



DRC Finals Operations Book

April 30, 2015. DISTAR Case 24508

Part 1. DRC Finals Safety

Part 2. DRC Finals Operations Guide

Part 3. Procedures for Conducting Runs at the DRC Finals



DRC Finals Safety

April 30, 2015

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Revision History

This section captures major changes to this document.

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Introduction

This document describes DARPA's approach to verifying the safe operation of team robots at the DRC Finals.

The operation, handling, and movement of a team's robot at the Finals will be done by team members, and not by the DARPA DRC staff.

Related Documents

- DRC Finals Scoring Guide. This document describes the approach to scoring the tasks performed at the DRC Finals.

Safety

Safety is the highest priority concern for the DRC Finals.

The DRC Finals robots pose a risk to human safety and the integrity of their physical surroundings. DRC robots are in the prototype stage and have not been certified in accordance with any safety standards.

DARPA has established safety procedures to be followed by teams to reduce the probability that a person will be accidentally harmed by contact with or physical proximity to a robot. The establishment of these safety procedures does not relieve the teams of their responsibility to ensure safe operation of their robots at all times.

- Teams are responsible for ascertaining the adequacy of DARPA's safety procedures.
- While DARPA has mandated and required a demonstration of an Emergency Stop (E-Stop) for the robots to qualify for participation, it is each team's responsibility to ensure that their robot's Emergency Stop works reliably.
- Teams are responsible for ascertaining all risks associated with their robot.
- Teams are responsible for implementing safety procedures and precautions they deem appropriate (which may go beyond DARPA's safety procedures) to protect against human injury and property damage.
- Teams assume full liability for any personal injury or property damage caused by their robot or by procedures implemented by the team.

DARPA understands that robot operation involves a variety of possible safety hazards:

- Electrical Hazards: A robot may electrocute a person.
 - According to international standards, voltages below 50V generally do not pose a serious hazard in dry conditions with small area contact, so robots may leave internal and tether circuits energized at less than 50V and not pose an electrical hazard as long as conditions are dry and contact with people is minimal.
 - It is the responsibility of teams who wish to leave voltages greater than 50V energized inside their robot while humans are in potential contact to ascertain for themselves, and if true assert to DARPA, that insulation is sufficient for this voltage to not pose an electrical hazard.
 - It is the responsibility of the team to de-energize robots in wet conditions or when contact with people is anything other than minimal.
- Thermal Hazards: A robot may burn a person. It is the responsibility of teams to ensure adequate thermal insulation or mechanical guarding to mitigate the risk of burns.
- Pressure Hazards: A robot may leak a jet of high-pressure fluid and blind or otherwise harm a person. While DARPA may also require such, teams are ultimately responsible for ensuring that their robot is pressurized only when nearby personnel are wearing safety glasses.
- Motion Hazards: A robot may cause harm by moving to contact or strike or pinch a person, or throw an object that strikes a person. A robot with motion disabled by a fail-safe circuit is assumed to not pose a motion hazard even if motor amplifier bus voltage

is present. Teams must ensure that people are not close enough to a robot to be harmed before enabling the robot. Teams must ensure that motion disabling circuits are fail-safe regardless of incorrect operation of software (e.g., by utilizing keep-alive heartbeats, etc.).

- **Eye Safety Hazards:** A robot may cause harm by shining high-power laser light into a person's eye(s). If any team is using a laser that is or might be an eye safety hazard, they must notify DARPA. A robot with lasers disabled does not pose an eye safety hazard. Teams are responsible for ensuring that such disabling will be reliable regardless of incorrect operation of software.
- **Gravity Hazards:** A robot may cause harm by falling on a person. Teams must ensure that people are not in a location where a robot may fall on them. It is the team's responsibility when working near a robot, whether they use DARPA equipment or their own, to ascertain the adequacy of mechanical support.
- **Other Hazards:** The above points may not be a comprehensive listing of all possible safety hazards. Teams are ultimately responsible for ascertaining and mitigating all hazards pertaining to their robots.

For the purposes of runs at the DRC Finals, a robot will be considered "SAFE" if it poses no hazards.

DARPA recognizes that teams use different terminology such as "e-stop," "m-stop," "disable," "pause," "kill," and other words to describe various level of robot shutdown and safety. Teams also use different indicator lights on the robot to show the robot's state.

To mitigate confusion, safety status will be communicated between DARPA and each team using only ONE word: "SAFE", defined as above. If a DARPA task official asks the Team Field Lead, "Is the robot SAFE?" the only acceptable answers are, "Yes, the Robot is SAFE" or "No, the Robot is NOT SAFE." Replies with other terms like, "The robot is e-stopped" or "The robot is disabled" should not be used as these can cause confusion and potentially lead to unsafe operation. Teams should avoid using the word "SAFE" when communicating with DARPA except as it is defined above.

STOP

A STOP will be triggered if:

1. Any member of the DRC staff observes a condition jeopardizing safety of people or property (for example, if the robot leaves a task area) and shouts the word "STOP" in any context, including, but not limited to, "STOP the robot!", "E-STOP the robot!" and "STOP!" DRC staff will NOT call for a STOP for other reasons (e.g., if a robot has fallen or is not making progress).

2. The Team Field Lead (possibly on advice from other members of his team) shouts the word “STOP” in any context for any reason, possibly including a robot falling or not making progress.

After hearing or shouting “STOP,” the Safety Official will disable the robot, first by using a method specified during task setup by the Team Field Lead, and if such is absent or not working, by activating the E-Stop. If for some reason the Safety Official cannot do his/her job and a safety issue exists, the nearest person should attempt to stop the robot. If the E-Stop is non-functional and the robot is externally powered, the power cable may be disconnected as a last resort. No one may approach an unsafe robot without explicit direction from the Safety Official or emergency personnel.

