the California Speedway (see Figure). The course is approximately 2 miles in length, and is specified by the RDDF

Registration All team members will register on-line at the URL sent via e-mail to team leaders. Registration must be completed by August 19, 2005.

Only 25 individuals (team leader included) are allowed to register and be included on the team roster. Additions, deletions, and replacements to the roster will be handled as described on the registration website. All roster changes must be confirmed by the team leader.

Travel and lodging information for the Fontana/Ontario area are available on the website.

Additional team personnel are welcome to the Speedway as team guests (see below) or as spectators.

Team Check-in All team members will check in upon arrival at NQE to receive an information packet and garage credentials .

All Grand Challenge vehicles must be checked-in at the garage area on September 27, between 12:00 PM and 5:00 PM. DARPA staff will be present to direct teams to the garages and answer questions.

Team member check-in at the California Speedway is open on September 27 from 12:00 PM to 7:00 PM. Arriving teams should follow the signs to the Credentials Building. (For team members that arrive after September 27, on-site registration and check-in will be open from 7:00 AM to 5:00 PM beginning September 28.)

Early team member check-in is available September 26 from 6:30 PM to 9:30 PM at the Ontario Marriott, Ontario, California.

Team members listed on the team roster will receive garage access credentials after signing the Speedway liability waiver. Team members who are under 18

must submit a signed and notarized Waiver and Release of Liability and Indemnity Agreement – Parents:Guardians:Minors form (available on the registration website).

Team leaders must check in prior to the Team Leader Welcome Meeting September 27 at 5:00 PM in the Drivers Briefing Room at the Speedway. Team leaders not able to attend the meeting should send an alternate. Team leaders who do not arrive in time should call the registration window at (703) 863-3832.

Team Guest Passes Each team leader will be issued 25 guest passes for access to the garage area for individuals not on the team roster. Guest passes may be used by team personnel, family and friends, and sponsors. Team leaders are responsible for ensuring their guests sign a liability waiver before entering the garage area and are responsible for supervising the activities of their guests.

Garages Each team will be assigned one garage bay at the Speedway. Teams may not share or trade assigned garage bays. Garage operating hours are 12:00 PM to 10:00 PM September 27, and 6:00 AM to 10:00 PM, September 28 to October 5.

The working space in each garage bay is approximately 20 feet wide and 26 feet deep. The bay entrance height is 88 inches, and the height inside the garage is approximately 12 feet. A limited number of garage bays have entrance heights of approximately 120 inches.

(The number of taller garage bays is limited. DARPA will attempt to accommodate all teams with vehicles above 88 inches; if there are not enough garages DARPA will work with the teams requiring taller garages to achieve an acceptable solution.)

The garages are equipped with 110V AC power; overhead fluorescent lighting; and a single, built-in shop table. The bays do not contain vehicle lifts, and adequate safety precautions are required when jacking, hoisting, or performing other potentially hazardous operations.

No machine tools are available at the Speedway.

The following rules apply in the garages:

- No welding.
- Vehicles must be removed from the garage to be fueled.
- No emission of exhaust inside the garage.
- No vehicles with dripping or leaking fluids.
- No smoking.
- No pets.
- No loud music, horseplay, or other disruptive activity.

Teams are responsible for the security of their vehicles, equipment, and other belongings in their assigned garage bay during daily track operations (6:00AM to 10:00PM). DARPA will provide overnight security in the garage area.

Grand Challenge autonomous vehicles must be stored overnight in their assigned garage or as directed by DARPA. Teams may not stay overnight on Speedway grounds under any circumstances.

Teams may hang team banners, but drilling or screwing into the garage walls is not allowed. Tape on the painted surfaces is not allowed, nor is attachment to the lights or sprinkler system.

Garages are not air conditioned; teams may wish to bring fans.

The Speedway area can be extremely windy in September and October; teams should plan accordingly. Free-standing tents or canopies may not be erected in the garage area.

Teams should bring chairs for use in the garages.

Additional Vehicles Each team leader will receive vehicle passes to allow two vehicles, in addition to the autonomous vehicle, to be parked in outside spaces near the garage area. If the team plans to park an oversized vehicle (tractor trailer or a vehicle-trailer combination), the second vehicle may not be oversized.

Additional overnight parking is available outside the garage area at the Speedway.

Inspection All autonomous vehicles will be inspected for rules compliance and safe autonomous operations prior to the first run on the NQE course. DARPA will conduct the inspections directly after the opening ceremony.

The inspection will consist of two parts, a static inspection followed by a dynamic inspection.

The static inspection will verify compliance with the Grand Challenge rules. A checklist will be published in advance detailing the items that will be verified during the inspection process.

The dynamic inspection may take place at any one of three practice areas. Teams must be able to select and load an RDDF for operation in less than 5 minutes.

The dynamic inspection will verify the proper operation of the PAUSE and DISABLE modes of the E-stop. An RDDF will be provided that brings the vehicle up to a speed of 10 mph, and DARPA will issue an E-stop PAUSE command to verify the vehicle comes to a complete stop within 100 feet. Once stopped, DARPA will issue an E-stop DISABLE command to verify the engine stops.

Once a vehicle has been inspected at NQE, this same vehicle is the only one allowed for the Grand Challenge (no substitutes).

If a team receives permission from DARPA to remove its inspected vehicle from the Speedway, the vehicle will be re-inspected before it can participate in track operations.

Practice Areas Three practice areas will be available. Multiple routes will be defined within each practice area with different RDDFs provided. Teams may not customize the RDDF for use in these areas. Obstacles that are similar to those on the NQE course will be available.

