Robots for Urban Search and Rescue

Performance Metrics and Standards

ASTM
E54.08.01

June 27, 2007

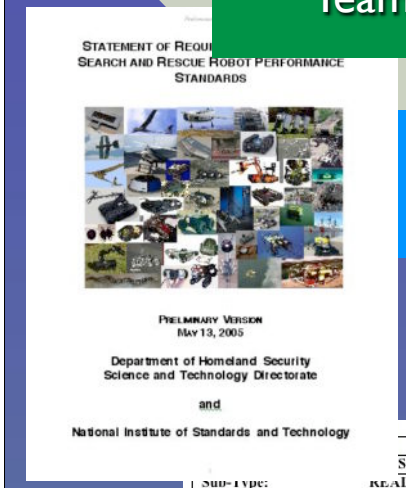
Scope Statement

- The scope of the task group is to specify a set of performance requirements, test methods, and associated standards for robot systems used in urban search and rescue applications. Emergency responders, pertinent technology developers, and interested government officials have defined these standards to provide an objective measure of robot performance for representative urban search and rescue applications. Results from such performance tests can be considered against specific purchaser/user performance objectives for envisioned applications.
  - These standards specify a variety of performance criteria and associated test methods for urban search and rescue robots. Several representative applications of robots used in urban search and rescue have been considered in defining these test methods. These representative applications, although comprehensive, are certainly not complete.
  - The standards developed by this task group will provide a means to ensure that a robot meets the performance requirements stated. Successful completion of the tests should not be construed as an ability to successfully operate in environments other than those specifically identified in the test methods.
  - These standards do not address special applications outside the stated requirements, such as certain extreme weather conditions for example. To ensure performance for such applications, additional requirements need to be established along with associated standards.

US&R Robot Standards: The Big Picture

Requirements from FEMA Teams → Standard Test Methods → "Consumer's Guide"

Responders Meet Robots Exercises

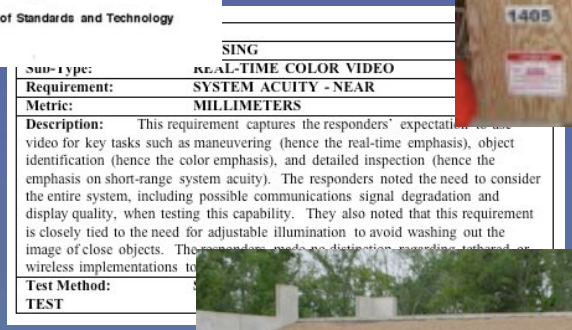

STATEMENT OF REQUI
SEARCH AND RESCUE ROBOT PERFORMANCE STANDARDS

PRELIMINARY VERSION
MAY 13, 2005

Department of Homeland Security
Science and Technology Directorate

and

National Institute of Standards and Technology


	SING
Sub-Type:	REAL-TIME COLOR VIDEO
Requirement:	SYSTEM ACUITY - NEAR
Metric:	MILLIMETERS
Description:	This requirement captures the responders' expectati… video for key tasks such as maneuvering (hence the real-time emphasis), object identification (hence the color emphasis), and detailed inspection (hence the emphasis on short-range system acuity). The responders noted the need to consider the entire system, including possible communications signal degradation and display quality, when testing this capability. They also noted that this requirement is closely tied to the need for adjustable illumination to avoid washing out the image of close objects. The … wireless implementations …
Test Method:	…
TEST	

Working Groups within E54.08.01

- Logistics - Bob McKee, FEMA Texas TF-1
- Communications - Kate Remley/Galen Koepke, NIST
- Human-System Interaction - Sal Schipani, NIST
- Sensing - John Evans, John Evans LLC
- Mobility - Bill McBride, SwRI
- Safety - Mark Micire, UML and American Standard Robotics
- Operating Environment - Glen Keller, Allentown Fire Department
- Power - TBD
- Terminology - Hui-Min Huang, NIST

Standards Process Status

- 6 Work Items introduced; 3 balloted
  - ⇨ Terminology
  - ⇨ Visual Acuity and Field of View
  - ⇨ Logistics, Cache Packaging
  - – Human-System Interaction: Usability
  - – Communications: Line of sight and Non-line of sight wireless
  - – Mobility
- Additional ones in queue
  - – Safety, Directed Perception, Grasping Dexterity, Aerial Stationkeeping

