



DRC Trials Task Description

Release 3 on October 18, 2013. DISTAR Case 21990

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Revision History

This section captures changes to this document.

Version	Date	Author	Section	Description
Release 3	10/18/2013	E.Krotkov, A. Jacoff	Introduction	Deleted references to first and second days
			Wall task	Revised task to “stay within the lines”
			Wall task	Updated description of drill and drill bit

Introduction

This document describes the tasks to be performed by the human-robot teams at the DRC Trials in December, 2013. This document differs from the previous document (*DRC Trials Initial Task Description*) by focusing on the competition tasks for December 2013, rather than focusing on the practice tasks leading up to the Trials.

The document describes the general outline of the tasks, and does not describe the exact parameters of the tasks. The rationale for this level of abstraction is to encourage and promote generality, and prevent solutions that “over-fit” the general problem of disaster response.

We encourage teams to provide feedback on the tasks described in this document, both through the DRC Forum, and at the DRC Trials Preview Meeting in Atlanta on October 18, 2013.

Note that the task numbering differs from the task numbering in the *DRC Trials Initial Task Description* document, which followed the numbering scheme in the BAA.

Note that many of the drawings in the *DRC Trials Initial Task Description* document show a floor. At the DRC Trials, the runs will take place on a flat level concrete surface, rather than on a floor surface.

Related documents include the following:

- *DRC Trials Initial Task Description* - Describes the practice tasks to be performed by the human/robot system in preparation for the DRC Trials
- *DRC Trials Rules* - Defines the official rules for the DRC Trials
- *DRC Trials Qualification* - Defines the qualification tasks that must be performed to qualify for participation in the DRC Trials
- *DRC Trials Documents Roadmap* - Lists the documents planned and their expected publication dates

Task 1 Vehicle

Figure 1 shows the planned course layout for the Vehicle task, which is unchanged from the *DRC Trials Initial Task Description* document. The start line is on the left of the diagram, and the finish line is on the right.

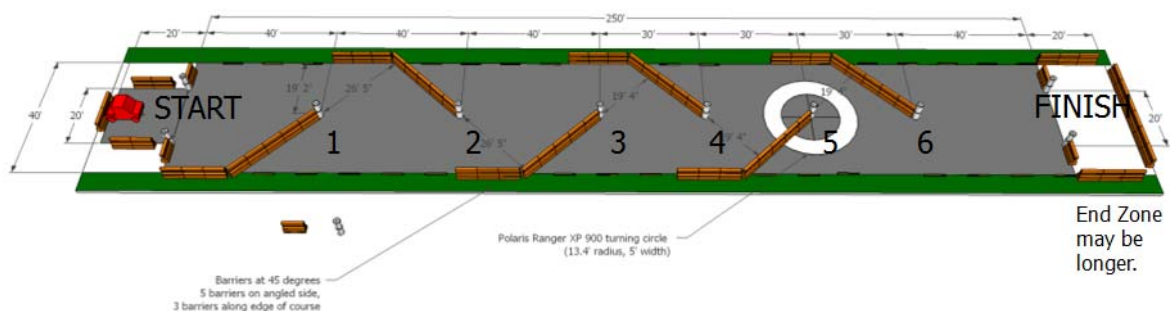


Figure 1. Course layout for Vehicle task (from DRC Trials Initial Task Description, p. 10)

The Vehicle task consists of two sub-tasks: (1) Robot drives the vehicle through the course (1 point), and (2) Robot gets out of the vehicle and travels dismounted out of the end zone (2 points).

For the first sub-task, the robot begins in the vehicle, drives through the course, and crosses the finish line. This sub-task shall be considered complete when both rear wheels of the vehicle have crossed the finish line. It does not suffice for these wheels to touch the finish line, they must completely cross the finish line.

For the second sub-task, the robot gets out of the vehicle, and travels dismounted out of the end zone. This sub-task shall be considered complete when all parts of the robot have departed from the end zone. In Figure 1, the exits from the end zone appear at the upper right corner and the lower right corner of the diagram, as gaps between the barriers that define the end zone. The robot may exit from either side of the end zone.