Run Termination Due to Unsafe Operation

Whether or not STOPS are triggered, the Safety Official may terminate a team’s run at any time if he/she believes a robot is unsafe to people or property. The Safety Official’s decision to terminate a run for this reason will not be up for debate. Rather, it will automatically trigger a mandatory review with the Chief Official before further robot operation may continue on any task. The robot may not continue at the Finals after such termination without permission from the Chief Official.

Safety Officer

Each team must have a Safety Officer.

Safety Brief

The Team Safety Officer must provide a verbal presentation to the Government liaison prior to conducting operations on Finals Courses. Topics for the Safety Brief will include the following:

1. Recovery from fall - If the robot falls, how will the team manage the robot? What are the safety risks and how are they mitigated?
2. Operations Lead - Who is the designated Operations Lead when conducting operations on Finals courses?
3. E-Stop Operator - Who is the designated E-Stop Operator? Under what conditions will they activate the E-Stop?
4. Robot Operator - Who is the designated Robot Operator? How do they communicate with the Operations Lead?
5. Personnel positioning - Where will personnel stand during operations on Finals courses?
6. Eye safety - What equipment poses safety risks to the eye? What lasers are used, and are they classified as eye-safe?
7. Hazardous materials - Identify all materials that pose hazards (see Operational Procedures document for descriptions of hazards), including batteries, fluids, and others.
8. Fire safety - Identify and describe all fire response equipment, including extinguishers.

9. Spill kits - Identify and describe all spill response materials and equipment.
10. Walkthrough - Step by step, explain the procedures to respond to a major event on the robot.
11. Hard points – Where are the hard points on the robot for lifting and transportation?

DARPA reserves the right to prohibit teams from running robots or operating equipment until approved by DARPA.

E-Stop

Team must demonstrate functionality of the E-Stop before conducting operations on Finals courses.

Protective Equipment for Personnel

All personnel must wear closed-toe footwear (ideally, but not necessarily, boots).

All personnel should eliminate possible entanglement hazards by removing all loose or dangling items such as scarves, jewelry, and similar accessories.

All personnel must wear safety glasses when working near a robot, within a task area, or performing any team or Finals activity of a maintenance or operations nature. General and logical safe shop rules apply, and individuals and teams should default to being more conservative and on the safer side than at one's home shop location for similar work.

All personnel should utilize safety equipment (hearing protection, gloves, helmets, others) as appropriate to their robot.



DRC Finals Operations Guide

April 30, 2015

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Overview

The purpose of this document is to provide teams participating in the DRC Finals with the details required to plan and prepare for the Finals and ensure a safe and successful event. More details will be provided to the Teams at on-site registration and during the welcome meeting. Please also read the DRC Finals Rules Book, as well as the *DRC Finals Procedures* and *DRC Finals Safety* documents that are included as attachments to get a complete understanding of the Finals. Questions about information provided in these documents should be sent to TheRoboticsChallenge@darpa.mil.