Standards Process Status

- 14 test methods (some covering multiple requirements) have been exercised at least once; comments taken, refinements made

Standards Process Status

- Terminology - 2nd set of terms balloted
- Logistics, Cache Packaging
  - 1 negative vote
  - 1 comment
- Visual Acuity
  - 1 negative ballot (resolved)
  - Repeatability data being collected
  - Discussion: John Evans

Disaster City Exercise June 18-22, 2007

Participating Robots

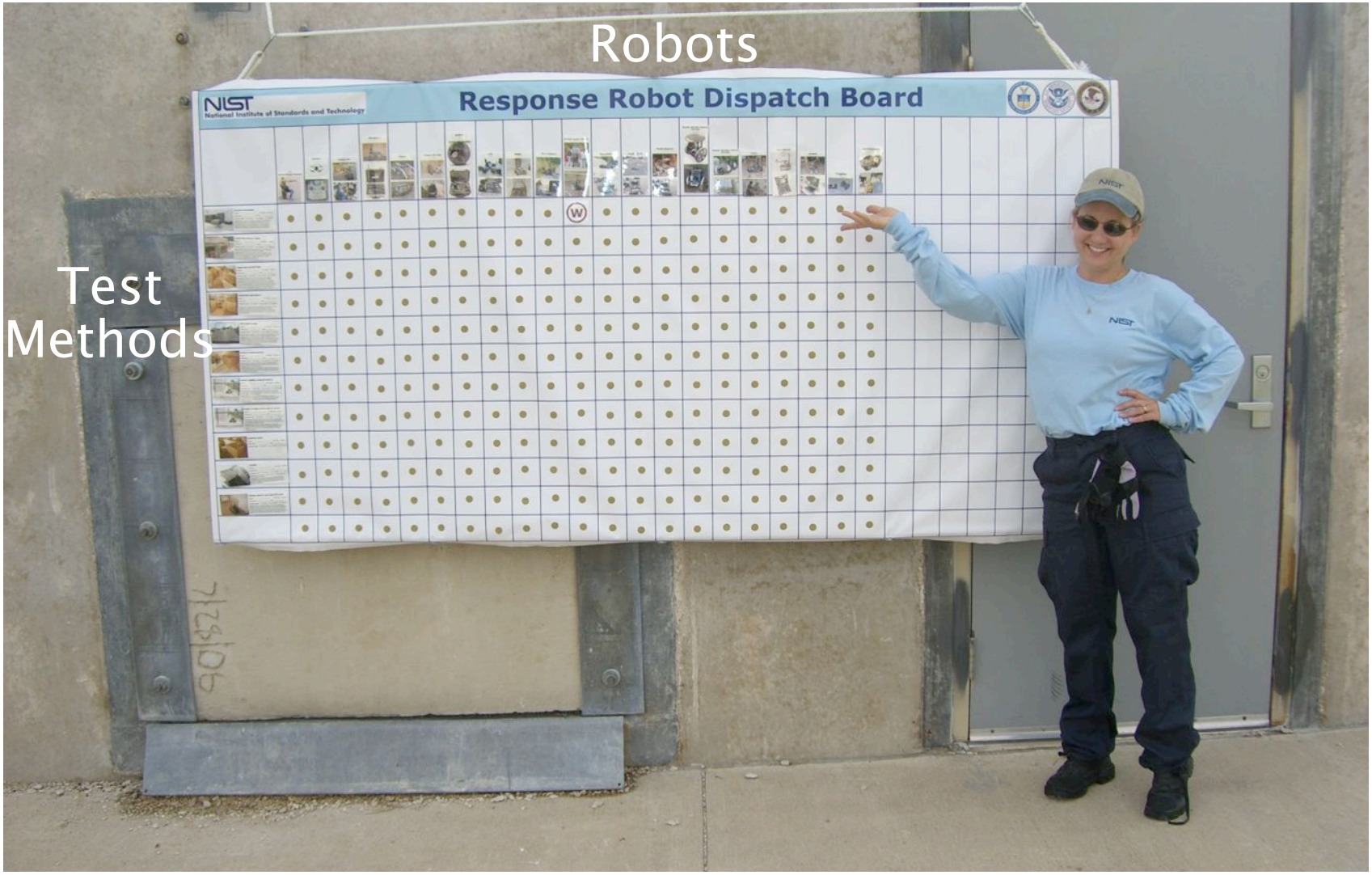
- Remington Technologies EyeBall
- Omnitech Robotics, LLC ToughBot
- Vortex LLC VRMP
- Robotic FX, Inc Negotiator
- First Response Robotics, LLC Hazardous Environment Robot Observer (HERO)
- Innovative Response Technologies, Inc. BomBot2
- iRobot Corp. PackBot Explorer
- iRobot Corp. PackBot EOD
- Mesa Robotics, Inc. Matilda
- Foster-Miller, Inc./Automatika, Inc. Dragon Runner
- Foster-Miller, Inc. TALON Hazmat
- Telerob, GmbH TeleMAX
- Segway Robotic Mobility Platform (RMP 200/INL: Autonomous Mapping)
- Segway Modular Logistics Platform (MLP 200/Hybrid: Ride-on or Teleop)
- Segway Robotic Mobility Platform (RMP 400)
- Tohoku University, Tadokoro Laboratory, Japan Active Scope Camera and Hokuyo Hi-URG 3D laser scanner
- AirRobot, GmbH AirRobot