Task 2 Obstacles

Figure 2 shows the planned course layout for the Obstacles task, which is a shortened version of the course shown in the *DRC Trials Initial Task Description* document. The start line is on the right of the diagram, and the finish line is on the left.

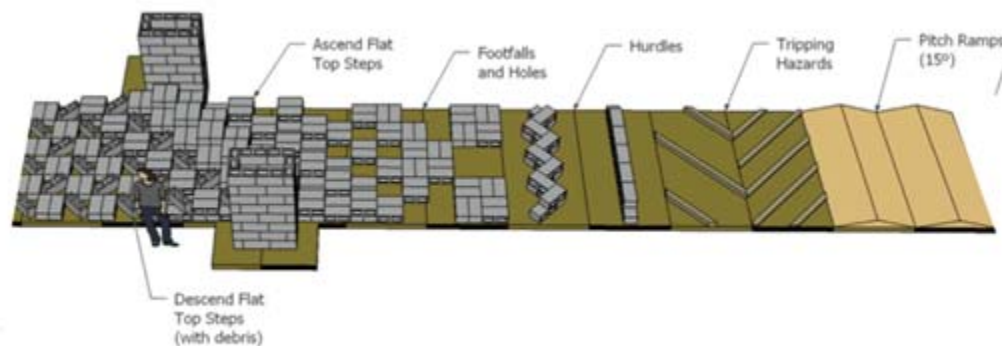


Figure 2. Course layout for Obstacles task (different from DRC Trials Initial Task Description)

The Obstacles task consists of three sub-tasks: (1) Traverse first segments (1 point), (2) Traverse next segments (1 point), and (3) Traverse final segments (1 point).

For the first subtask, the robot crosses the pitch ramps, the tripping hazards, and the straight hurdles. This sub-task shall be considered complete when all parts of the robot (excepting the

tether¹) have crossed a line marked after the straight hurdles. It does not suffice for part of the robot to cross the line; the entire robot must cross the line.

For the second sub-task, the robot crosses the zig-zag hurdles and footfalls with holes. This sub-task shall be considered complete when all parts of the robot (excepting the tether) have crossed a line marked after the footfalls with holes. It does not suffice for part of the robot to cross the line; the entire robot must cross the line.

For the third sub-task, the robot ascends and descends the flat top steps. This sub-task shall be considered complete when all parts of the robot (excepting the tether) have crossed a line marked after the step-over obstacles. It does not suffice for part of the robot to cross the line; the entire robot must cross the line.

DARPA reserves the right to shorten the course, or divide it into different segments, based on the progress teams demonstrate. Of the eight tasks, this is the one with the greatest uncertainty about system competence. So not only does DARPA reserve the right to alter the course, teams may anticipate a high likelihood of alteration.

Task 3 Ladder

Figure 3 shows the planned course layout for the Ladder task, which is unchanged from the *DRC Trials Initial Task Description* document. The robot begins to the left of the diagram.

¹ It is expected that there will be a physical tether for the E-Stop function, independent of power and comms.

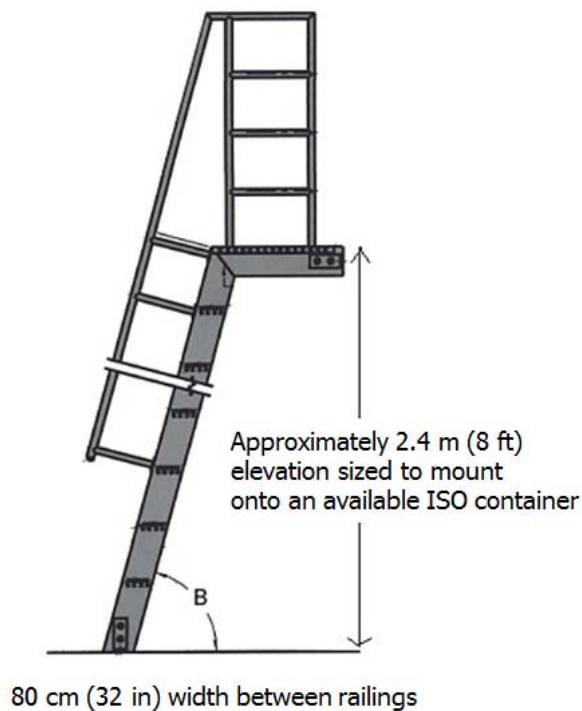


Figure 3. Course layout for Ladder task (from *DRC Trials Initial Task Description*, p. 39)