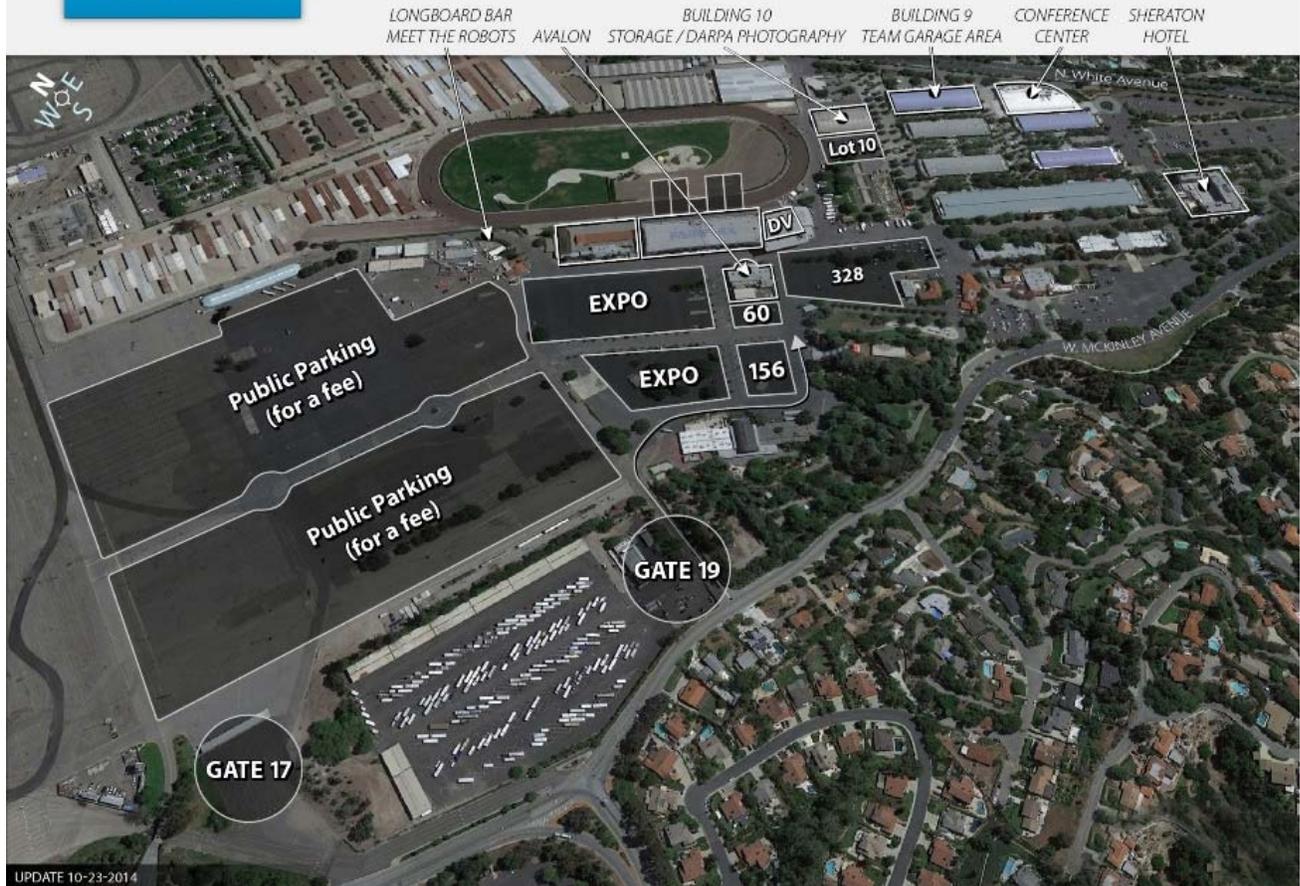
Fairplex

The DRC Finals will be conducted at Fairplex, in Pomona, Calif. Fairplex is home to the L.A. County Fair, the largest county fair in the world. Fairplex also operates a diverse hospitality business with McKinley's Grille, KOA RV Park, Finish Line Sports Grill, and the Sheraton Fairplex Hotel and Conference Center. The campus is also home to the NHRA Motorsports Museum and Auto Club Raceway at Pomona.

The Fairplex campus contains several facilities that will be part of the DRC Finals. Teams will be given an overview of the campus during the welcome meeting and do not need to familiarize themselves with the Fairplex before May 31st. The Fairplex is a public venue, however visiting prior to May 24th is discouraged, and only DRC Staff will be allowed access from May 25th through May 31st, with the exception of the Sheraton Conference Center on the afternoon of May 31st.



DARPA ROBOTICS CHALLENGE FINALS 2015



DRC Finals at Fairplex Overview

Hotels

The DRC Finals does not have a hotel room block for teams. Attendees are responsible for making their own hotel reservations. If you are interested in securing a room block for your group, please contact Mr. Fred Kokash:

Point of Contact: Fred Kokash
Phone Number: 909-868-5954
Email: fred.kokash@sheraton.com

On-Site Schedule

| Sunday, May 31, 2015 | |
|-----------------------------|--|
| Travel Day | |
| 3 PM to 7 PM | Team Registration at Sheraton Conference Center |
| 7 PM to 9 PM | Team Welcome Meeting at Sheraton Conference Center |

| Monday, June 1, 2015 | |
|-----------------------------|--|
| 7 AM to 5 PM | Registration for Teams at Sheraton Conference Center |
| 8 AM to 5 PM | Team Move-in and Set-up in Building 9 |
| 5 PM to 12 AM | Overnight access for teams |

| Tuesday, June 2, 2015 | |
|------------------------------|--|
| 12 AM to 7 AM | Overnight access for teams |
| 8 AM to 5 PM | Registration for Teams at Sheraton Conference Center |
| 7 AM to 5 PM | Team Vehicle Shakeout in Building 10 |
| 8 AM to 6 PM | Team Photos in Building 10 |
| 5 PM to 12 AM | Overnight access for teams |

| Wednesday, June 3, 2015 | |
|--------------------------------|--|
| 12 AM to 7 AM | Overnight access for teams |
| 8 AM to 5 PM | Registration for Teams at Sheraton Conference Center |
| 7 AM to 5 PM | Team Comms check (in Building 9 Garage) |
| 5 PM to 12 AM | Overnight access for teams |

| Thursday, June 4, 2015 | |
|-------------------------------|--|
| 12 AM to 7 AM | Overnight access for teams |
| 8 AM to 5 PM | Registration for Teams at Fairplex, Club One, behind the Grandstands |

| | |
|---------------|----------------------------------|
| 7 AM to 6 PM | Full Dress Rehearsal (on Course) |
| 5 PM to 12 AM | Overnight access for teams |

Friday, June 5, 2015

| | |
|---------------------|--|
| 12 AM to 7 AM | Overnight access for teams |
| 6 AM to 5 PM | Registration for Teams at Fairplex, Club One, behind the Grandstands |
| 7 AM to 6 PM | DRC Finals Event |
| 5 PM to 12 AM | Overnight access for teams |

Saturday, June 6, 2015

| | |
|---------------------|--|
| 12 AM to 7 AM | Overnight access for teams |
| 6 AM to 5 PM | Registration for Teams at Fairplex, Club One, behind the Grandstands |
| 7 AM to 6 PM | DRC Finals Event |
| Approx. 7 PM | Finals Announcement Ceremony |
| 10 PM | Team Garage access closes for night (reopens 7 AM Sunday, Jun 7) |

Sunday, June 7, 2015

| | |
|--------------|---|
| 7 AM to 6 PM | Team Move Out; all team personnel out of Building 9 by 6:00 PM. |
| 9 AM to 3 PM | DRC Workshop *Additional registration is required to attend this event. All registered team members will receive the DRC Workshop registration link via email when registration opens. |

Monday, June 8, 2015

| | |
|--------------|---|
| 7 AM to 5 PM | TotalExpo picks up team packages for shipping |
|--------------|---|

Online Registration

All Team members and Team Robot should have registered by April 15th via the following link:

Team Member Registration: www.sa-meetings.com/DRCFinalsTeamRegistration

Username: DRCteams

Password: fairplex

Robot Registration: www.sa-meetings.com/DRCFinalsRobotRegistration

Username: DRCrobots

Password: California

If you missed this deadline, you must contact drcreg@sainc.com for access.

Onsite Team Registration

Team registration will open on Sunday, May 31st, at 3:00 PM. Onsite registration will be conducted at the Sheraton Fairplex Conference Center, located at 601 West McKinley Avenue, Pomona, California 91768. For team registration and the Team Welcome Meeting, teams should park in Red Lot, which can be accessed at Gate 3 on West McKinley Avenue; follow the signs to the Sheraton Conference Center.

Registered team members will receive photo badges. The primary Team Leader will receive a team packet including vehicle passes, safety vests and the schedule of events. The entire team does not need to register together.

The team leader will need to confirm his/her mobile phone number and email address as most updates during the week will be communicated electronically.

Registration will close at 7:00 PM on Sunday, May 31st, and will reopen at 7:00 AM on Monday, June 1st.