Participating FEMA US&R Task Forces

- CA-TF1
- CO-TF1
- IN-TF1
- MA-TF1
- MD-TF1
- NE-TF1
- NY-TF1
- PA-TF1
- TX-TF1
- VA-TF1
- VA-TF2
- WA-TF1

Some commercial products are shown for illustration purposes. This does not imply endorsement by NIST.

Testing the Test Methods



DHS Standard Test Methods for Performance and Use of US&R Robots

General Feedback on Tests

- Note in detail the configuration of the robots at test time
  - For example, there was discussion regarding a robot's ability to bring and deploy equipment to cross gaps. The consensus was that if the robot carried and deployed a "kit" it should be okay, but would need to be asterisked in the data that it requires the optional "kit."
  - We need to capture all the options used in the robot spec sheets.
  - In general, configuration of robot during test must be noted. For example, whether it is carrying fiber spool, which could affect ramp or other test performance.

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Technology Administration, U.S. Department of Commerce

Developing

Standard Test Methods For Response Robots

Version: 2007.4

VISUAL ACUITY and FIELD OF VIEW

ROBOT: _____ TETHER ☐ RADIO ☐

OPERATOR: _____ ORG: _____

TRAINING TIME: 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS ☐

ADMINISTRATOR: 1) NOTE THE CAMERA LOCATION AND ASSOCIATED FEATURES. 2) PLACE THE SNELLEN CHARTS AT THE PROPER DISTANCES: *FAR FIELD* = 6 M AND *NEAR FIELD* = 40 CM. 3) NOTE THE LUX LEVEL OF LIGHTED AND DARK CHARTS. 4) CIRCLE THE DECIMAL EQUIVALENT FOR THE SMALLEST CORRECT LINE READ NORMALLY AND WITH ZOOM LENS IN AMBIENT LIGHT. 6) REPEAT WITH LIGHTS OUT (ILLUMINATION <1 LUX).

CAMERA: _____ FOV:____° PAN:____° TILT:____° ZOOM:____x LIGHT: Y | N VARIABLE: Y | N

FAR FIELD TEST (DISTANCE = 6.0 METERS)