The Ladder task consists of three sub-tasks: (1) Two feet on or above the first step (1 point), (2) Two feet on or above the fourth step (1 point), and (3) Two feet on or above the landing (1 point).

No further explanation is needed for the sub-tasks.

Task 4 Debris

Figure 4 shows the planned course layout for the Debris task, which is unchanged from the *DRC Trials Initial Task Description* document. The robot begins a few meters to the left of the vantage point for the photograph in the figure, so that the debris lies directly between the start point and the doorway.



Figure 4. Course layout for Debris task (from DRC Trials Initial Task Description, p. 34)

The Debris task consists of three sub-tasks: (1) Remove five pieces of debris (1 point), (2) Remove an additional five pieces of debris (1 point), and (3) Travel through the open doorway (1 point).

For the first and second sub-tasks, the robot removes debris by moving it from its initial position to a position on the far side of either wall of cinder blocks, thus clearing a lane to the doorway. This sub-task shall be considered complete when the required number of debris pieces are at rest outside of the lane to the doorway. The debris may lean against the wall of cinder blocks. The debris may end up on both sides of the wall of cinder blocks, or may end up on only one side, or may end up behind the robot (away from the doorway).

For the third sub-task, the robot must travel through the open doorway. This sub-task shall be considered complete when all parts of the robot (excepting the tether) have crossed a line marked on the ground after the door threshold. It does not suffice for part of the robot to cross the line; the entire robot must cross the line.

Task 5 Door

Figure 5 shows the planned course layout for the Door task, which is unchanged from the *DRC Trials Initial Task Description* document. The robot begins to the right of the diagram and proceeds to the left.