Team Welcome Meeting

All registered team members are invited to attend the Team Welcome Meeting on Sunday, May 31st, 7:00 PM in the California Ballroom at the Sheraton Fairplex Conference Center. DARPA staff will provide an overview of the load-in procedures and details about the week's operations leading up to the DRC Finals.

Access to the Fairplex

Teams will be operating in Building 9 at the Fairplex. Team badges will be required to enter the Fairplex at Pepper St. Gate, which is adjacent to the Red Lot at Gate 3. Pedestrian access only will be permitted thru the Pepper St. Gate. The Pepper St. Gate will be open to registered team members from 8:00 AM on Monday, June 1st, on a 24-hour basis until 10:00 PM on Saturday, June 6th.

Move-in

On Monday, June 1st, at 8:00 AM, teams may begin moving into their assigned team areas in Building 9 at the Fairplex. Teams that have shipped their robots and equipment thru TotalExpo may enter Building 9 at 8:00 AM to begin unpacking.

Teams that choose to drive in their own equipment will be assigned 30 minute arrival windows between 8:00 AM and 12:00 PM on Monday, June 1st, in order to stagger the arrival of trucks at Fairplex Gate 12. You must notify DARPA via email at DRCReg@sainc.com by Friday, May 1st, if you will be driving in your own trucks so you can be assigned a delivery window. For move-in day ONLY, trucks will enter at Gate 12 off N. White Avenue; unload in Lot 10 (located adjacent to Building 10) if too large, or in Building 9 itself, and exit at Gate 6. Note that there is no loading dock in Building 9. Teams that are moving in themselves are encouraged to not use Vehicles larger than 26' Box Trucks and should have powered lift gates. Larger trailers will have to be offloaded in Lot 10 and equipment hand carried in or teams may bring pallet jacks.

Regardless of delivery method, all equipment and support vehicles will be moved in between 8:00 AM and 5:00 PM on Monday, June 1st. All equipment is expected to remain in place in Building 9 until 6:00 PM on Saturday, June 6th. Delivery equipment larger than the allocated space will have to be moved to a separate parking area by 5:00 PM on June 1st. If a team has one truck that is desired to remain close, it will be parked in Lot 10.

Team Parking and Vehicles

Each team leader will receive ten (10) vehicle passes for daily parking in Red Lot.

The lot is approximately 1,000 feet from Building 9, so teams should plan usage and storage in their garage accordingly. Other than June 1st Move-in and June 7th Move-out, teams will not be able to drive in or near Building 9.

Teams that require a support vehicle, trailer, bus or RV, will be allowed one 40' long parking spot in Lot 10, which is adjacent to Building 9. Teams requesting this need to send their details to drcreg@sainc.com if not stated in their Robot Registration.

Hours of Operation

Teams will have 24 hour access to their Garage (Building 9) beginning 8:00 AM June 1st and continuing through 10:00 PM June 6th. However, Teams are only allowed on the Courses or Staging areas during scheduled times on June 2nd, 4th, 5th and 6th.

Teams members found on Courses or other prohibited areas without prior approval risk immediate disqualification from the DRC Finals.

Team Garages

Each team participating in the Finals will be provided a set garage space in Building 9, a large exposition facility. Each garage will be approximately 40 feet long and 20 feet wide, with temporary walls that are 10 feet high. The building itself has 20-foot ceilings, so these garages will not have individual ceilings and can accommodate taller gantry systems and similar hardware. Garages will come empty except for DRC-provided network equipment. If teams would like to outfit their garages with tables, chairs, etc., they should refer to the TotalExpo Team Kit or bring their own equipment.

The garages will serve as the teams shake-out area, repair area, and location for their Operator Control Unit (OCU). Teams should plan the use for the space prior to arrival.

Each garage will be provided with three 20 Amp/110V Circuits to plug in all computers and robot charging equipment.

The garages will be staffed with 24-hour security, and all team members will need to be badged for access. Team guest badges will be accepted; no escort required. The garages will NOT be open to the public, and only open to limited, guided walkthroughs by media and distinguished visitors.

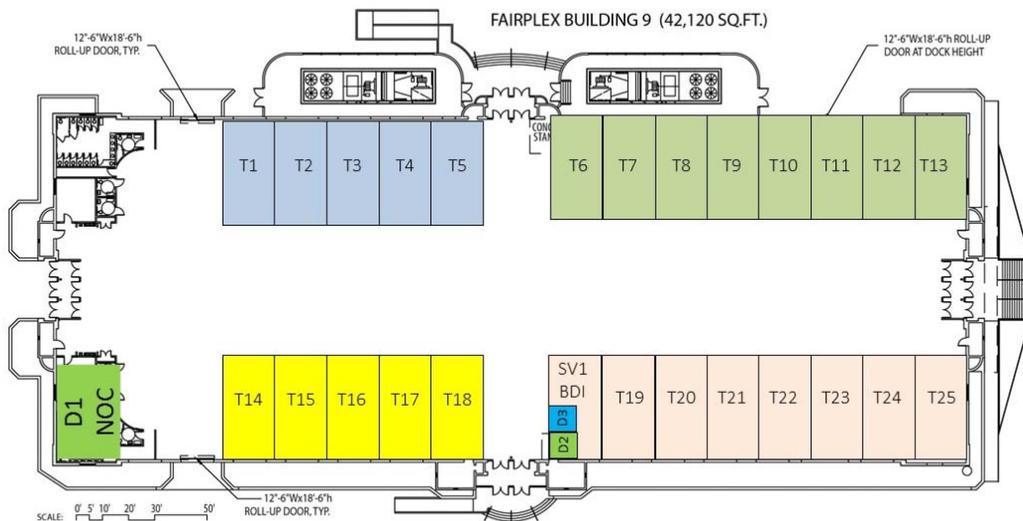
There will be 25 teams and a handful of support vendors all co-located in Building 9, so please be considerate of your fellow competitors with regards to noise and operation outside their areas.