TEST DISTANCE		LIGHTED CHART (_____ LUX)		DARK CHART (_____ LUX)	
6 M	(20 FT)	NORMAL	ZOOM	NORMAL	ZOOM
AERIAL CHART		NONE	NONE	NONE	NONE
6/90	(20/300)	0.07	0.07	0.07	0.07
6/75	(20/250)	0.08	0.08	0.08	0.08
6/60	(20/200)	0.10	0.10	0.10	0.10
6/45	(20/150)	0.13	0.13	0.13	0.13
FAR FIELD CHART (6M)					
6/30	(20/100)	0.20	0.20	0.20	0.20
6/24	(20/80)	0.25	0.25	0.25	0.25
6/18	(20/60)	0.33	0.33	0.33	0.33
6/15	(20/50)	0.40	0.40	0.40	0.40
6/12	(20/40)	0.50	0.50	0.50	0.50
6/9	(20/30)	0.67	0.67	0.67	0.67
6/7.5	(20/25)	0.80	0.80	0.80	0.80
6/6	(20/20)	1.00	1.00	1.00	1.00
6/4.8	(20/16)	1,25	1.25	1.25	1.25
6/3.8	(20/12)	1.7	1.7	1.7	1.7
6/3.0	(20/10)	2.0	2,0	2.0	2.0
6/2.4	(20/8)	2.5	2.5	2.5	2.5
6/1.7	(20/6)	3.3	3.3	3.3	3.3
6/1.5	(20/5)	4.0	4.0	4.0	4.0
NEAR FIELD CHART (BOTTOM NINE LINES ADJUSTED TO 6M)					
6/1.25	(20/4)	5.0	5.0	5.0	5.0
6/1.00	(20/3.3)	6.0	6.0	6.0	6.0
6/0.8	(20/2.7)	7.5	7.5	7.5	7.5
6/0.6	(20/2.0)	10	10	10	10
6/0.5	(20/1.7)	12	12	12	12
6/0.40	(20/1.3)	15	15	15	15
6/0.3	(20/1.1)	20	20	20	20
6/0.25	(20/.08)	24	24	24	24
6/0.20	(20/.07)	30	30	30	30

VISUAL ACUITY RATIOS NOTED MEAN:

READABLE AT ACTUAL TEST DISTANCE

READ~~ABLE DISTANCE WITH STANDARD VISION~~

CIRCLE DECIMAL EQUIVALENT IN EACH COLUMN

NEAR FIELD TEST (DISTANCE = 0.40 METER)

EQUIVALENT DISTANCE		LIGHTED CHART (_____ LUX)		DARK CHART (_____ LUX)	
6 M	(20 FT)	NORMAL	ZOOM	NORMAL	ZOOM
NEAR FIELD CHART		NONE	NONE	NONE	NONE
6/120	(20/400)	0.05	0.05	0.05	0.05
6/96	(20/320)	0.06	0.06	0.06	0.06
6/75	(20/250)	0.08	0.08	0.08	0.08
6/60	(20/200)	0.10	0.10	0.10	0.10
6/48	(20/160)	0.12	0.12	0.12	0.12
6/38	(20/125)	0.16	0.16	0.16	0.16
6/30	(20/100)	0.20	0.20	0.20	0.20
6/24	(20/80)	0.25	0.25	0.25	0.25
6/19	(20/63)	0.32	0.32	0.32	0.32
6/15	(20/50)	0.40	0.40	0.40	0.40
6/12	(20/40)	0.50	0.50	0.50	0.50
6/9.5	(20/32)	0.63	0.63	0.63	0.63
6/7.5	(20/25)	0.80	0.80	0.80	0.80
6/6.0	(20/20)	1.00	1.00	1.00	1.00
6/4.8	(20/16)	1.25	1.25	1.25	1.25
6/3.8	(20/12)	1.60	1.60	1.60	1.60
6/3.0	(20/10)	2.00	2.00	2.00	2.00

TEST LEADER _____ DATE _____ NOTES ☐


RADIOACTIVE
1760

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Developing

Standard Test Methods For Response Robots

Logistics - Cache Packaging

ROBOT: _____ ☐ TETHER ☐ RF

OPERATOR: _____ ORG: _____

SKILL LEVEL: ☐ Novice ☐ Intermediate ☐ Expert

INSTRUCTIONS: 1) Note the number and weight of each packaging container necessary for robot to deploy for 10 days, without re-supply for the first 96 hours. 2) Time the setup process until ready to go downrange. 3) Weigh the deployable robot and operator control unit. 4) Note the tools needed to perform setup and repair.