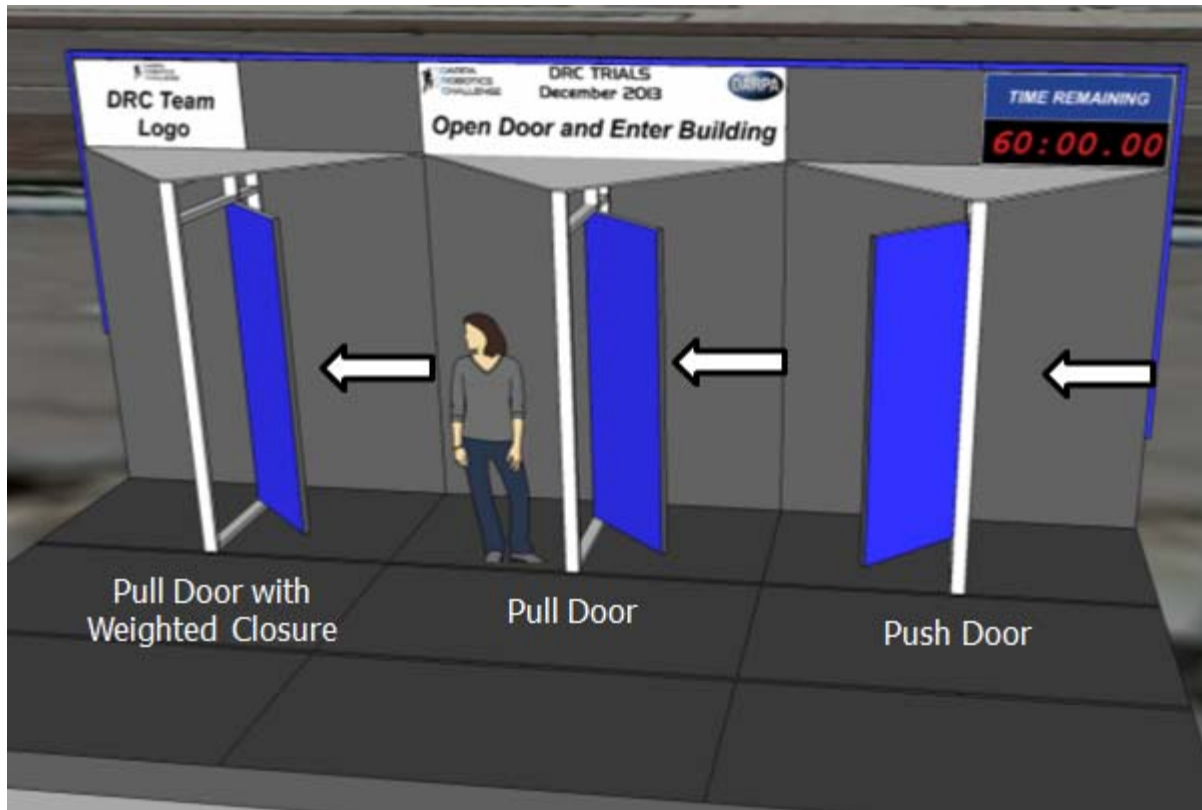


Figure 5. Course layout for Door task (from DRC Trials Initial Task Description, p. 37)

The Door task consists of three sub-tasks: (1) Enter push door (1 point), (2) Enter pull door (1 point), and (3) enter pull door with weighted closure (1 point).

For each of the three sub-tasks, completion requires the robot to first open the door and then travel through the open doorway and cross a line on the floor on the far edge of the door jamb. This sub-task shall be considered complete when all parts of the robot (excepting the tether) have crossed the line. It does not suffice for part of the robot to cross the line; the entire robot must cross the line.

The robot may complete the sub-tasks in any order. However, the shortest path will be to first go through the push door, next the pull door, and finally the pull door with weighted closure.

The DRC Trials will use a 36 inch doorway. Note that when a 36" door frame opens, the true width with jamb and the side of door is about 33.5 inches. (The DRC Trials Initial Task Description Bill of Materials specifies a 36 inch doorway. Note that the DRC Qualification document initially specified a 32 inch doorway, which was then relaxed to a 36 inch doorway.)

Task 6 Wall

Figure 6 shows the planned course layout for the Wall task, which differs from the layout shown in the *DRC Trials Initial Task Description* document.

The robot will use a cordless drill with an additional side handle and saw drill bit to cut through wall boards to remove a prescribed shape. The wall will be made of ½ inch thick Duroc cement board or similar material. There will be no obstruction or supports directly behind the cut pattern. The drill will be a cordless drill with ½ inch chuck and 3 speeds (model DCD980M2 or similar). Two fully-charged drills will be provided on a table in the workspace, both set to the highest speed. One drill will be configured for left-handed operation, the other for right-handed operation. If one of the tools does not function, the second tool may be used. Both drills will have 5/16 inch diameter saw drill bits pre-installed.

Two triangles will be drawn on the wall, one inside the other. The outer triangle will have vertices spaced roughly two (2) feet apart. The inner triangle will have vertices spaced roughly three (3) inches from the vertices of the outer triangle. The task is to completely remove the area of the inner triangle, while removing no material outside of the outer triangle.

There is no requirement regarding straightness of the cut lines. There is no requirement regarding the order or number of cuts. There is no requirement to remove the area between the two triangles.

The Wall task will be scored as follows: (1) Cut one edge (1 point), (2) Cut a second edge (1 point), and (3) Cut a third edge and remove triangular piece from wall (1 point).

The robot may need to move a short distance from the start point to reach the workspace.