The DRC will post a Garage Manager from 8:00 AM to 6:00 PM to assist teams with any issues, including contacting the DRC Staff and Network Team.

| | |
|-----------|-----------------------|
| Garage 1 | Team NEDO JSK |
| Garage 2 | Team HRP2 Tokyo |
| Garage 3 | Team NEDO-Hydra |
| Garage 4 | Team AIST-NEDO |
| Garage 5 | Team Aero |
| Garage 6 | Team Grit |
| Garage 7 | Team RomoSimian (JPL) |
| Garage 8 | NREC-Tartan Rescue |
| Garage 9 | Team Valor (VaTech) |
| Garage 10 | Team Walkman |
| Garage 11 | Team Hector |
| Garage 12 | Team NimbRo Rescue |
| Garage 13 | Intelligent Pioneer |
| Garage 14 | Team Robotis |
| Garage 15 | Team SNU |
| Garage 16 | Team THOR (UCLA) |
| Garage 17 | Team Kaist |
| Garage 18 | DRC-Hubo @ UNLV |
| Garage 19 | Team IHMC Robotics |
| Garage 20 | Team MIT |
| Garage 21 | Team TRAC Labs |
| Garage 22 | Team Trooper (LM) |
| Garage 23 | Team ViGIR (TORQ) |
| Garage 24 | Team WPI-CMU |
| Garage 25 | Team HKU |

Team Garage Assignments

LAYOUT C



Booth Size: 20 ft. x 40 ft.
 Total Booths/Team Garage: 25
 Cross aisle width: 50 ft.

Field computer office – 10 x 10 with door
SSC / NOC Access to Network Closet – 10 x 10 with door
Atlas = needs 480V drops in these garages

Building 9 – Team Garages

Power

DARPA will provide power to the teams in two locations: in the garages and near the start of the courses. In the garages there will be three 120V, single phase, 20A circuits, and on the course there will be a generator providing one 120V, single phase, 20A circuit. Both of these locations will have NEMA 5-20R T-slot receptacles. Teams should plan accordingly to have the correct adapters, chargers, and power strips to match their individual team needs. International Teams need to have appropriate converters. If teams have additional power needs, they need to be requested in their Robot Registration, but DARPA does not guarantee they will be accommodated.

For Teams with Atlas robots, there will be 480V 3-phase, 20A power in their garage to operate via the battery emulator within the garage. Boston Dynamics will handle all operations with regards to battery including charging and installation.

Inbound Shipping

TotalExpo, Inc. is the sole source for all DRC drayage (shipping) needs. Should you choose to ship your equipment instead of driving it into the Fairplex yourself, TotalExpo will assist with the transport and delivery of your packages. Please read your shipping options below, as well as the attached TotalExpo Team Kit for additional information and pricing.

(1) **Advanced Shipping to the TotalExpo Warehouse**

Teams may send advance shipments, arriving between April 30th and May 27th, to the TotalExpo warehouse using the “Advanced Warehouse Shipping Labels” provided in the Team Kit. Please include your assigned garage number on the shipping labels.

TotalExpo will move your shipments into your team garage area for you. You will have access to the equipment beginning at 8:00 AM on Monday, June 1st. Shipments and payment will be coordinated directly with TotalExpo using the form in the Team Kit.

(2) **Direct Shipping to TotalExpo at the Fairplex**

Teams may send direct shipments to the Fairplex for delivery on May 28th and 29th ONLY. These direct shipments should be sent to TotalExpo at the Fairplex using the “Direct to Show Site Shipping Labels” provided in the Team Kit. Please include your assigned garage number on the shipping labels. TotalExpo will move your shipments into your team garage area for you. You will have access to the equipment at 8:00 AM on Monday, June 1st. Shipments and payment will be coordinated directly with TotalExpo using the form in the Team Kit.

(3) **Drive your own truck/vehicle**

Teams are able to drive their own equipment into the Fairplex on Monday, June 1st. There is no loading dock in Building 9. You will be responsible for unloading and moving your own equipment. Teams will be assigned 30-minute arrival windows between 8:00 AM and 12:00 PM on Monday, June 1st, in order to stagger the arrival of trucks at Fairplex Gate 12. You must notify DARPA via email at DRCReg@sainc.com by Friday, May 1st, if you will be driving in your own trucks so you can be assigned a delivery window. Teams should plan to use vehicles with lift gates or ramps, since a forklift may be available, but not guaranteed to specific timing.

Outbound Shipping

(1) **Outbound Shipping on and after June 8th**

If your team chooses to use TotalExpo for inbound shipping (options 1 and 2 above), then outbound shipping labor fees for all June 8th pick-ups are included. Teams will be responsible for scheduling the pick-up with their freight carrier of choice and all freight carriers must check-in by 12:00pm on June 8th. If your freight carrier has not checked-in with TotalExpo by 12:00pm on June 8th, TotalExpo will bring the equipment back to their warehouse and ship from there. Teams are still responsible for scheduling the pick-up with their freight carrier of choice. Please note that this option will incur additional drayage costs. Teams do not have to wait with their equipment on June 8th if this option is selected.

(2) **Outbound Shipping on June 8th (Equipment driven in by team)**

If your team has chosen inbound shipping option 3 above but would like to do outbound shipping instead of driving the equipment out on its own, TotalExpo will charge for drayage and can provide a cost estimate amount on site. Teams do not have to wait with their equipment on June 8th if this option is selected.

(3) **Drive your own truck/vehicle on June 7th**

Teams that would like to drive their equipment out themselves must do so on **Sunday, June 7th ONLY!** You will be responsible for moving and loading your own equipment. Teams may not move out on their own on after 6:00pm, Sunday, June 7th.

Polaris Rangers at Finals

Teams are strongly discouraged from bringing their own Polaris Rangers driving vehicles unless pre-approved by the DRC Staff. There is no practice area for driving and any vehicles will need to stay in the Team's garage space with the engine off and unfueled. Driving of any Rangers or other utility vehicles on Fairplex property by any Teams or their Robot will not be allowed.