Planning for a 10 day deployment, without resupply for the first 72 hours

Number of packages plus total weight for each type of package

_____ Pelicans _____ kg or _____ lb

_____ Hardiggs _____ kg or _____ lb

_____ Ropacks _____ kg or _____ lb

_____ Pallets _____ kg or _____ lb

Pallet dimension: _____ x _____ mm (_____ x _____ in)

Total Weight: _____ kg or _____ lb

Measure the length of time to unpackage the robot system and fully prepare it for deployment.

Setup Time:

Start Time: _____

End Time: _____

Elapsed: _____ minutes

Down-Range Weight:

Robot: _____ kg Operator Control Unit: _____ kg Total: _____ kg

Robot: _____ lbs Operator Control Unit: _____ lbs Total: _____ lbs

---

Setup and Repairs can be performed at the base of operation

Tools Needed:

☐ None

☐ Typical Toolbox: Metric or English (circle one)

☐ Any Specialized Tools: Describe: _____

Describe: _____

Describe: _____

TEST LEADER DATE NOTES ☐

ROBOT: _____ ☐ TETHER ☐ RADIO

OPERATOR: _____ ORG: _____

TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: TRAVERSE THE TWO PATTERNS SHOWN WITH THE CENTER OF GRAVITY OF THE ROBOT ROUGHLY PASSING OVER EACH TARGET.

ADMINISTRATOR: 1) FOR EACH ANGLE, CHECK IF COMPLETE OR NOTE THE NUMBER OF SEGMENTS COMPLETED IN ORDER. TARGETS TOUCHED OUT OF ORDER IS INCOMPLETE. 2) TIME THE SEQUENCE. 4) INCREASE THE ANGLE UNTIL INCOMPLETES REPEAT. THE PREVIOUS COMPLETE ANGLE WILL BE CONSIDERED AS THE MAXIMUM.

INCLINE (CHECK ONE):

90° VERTICAL WALL

☐ .....

45°

☐ **40°**

35°

☐ **30°**

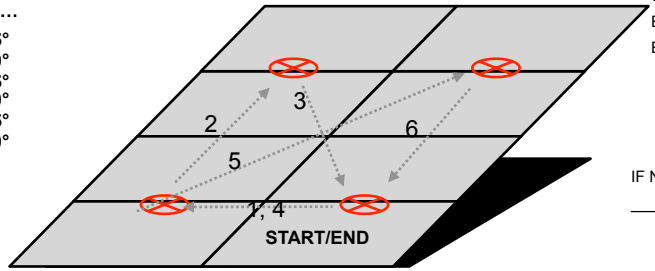
25°

☐ **20°**

☐

☐

☐



SURFACE TYPE:

☐ OSB PANELS

☐ OTHER: _____

START TIME: _____

END TIME: _____

ELAPSED _____ m:s

COMPLETE?

(YES = √ , NO = X)

☐

IF NO, SEGMENTS COMPLETED WERE

_____ OF 6 (DRAW ON GRAPHIC)

INCLINE (CHECK ONE):

90° VERTICAL WALL

☐ .....

45°

☐ **40°**

35°

☐ **30°**

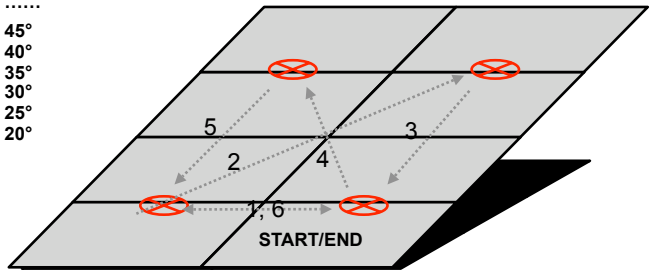
25°

☐ **20°**

☐

☐

☐



SURFACE TYPE:

☐ OSB PANELS

☐ OTHER: _____

START TIME: _____

END TIME: _____

ELAPSED _____ m:s

COMPLETE?