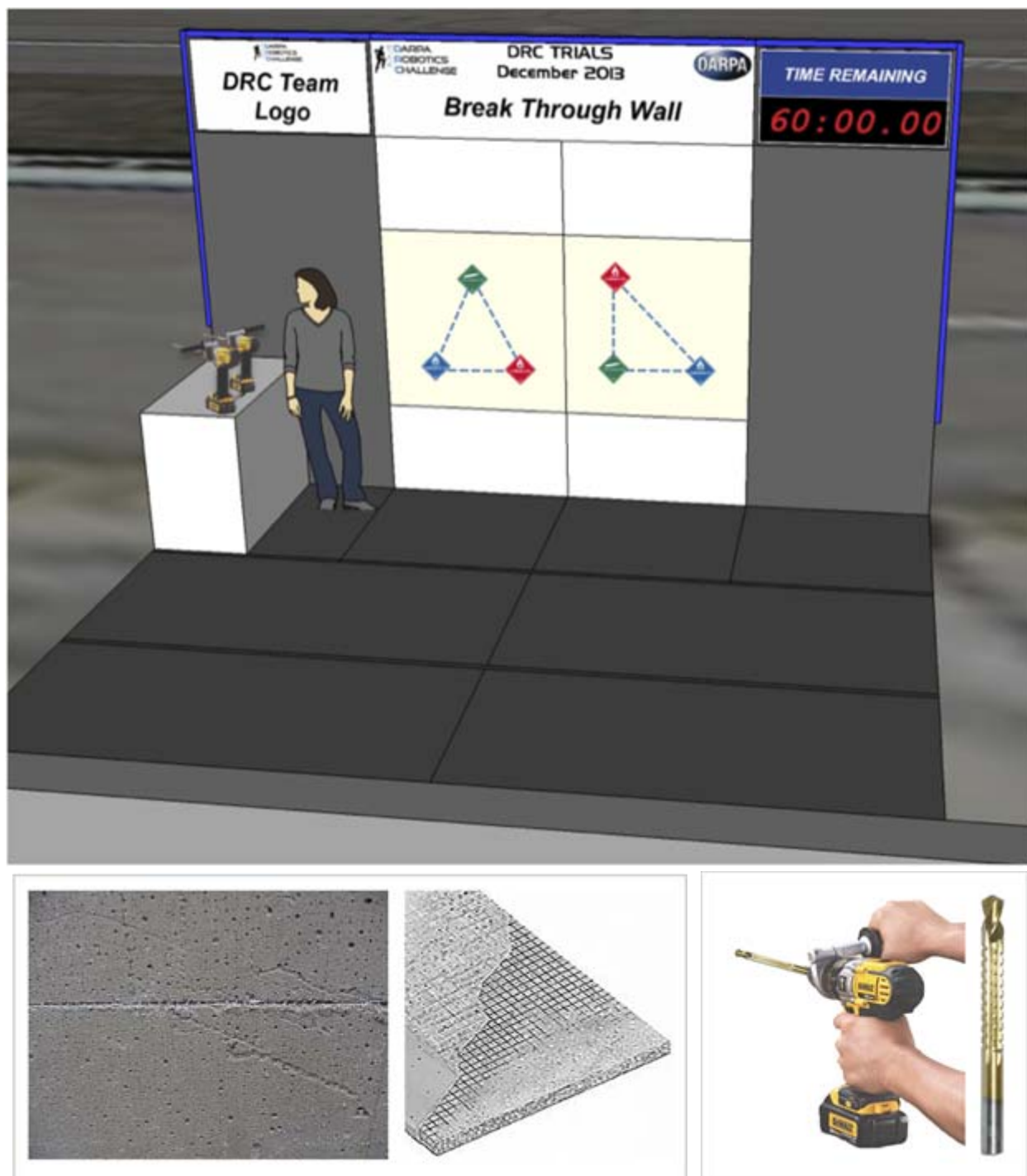


Figure 6. A) Course layout for Wall task (different from DRC Trials Initial Task Description, p. 37). B) Cement board for the cutting wall surface contains a fine interior mesh. C) The cordless, two handled drill and a 5/16 inch diameter saw bit, which allows plunging through the material as well as cutting to the sides.

Task 7 Valve

Figure 7 shows the planned course layout for the Valve task, which is a subset of the valve tasks in the *DRC Trials Initial Task Description* document.