DARPA will provide the Polaris Rangers for the Driving Task of the Course. Teams will have an opportunity on Tuesday, June 2nd, to test fit their robots, clarify the procedure for their robot into the vehicle, as well as show the DRC staff any vehicle modifications with the Rangers. The Polaris Ranger will be powered off the entire time.

Movement of the robots to the courses will be done by DARPA-driven Polaris GEM eL XD Utility vehicles where the robots will be secured on the flatbed in a horizontal position and transported 400 meters to the starting area. If this approach isn't compatible with a Team's robot, plan to use your own non-motorized mobile gantry or lift. The Field Team will walk to the starting area with the robot. Certain low power components may be on during the load and transport, as long as the robot is SAFE as defined in the Safety section.

Teams are strongly encouraged to bring tools that may be needed for field repairs or field maintenance while away from the garage.

The DRC Finals Courses

There will be four courses at DRC Finals: Blue, Red, Green and Yellow. They may have some slight differences from each other within the margins of the building materials being used. They will not be made intentionally different.

The courses at DRC Finals will be not be available for practice. Teams will have two opportunities to access a course before their first run on Day 1, Friday, June 5th. Teams may not access the courses outside those scheduled times.

Tuesday, June 2nd – Team Leads and one other team member can participate in a walk-through of the courses led by the DRC Team to explain the layout and the rules. Photos and measurement are allowed.

Thursday, June 4th – Teams will have one rehearsal run on the course under real conditions. The results from the rehearsal will not count in the standings, but will determine starting order for Day 1. Teams must operate un-tethered and using the DRC wireless network.



Course Order at DRC Finals

The courses will be intentionally changed after rehearsal on Thursday June 4th, and after Day 1 of the competition on Friday June 5th. Approaches that rely on mapping the course and scripting behaviors are expected to perform poorly with the intentional changes.

Surprise Task

The DRC Finals will have a Surprise Manipulation task as part of the course. Examples of potential Surprise Tasks will be displayed to Teams on Monday, June 1st. Teams will be told by 7:00 PM the evenings before their runs which option will be used on the course the following day.

Run Operations

Refer to the DRC Finals Procedures for detailed instructions on Operations at Finals.

Field Team

Teams must provide a Field Team consisting of one to five personnel that will be responsible for setting up and recovering their robot during a run. Teams will be provided vests and helmets for up to five people. The Field Team Lead will be responsible for interacting with the Course Official during the execution of the run. In case of significant network issues, operations may switch from wireless to wired Ethernet. The Field Team will wrangle the wired Ethernet cable as the robot progresses through the Course. The Field Team will maintain a distance of at least 20 ft from the robot at all times while wrangling. Except for this possibility, the Field Team will not be within the course barriers while the robot is powered.

Departure

After completion of events on Saturday, June 6th, teams can move out of their garages on either Saturday night June 6th by 10:00pm or on Sunday, June 7th. All teams are required to be moved out by 6:00 PM on Sunday, June 7th. Each team will be required to return its garage to its original clean condition. Team Leaders will need to complete a check-out with DARPA Staff prior to departing the Fairplex facility.

Note that the Technical Workshop will take place on Sunday, ending at 3:00pm. Teams should consider how to organize their efforts to accommodate both workshop and move-out activities.

Security

DARPA will provide security for the DRC Finals. The primary goal of this is personnel security, with a secondary goal of infrastructure protection. Since all of the team areas are open spaces, teams should consider bringing a small locker or trailer to secure critical items.

DARPA is not responsible for any lost or stolen equipment. However, acts of theft or sabotage will not be tolerated and will result in immediate disqualification of the entire team responsible.

Safety

Please refer to *DRC Finals Safety* document for all safety guidelines for the Finals.

Screen Capture

In the 30 minutes leading up to a team's scheduled run slot, DRC staff will install a video camera on a tripod, along with a computer capture case. The team will need to provide DARPA a DVI output from their main OCS display connected to the capture case. The capture case

includes a DVI pass-through allowing the teams to connect their display and see the original signal from the computer.

The case will record both the video camera feed, along with the OCS display, and transmit both of those feeds to the command center and the production team to possibly be used as part of the live program being displayed at the track and on-line. If a team has multiple displays, it is recommended that they select the one that they want the public to see, with no propriety information or trade secrets being displayed.

Operator Control

Teams will set up their Operator Control Stations inside their garages and will not need to move them during the Finals. Teams are allowed to set up whatever hardware configuration they need to operate their robot, within the limitations of power.

Garage Observer

During a Team's Run, DARPA will provide an observer that will sit in the Team's garage to act as a secondary relay to the Course Official, as well as watch OCU operations to ensure fairness and gather insight on Human-Robot interaction strategies. The Observer will also assist to make sure the camera and screen capture devices are working and in optimal position.

Network Communications

All communication with the robots will be done through the DRC-provided VLAN and the wireless radio provided during runs. Teams will connect via a Ethernet or RF cable while in their garage area.

Teams will have two scheduled sessions to work with the Network Team. On Tuesday, June 2nd the goal is to identify and resolve any issues including confirming that the physical backup works. On Wednesday, June 3rd, teams will be able to connect to their robot in their garage through the DARPA network, including the DCE running as it would during a run. Times for these will be provided to Team Leaders during their check-in on May 31.

Network Checkout Procedures

1. Robot Client Radio will be flashed to new configuration.
2. Robot Client Radio will be attached to Cart AP via RF cables.
3. If the Robot is already powered, the Robot will be power-cycled. Otherwise, the Robot will be powered up for in-garage comms checkout.
4. Comms checkout will be completed to verify communications between Robot Radio and Cart. AP. Communications will also be verified from Cart AP to the Robot IP address(es).
5. Robot will be disconnected from Cart AP, powered off, and moved to course.
6. Robot will be powered up on course and comms checkout will be performed again, including both OCS to Robot and Robot to OCS, and Robot to Field Computer, if present.