(YES = √ , NO = X)

☐

IF NO, SEGMENTS COMPLETED WERE

_____ OF 6 (DRAW ON GRAPHIC)


130
1377

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STAIRS

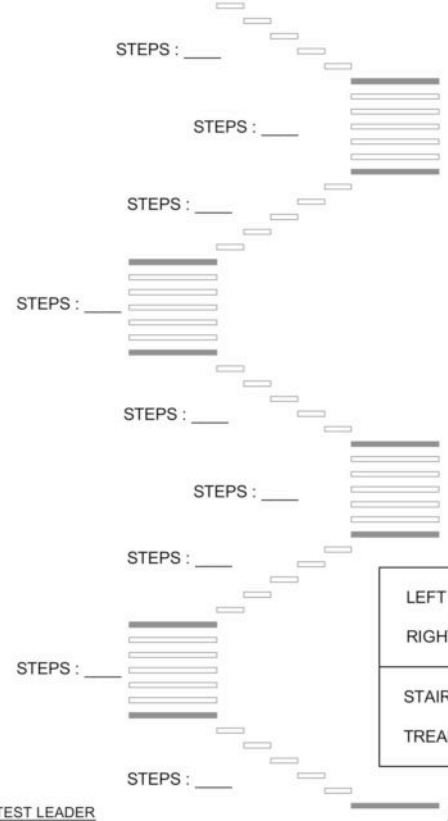
ROBOT: _____ ☐TETHER ☐RADIO

OPERATOR: _____ ORG: _____

TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: ASCEND THE STAIRS TO THE TOP, TURN AND DESCEND BACK TO THE START POINT.

ADMINISTRATOR: 1) NOTE THE AVERAGE STEP RISER AND TREAD DIMENSIONS. 2) NOTE THE WALL CONDITIONS AS SOLID OR OPEN. 3)NOTE THE NUMBER OF STAIRS AND LANDINGS (SHOWN IN GREY). 4)TIME THE SEQUENCE.



	ASCENDING	DESCENDING
START TIME:	_____	_____
END TIME:	_____	_____
ELAPSED TIME:	_____ s	_____ s
TOTAL STEPS:	_____	_____
	(COUNT LANDINGS AS A STAIR)	
AVG RATE:	_____	_____
	(COUNT LANDINGS AS A STAIR)	

LEFT WALL (ASCENDING): ☐ SOLID ☐ EMPTY W/ RAILING

RIGHT WALL (ASCENDING): ☐ SOLID ☐ EMPTY W/ RAILING

STAIR HEIGHT: _____ cm ☐ SOLID RISER

TREAD DEPTH: _____ cm ☐ EMPTY RISER

TEST LEADER _____ DATE _____ NOTES ☐

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STEP/GAP

ROBOT: _____ ☐TETHER ☐RADIO

OPERATOR: _____ ORG: _____

TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: TRAVERSE THE OBSTACLE AND RETURN TO START POINT (ONE REPETITION). REPEAT FIVE TIMES CONTINUOUSLY.

ADMINISTRATOR: 1) FOR EACH OBSTACLE, INCREASE OBSTACLE UNTIL UNSUCCESSFUL IN ONE OF FIVE REPETITIONS. CIRCLE THE MAXIMUM OBSTACLE DIMENSION WITH FIVE CONTINUOUS REPETITIONS. 2) NOTE THE ELAPSED TIME FOR FIVE CONTINUOUS TRAVERSES.

STEP WITH EDGE

	HEIGHT	1	2	3	4	5	ELAPSED TIME
☐	100 cm	☐	☐	☐	☐	☐	_____ m:s
☐	90 cm	☐	☐	☐	☐	☐	_____ m:s
☐	80 cm	☐	☐	☐	☐	☐	_____ m:s
☐	70 cm	☐	☐	☐	☐	☐	_____ m:s
☐	60 cm	☐	☐	☐	☐	☐	_____ m:s
☐	50 cm	☐	☐	☐	☐	☐	_____ m:s
☐	40 cm	☐	☐	☐	☐	☐	_____ m:s
☐	30 cm	☐	☐	☐	☐	☐	_____ m:s
☐	20 cm	☐	☐	☐	☐	☐	_____ m:s
☐	10 cm	☐	☐	☐	☐	☐	_____ m:s