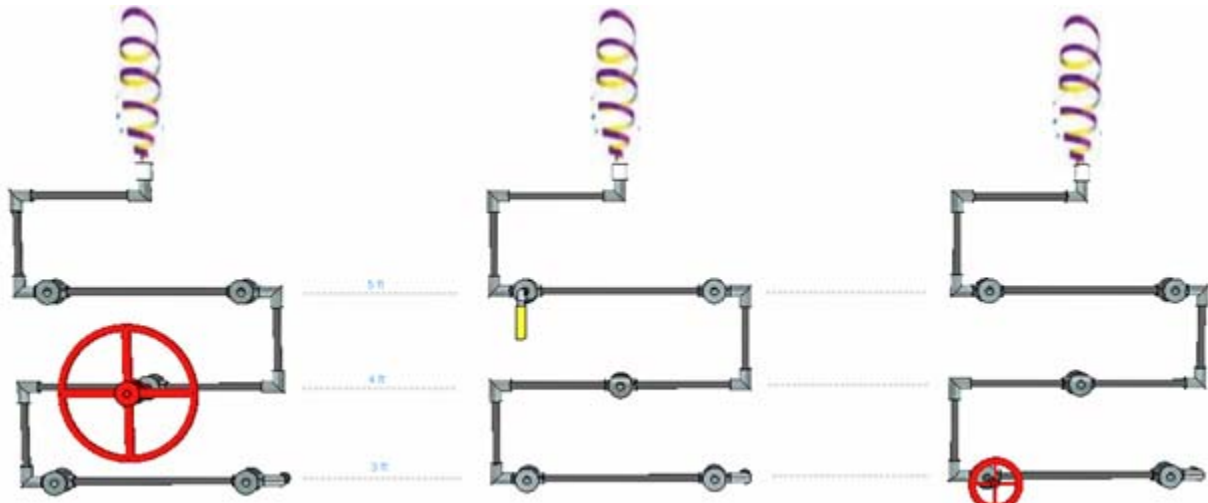


Figure 7. Course layout for Valve task (from *DRC Trials Initial Task Description*, p. 52)

The Valve task consists of three sub-tasks: (1) Close Valve 1 (1 point), (2) Close Valve 2 (1 point), and (3) Close Valve 3 (1 point).

Valve 1 will be a 90 degree shut-off valve that requires a rotation of 90 degrees to close. Valve 2 will be a mid-size rotary valve that requires five (5) complete clockwise rotations to close. Valve 3 will be a large rotary valve that requires five (5) complete clockwise rotations to close.

A visual indicator on the rotary handwheels will enable tracking of full rotations required for closure. The valves will also control air flow in pipes, with fixtures such as streamers to visually indicate the flow of air. For each of the three sub-tasks, completion requires turning the valve until the flow of air stops.

The center of the valves will lie between three (3) and five (5) feet above the ground surface.

As shown in the figure, the robot must travel a short distance from valve to valve.

Task 8 Hose

Figure 8 shows the planned course layout for the Hose task, which is a subset of the tasks described in the *DRC Trials Initial Task Description* document.



Figure 8. Course layout for Hose task (left, from DRC Trials Initial Task Description, p. 54, note that the tools shown are not needed to perform the task) and photograph of firehose connector (right)

The Hose task consists of three sub-tasks: (1) Hose end moves past start line (1 point), (2) Hose end moves into hydrant area (1 point), and (3) Hose end attaches to hydrant (1 point).

For the first sub-task, the robot approaches the hose, grasps the end of the hose, and begins to unreel the hose. This sub-task shall be considered complete when the end of the hose passes the start line marked on the ground. The robot will need to move a short distance from the start point to reach the workspace.

For the second sub-task, the robot continues to unreel the hose, moving the hose end to the hydrant. The distance between the start line and the hydrant will be approximately 10-20 feet. This sub-task shall be considered complete when the hose end makes physical contact with the hydrant.

For the third sub-task, the robot attaches the hose end to the hydrant. Typically, this would involve one hand holding the hose in place, and the other hand rotating the hose collar to mate with the hydrant. (If one rotates only the hose body, then the threads do not engage.) This sub-task shall be considered complete when the hose end remains in contact, unsupported by the robot, with the hydrant.