E-Stops

All teams participating at the Finals must have integrated the HRI E-Stop that was provided to them in February 2015. Successful integration of the HRI is required for participation in the DRC Finals. These will be verified as part of the Vehicle Checkout on Tuesday, June 2nd.

Field Computers

Teams that plan to use the optional Field Computers at Finals should plan to operate them remotely with only limited access once they are setup. The DRC Finals Rule Book describes Field Computer location and access in Communications section 2.1.3 (page Comms-16).

Tethers/Belays

Tethers, belays or any type of fall prevention will not be allowed on the courses during active runs. DARPA will have a gantry at the starting area and near the stage to assist with robot setup and recovery after resets. Teams are welcome to bring and use their own recovery equipment to be used in their garage and on the course by their Field Team. The DARPA gantry and hoist will have a single attachment point and teams should plan connection points accordingly.

In the event of significant network issues with regards to wireless connection. DARPA will switch to a physical link with an Ethernet cable. Teams should be prepared to operate their robot in this mode. DARPA will provide the cables on the course and the Field Team will manage the cable for their robot.

Meet the Robots

Immediately following a run, each Teams' robot will be transferred to the "Meet the Robots" area for one hour. This will be chance for the public to get close to the robots for a photo opportunity. Teams are welcome to participate with friends and families. Robots will be held in position using a DARPA-provided hoist and be completely powered off. Robots will be returned to the garages after their hour.

Robot Personalization

Teams may brand (logos, colors, etc) their robot as they desire, but DARPA reserves the right to require changes for anything that it deems improper.

Team Photo

As part of the Robot-Vehicle Testfit sequence on Tuesday, June 2nd, the DRC will be scheduling team photos with their robots in front of specially designed backgrounds. These will be used as part of the Finals production and also be given to Teams for their own use. The schedule will be provided on May 31st to Team Leads.

Food

No meals will be provided to teams. Food vendors will be open during the DRC Finals for team members to purchase food. Sheraton Fairplex is the exclusive food and beverage provider for inside Building 9. Teams who wish to cater meals in their garage area may contact Amy McNeil at Amy.McNeill@sheraton.com for more information.

Weather

The weather in Pomona during early June is warm, with an average high of 84 degrees Fahrenheit and low of 58 degrees Fahrenheit. While much of the preparations for Finals will be conducted inside Team Garages, the runs themselves will take place outdoors in the sun. The Field Teams should plan accordingly, including sunscreen, water and appropriate clothing. The DRC Finals Operations team will monitor the weather. Although rain is extremely unlikely, there is the possibility of heavy winds.



Procedures for Conducting Runs at the DRC Finals

April 30, 2015

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Revision History

This section captures major changes to this document.

| Version | Date | Section | Description |
|---------|------|---------|-------------|
|---------|------|---------|-------------|

| | | | |
|-----------|-----------|----------|---------|
| Release 1 | 4/30/2015 | Document | Created |
|-----------|-----------|----------|---------|

1 Introduction

This document describes operating procedures for the DRC Finals in June, 2015.

Related documents include the following:

- *DRC Finals Rules* - Defines the official rules for the DRC Finals
- *DRC Finals Safety* - Defines terminology for common understanding of safety, and describes safety requirements and procedures for the DRC Finals

2 Procedure for Moving to the Start Area and Setting up a Run

The procedure for setting up a run and moving to the starting area will begin 90 minutes before a team's run:

Minute (T-90 – T-60) Teams will ensure their radios are flashed

Minute (T-60 – T-50) The DRC utility vehicle will arrive to pick up robot

Minute (T-50 – T-45) The robot will be driven to the starting area. Certain low power components may be on during the load and transport, as long as the robot is SAFE as defined in the Safety section above.

Minute (T-45 – T-20) Teams will move their robots into the Ranger XP (including making any modifications). If not driving, the robot may remain supported by a gantry or hoist

Minute (T-20 – T-5) Teams will power on their robots and conduct communications checks to the OCU over the wireless

Minute (T-5 – T-2) Teams will disconnect from 110V shore power (if needed) and prepare to begin run. The Polaris Ranger will be started and put into gear.

The Field Team is limited to five (5) people per team.

The Field Team is allowed to be in constant contact with the Team Operator during this period.

3 Procedure for Starting or Resuming a Run

The procedure for starting a run begins once the robot is behind the start line for the course.

The procedure for resuming a run after a Reset begins once the robot is in the appropriate Reset Area.

Minute T-5

- The Course Official confirms the start time with the Team Field Lead. The Team Field Lead in turn confirms the start time with the Team Operator.

Minute T-3

- Network communications mode switches from Setup (unlimited) to Run (limited)

Minute T-0

- The Team Operator uses a network-based clock to verify that the start time has arrived, and begins the Run.
- The Course Official uses a network-based clock to verify that the start time has arrived, and verbally announces to all personnel on the course that the Run has begun.
- The Scribe ensures that the Scoring App has recorded the start of the Run.

Minute T+1

- The Team Field Lead and the Team Operator discontinue verbal communications

A team that starts a Run before the designated start time is subject to a penalty to be determined by the Chief Official. If the penalty is to add time, the amount of the time penalty may exceed the amount by which the team started early.

If for any reason the network-based clock approach breaks down, the backup approach will use voice communications and/or an Observer at the Operator Control Station.

4 Procedure for Communications with Team Operator

DARPA will provide each team a pair of prepaid cellular phones for communications between the operator in the garage and the Team Field Lead in the field with the robot. The teams may use these, but may also use their own radios, phones, or other communication devices.

When not performing a run (for example, in transit, during setup for a run, or during a Reset while performing a Run) the Team Field Lead and the Team Operator may communicate freely.

During a Run, the Team Field Lead **may not** communicate information to the Team Operator. The sole exceptions to this rule are that the Team Field Lead may inform the Team Operator of the following:

- An E-Stop has been triggered
- A Reset has been requested
- The Run is complete

From the time that a Run has begun until the time that a Run has terminated, the Team Field Lead and anyone else with direct view of the run is **specifically prohibited** from giving advice to the Team Operator, and from communicating information to increase the Team Operator's situation awareness.