Practice area slots will be allocated to teams according to a practice area lineup. Teams must be ready to enter the practice area at the allotted time or forfeit their practice slot. In cases where practice area times and test course times conflict, teams will lose the practice area slot without compensation. Teams are allowed to swap practice slots with other teams provided the NQE staff is notified in advance.

All team members are welcome to observe the practice runs, but only 10 team members are allowed at the practice area chutes to work on the vehicle during the practice session. No team members are allowed in the practice area while the vehicle is operating autonomously.

Vehicle Movement Autonomous vehicle operations are allowed only in the practice areas and on the test course. Transit of the vehicle between these locations and the garage will be under manual control and direct escort by DARPA staff.

Teams planning to use a wireless controller should notify DARPA (grandchallenge@darpa.mil) before September 1 with information regarding the type of controller and frequency band for coordination purposes. At NQE, these teams should identify the receiver and antenna to officials during the static inspection.

Teams must use the DARPA-provided E-stop system and may not bring E-stop transmitters to the NQE.

Wireless devices, remote control devices, and laptops are not allowed alongside the course in view of the test route during track operations.

Course Schedule DARPA will direct teams to enter the NQE course queue based on their position in a published start-order lineup. DARPA will keep the start-order line up updated so teams can monitor course status and be ready to enter the queue when directed. Teams that are not ready to enter the queue when their turn arrives will lose their run, and their overall performance rating will be affected.

Teams should ensure at least one team member monitors the status of the start-order lineup during track operations.

Course Runs Teams will assign a launch team of no more than three team members to bring the vehicle to the start area and prepare the vehicle for autonomous operations in the start chute. These team members will remain at a marshalling point near the start area while their vehicle is on the NQE course.

Once the vehicle is positioned in the chute and the E-stop is placed in PAUSE mode, DARPA will direct the team members to place the vehicle in autonomous mode. This operation must be completed and the vehicle ready to run in 5 minutes or less. Team members must depart the course area and proceed to the

marshalling point near the entry gate, as directed by NQE staff. Team members are not allowed on the test course while the vehicle is in autonomous mode unless so directed by DARPA.

DARPA will launch the vehicle by issuing an E-stop RUN command.

The launch team will remain at the marshalling point until directed by DARPA to proceed to the finish area or otherwise assist in vehicle recovery.

At the finish area, the team will place its vehicle in manual mode when directed by DARPA and await a DARPA escort for return to the garage area. Should the vehicle fail to complete the course, DARPA will coordinate recovery with team members.

As access to the E-stop on the vehicle before and after every run is essential to smooth operation at NQE, teams must ensure the E-stop is installed in a way that affords immediate access by DARPA staff.

Scoring Grand Challenge vehicles are expected to complete the NQE course in a quick, but safe, speed while avoiding obstacles, overcoming challenges, and staying within the course boundaries. Course speeds will be listed in the RDDF. Vehicle runs will be timed.

DARPA will evaluate each vehicle's ability, at a minimum, to:

- Navigate and complete a specified course.
- Remain within course boundaries.
- Avoid obstacles while remaining within boundaries.
- Complete the course expeditiously and remain in compliance with course speeds listed in the RDDF.
- Respond to E-Stop commands effectively and appropriately.

Sample challenges on the NQE test course and the expected vehicle behavior are:

- Cattle guard – navigation through narrow gates
- Hill – positive movement up and controlled movement down a steep hill
- Narrow path – positive movement along narrow roads that are marked by on the sides by berms and/or foliage
- Multiple obstacles in the immediate area – determine the best path using sensors (in lieu of GPS path following) when multiple obstacles are present
- Tunnel – navigation and positive movement in areas with no GPS signal and low light conditions
- Passing – navigation and positive movement around one or more stopped vehicles
- Sharp turns –management of acute turns and operation solely within the course boundaries

- Switchbacks –navigation of roads where there is a steep vertical wall on one side of the road and a steep vertical drop on the other
- Foliage –navigation of route areas with occluding foliage
- Water –operation in wet conditions, including rain and puddles

Other Considerations

Internet Limited wired internet access will be available in the Team Internet Center, which is walking distance from the garages. Teams will need to bring laptops and Ethernet cables.

Fuel The fuel pumps at the Speedway will be open during the event on a schedule to be determined.

Media Accredited media will be issued credentials through a separate registration process. Details will be posted at www.darpa.mil/grandchallenge. If a team will be covered by a documentary film crew at NQE, send a brief description of the project, expected size of the crew, contact information, and special requests to grandchallenge@darpa.mil by September 1 for consideration.

Hospitality Tents A limited number of spaces are available for teams or their sponsors to operate hospitality tents. Tent leasing and construction is coordinated through the registration website. Teams or sponsors intending to sell merchandise must contact DARPA (grandchallenge@darpa.mil) before September 1. Teams may not sell food and drink on the Speedway premises and may not operate grills anywhere on the grounds.

Shipping The shipping address at the Speedway for deliveries is:

Attn: <Team Name> DARPA Grand Challenge
Maintenance Building
California Speedway
9300 Cherry Ave.
Fontana, CA 92335

Vehicles may be shipped directly to the Speedway to arrive after September 20. The vehicle transport agent should report to the main gate, inform the security staff a vehicle is being delivered for the DARPA Grand Challenge, and leave the vehicle in Lot 7. The vehicle will be stored in a secure, outdoor lot on Speedway grounds. Vehicles or deliveries that arrive before this date will not be accepted.

Please direct questions or comments to grandchallenge@darpa.mil.