GAP WITH NO STEP

	HEIGHT	1	2	3	4	5	ELAPSED TIME
☐	100 cm	☐	☐	☐	☐	☐	_____ m:s
☐	90 cm	☐	☐	☐	☐	☐	_____ m:s
☐	80 cm	☐	☐	☐	☐	☐	_____ m:s
☐	70 cm	☐	☐	☐	☐	☐	_____ m:s
☐	60 cm	☐	☐	☐	☐	☐	_____ m:s
☐	50 cm	☐	☐	☐	☐	☐	_____ m:s
☐	40 cm	☐	☐	☐	☐	☐	_____ m:s
☐	30 cm	☐	☐	☐	☐	☐	_____ m:s
☐	20 cm	☐	☐	☐	☐	☐	_____ m:s
☐	10 cm	☐	☐	☐	☐	☐	_____ m:s

STEP WITH PIPE

	HEIGHT	1	2	3	4	5	ELAPSED TIME
☐	100 cm	☐	☐	☐	☐	☐	_____ m:s
☐	90 cm	☐	☐	☐	☐	☐	_____ m:s
☐	80 cm	☐	☐	☐	☐	☐	_____ m:s
☐	70 cm	☐	☐	☐	☐	☐	_____ m:s
☐	60 cm	☐	☐	☐	☐	☐	_____ m:s
☐	50 cm	☐	☐	☐	☐	☐	_____ m:s
☐	40 cm	☐	☐	☐	☐	☐	_____ m:s
☐	30 cm	☐	☐	☐	☐	☐	_____ m:s
☐	20 cm	☐	☐	☐	☐	☐	_____ m:s
☐	10 cm	☐	☐	☐	☐	☐	_____ m:s

GAP WITH 20CM STEP

	HEIGHT	1	2	3	4	5	ELAPSED TIME
☐	100 cm	☐	☐	☐	☐	☐	_____ m:s
☐	90 cm	☐	☐	☐	☐	☐	_____ m:s
☐	80 cm	☐	☐	☐	☐	☐	_____ m:s
☐	70 cm	☐	☐	☐	☐	☐	_____ m:s
☐	60 cm	☐	☐	☐	☐	☐	_____ m:s
☐	50 cm	☐	☐	☐	☐	☐	_____ m:s
☐	40 cm	☐	☐	☐	☐	☐	_____ m:s
☐	30 cm	☐	☐	☐	☐	☐	_____ m:s
☐	20 cm	☐	☐	☐	☐	☐	_____ m:s
☐	10 cm	☐	☐	☐	☐	☐	_____ m:s

TEST LEADER DATE NOTES ☐

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Standard Test Methods For Response Robots

Version: 2007.4

MOBILITY/ENDURANCE

ROBOT: _____ ☐TETHER ☐RADIO

OPERATOR: _____ ORG: _____

TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: TRAVERSE THE FIGURE-8 WITHOUT BUMPING THE WALLS FOR ONE COMPLETE BATTERY CYCLE. REPAIRS ARE ALLOWED BUT MUST BE DONE IN PLACE TO CONTINUE TEST.

ADMINISTRATOR: 1) COUNT THE NUMBER OF LAPS (16 PALLETS PER LAP). 2) NOTE THE ELAPSED TIME. THE CLOCK SHOULD STOP FOR SWITCHING OF OPERATORS AND REPAIRS. 3) NOTE THE NUMBER OF REPAIRS, TYPE OF REPAIRS, AND TOOLS USED.

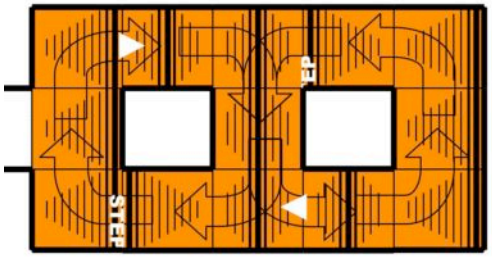
PITCH/ROLL RAMPS

START TIME: _____

END TIME: _____

ELAPSED TIME: _____ m:s

TOTAL PALLETS: _____



REPAIRS

TYPE	TIME		TOOLS		
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL

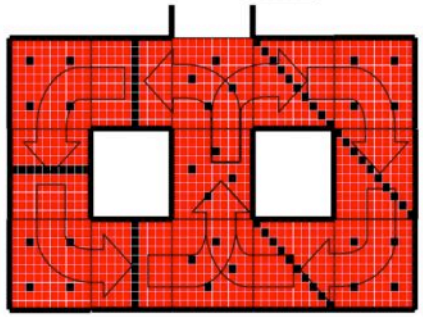
FULL CUBIC (RED) STEPFIELDS

START TIME: _____

END TIME: _____

ELAPSED TIME: _____ m:s

TOTAL PALLETS: _____



REPAIRS

TYPE	TIME		TOOLS		
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL
_____	_____	m:s	☐ NONE	☐TYPICAL	☐ SPECIAL