During a Run, the Team Operator may communicate with the Team Field Lead to request a STOP. The Team Field Lead must then relay such requests to the Course Official or the Safety Official.

5 Procedure for Stopping a Robot after a Run

Once the robot has achieved its last point, the Field Team or the Operator must place the robot in a safe position so it can be recovered. This must be in a safe state so the Field Team can approach to attach to the DARPA-provided hoist, if needed. Since each robot is different it is up to the Team to define the safe procedures for recovering their robot.

The Field Team may be in communications with the Operator during this time.

The Field Team Lead will inform the Course Official when it is safe to approach the robot (see *DRC Finals Safety* document).

6 Procedure for Resetting a Robot during a Run

If a robot is not deemed unsafe to continue by the Safety Official, and sufficient time remains in the Run (see below), a STOP triggers an opportunity for a Reset.

Resets (which are always preceded by STOPS) are carried out as follows:

- 1) The Team Field Lead will make the robot SAFE and inform the Safety Official when he/she believes the robot to be SAFE (see *DRC Finals Safety* document).
- 2) If the Safety Official believes the team's declaration is likely correct and no other circumstances (for example, operations nearby) are preventing it, the Safety Official will grant permission for the team to approach the robot. Notice that this does not relieve the team of its responsibility for ensuring the safe operation of the robot at all times. The opinion of the Safety Official never implies this responsibility has shifted away from the team.
- 3) Once the Safety Official allows the team to access the robot, the Scribe will note the beginning time of the Reset.
- 4) The team will then deploy up to five (5) personnel into the field to move the robot to the restart location and to ready the robot to continue the Run.
- 5) The Run may not resume until at least ten (10) minutes have elapsed from the start time noted by the Scribe in Step 3. The Scribe will inform the Course Official when this has occurred.
- 6) Once the robot has been reset, the Team Field Lead will inform the Course Official that the team is ready to continue the Run. Assuming the Course Scribe has already noted that 10 minutes have passed since Step 3, the Course Official will verbally announce the end of the Reset, and the run may resume. The Scribe will record the end of the Reset.

7 Procedure for Conducting a Run Review

7.1 Definition of a Run Review

A Run Review is a re-examination of a team's performance on a DRC Run by the Chief Official. A Review may result in the alteration of a team's score or permission to re-run a Run or sub-Run. A Review may be initiated by a team and may only pertain to that team's performance. A Review may also be initiated by the Course Official.

7.2 Requesting a Run Review

If a team believes that a Course Official made an erroneous ruling while the team was executing a run, or that a clerical error was made, that team may request a Review. The request for a Review must be made within two hours after the time allocated to the Run (including tear-down) has elapsed. This time is reduced to 1 hour on Day 2 after 1200.

Example: if the run was scheduled from 13:00 – 14:00 on Day 1, the deadline would be 16:00, two hours after the time allocated to the Run.

Example: if the run was scheduled from 13:00 – 14:00 on Day 2, the deadline would be 15:00, one hour after the time allocated to the Run.

The request may only be made by the designated Team Leader. The Team Leader shall submit a "Request for Review" form to the Chief Scorer. The form may be obtained at the Team Registration Desk and be returned to the same location. The form will require the Team Leader to state why the Run Review is requested and what further action is sought.

A Course Official may also request a Review. This request can be initiated by delivering a Review Request form to the Chief Scorer.

7.3 Granting a Run Review

The Chief Official, at his discretion, may choose to accept the request for a Review. The Chief Official may base his decision, in part, on consultation with the Course Official. The Chief Official may choose to review a video recording of the Run in question.

The Team Leader will be notified by a DRC Official whether or not the request for a Review has been granted. Usually this notification will take place within one hour after the submittal of the Request for Review form.

7.4 Performing a Run Review

If the Review is granted, the Team Leader may be asked to meet with the Chief Official at a designated time and place. Such a meeting notice will be sent by a DRC Official to the Team Leader and the Course Official. The meeting should last no longer than 15 minutes. The Chief Official may choose to consult with the Course Official. At his discretion, the Chief Official may choose to modify the score of the Run in question or propose a Re-Run (see form below).

The Chief Scorer shall document the resolution of all reviews (see form below).

All decisions of the Chief Official are final.

7.5 Re-Runs

Upon reviewing the Run in question, the Chief Official may propose that the Run be re-executed ("Re-Run") with the score from the Re-Run replacing the previous score. The Chief Official, or his designated agents, will assign a time and a location for the Re-Run.

This information will be entered on the Re-Run Acceptance Form, and delivered to the Team Leader. The Team Leader may accept or decline the offer of a re-run by completing the Re-Run Acceptance Form and delivering it to the Registration Desk. If the Team Leader declines, no other Re-Run will be offered, and the original score will stand. No further request for a Run Review for the Run in question will be granted.

Request for Run Review Form

Date: _____

Time: _____

Team Name: _____

Team Leader: _____

Team Leader Cell Phone Number: _____

Course Number (circle one): Blue Red Green Yellow

Reason:

Action Sought:

Re-Run Acceptance Form

This section to be completed only by the Scorer.

Date: _____

Time: _____

Original Course Number (circle one): Blue Red Green Yellow

Re-Run Date: _____

Re-Run Time: _____

Re-Run Location (circle one): Blue Red Green Yellow

This section to be completed only by Team Lead, and returned to the Registration Desk.

Date: _____

Time: _____

Team Name: _____

Team Leader: _____

Decision (circle one): Accept Decline

Resolution of Run Review Form

This form to be completed only by the Scorer.

Date: _____

Time: _____

Course Number (circle one): Blue Red Green Yellow

Team Name: _____

Team Leader: _____

Re-Run Done?: _____

Re-Run Date: _____

Re-Run Time: _____

Re-Run Location: _____

Re-Run Results: _____