TEST LEADER DATE NOTES ☐

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Version: 2007.4

GRASPING DEXTERITY

ROBOT: _____ ☐TETHER ☐RADIO

OPERATOR: _____ ORG: _____

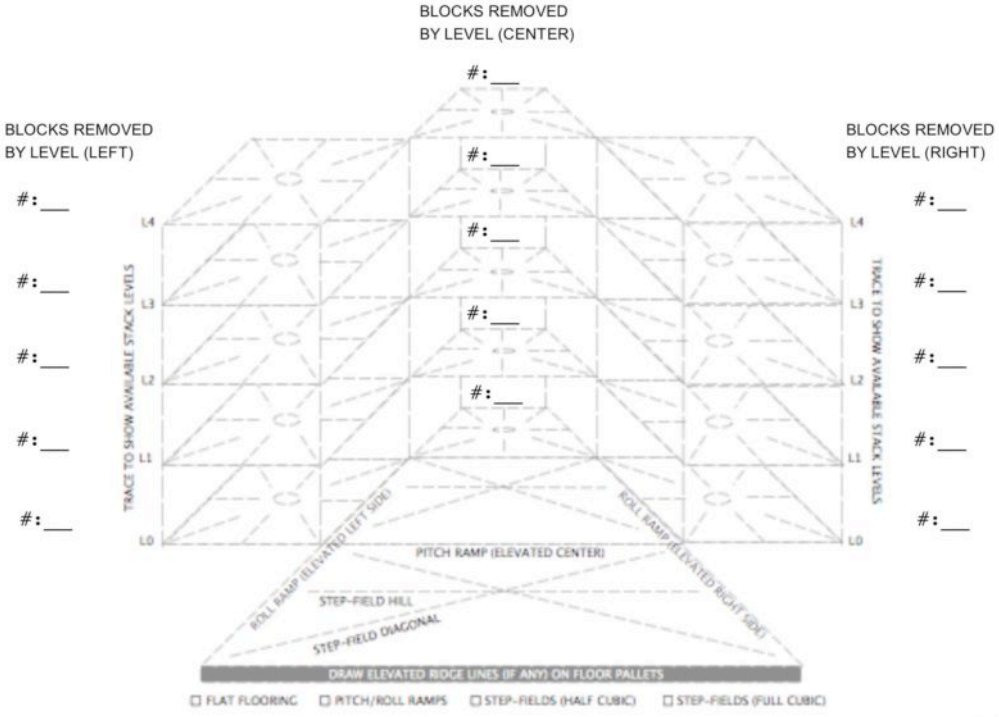
TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: 1) TRACE GROUND TERRAIN AND STACK HEIGHTS. 2) TIME SEQUENCE TO REMOVE AS MANY BLOCKS FROM EACH LEVEL AS POSSIBLE (DROPPING BLOCKS ONTO FLOOR IS OKAY). 3) TRACE WHICH ANGLED BLOCKS ("B") AND CENTERED OBJECTS ("O") ARE REMOVED. 4) NOTE ELAPSED TIME.

START TIME: _____

END TIME: _____

ELAPSED: _____ s



TEST LEADER DATE NOTES ☐

Developing

Standard Test Methods For Response Robots

the MAZE (Traverse *and* Search)

Robot: _____

Operator: _____

Skill Level: NOVICE ☐ INTER ☐ CONT. EX. ☐ E. RESP. PROF. ☐

MAZE Configuration #**2**

Date _____

Run _____

Forward ☐ ⇦ *Reverse* ☐ ⇨

⇨ Hits = _____

⇨ Targets = _____ *of* _____

Course *Time*: ⇨ Start _____ ⇨ End _____ = TOTAL _____

⇨ *Time* Decision point ***A*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***B*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***C*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***D*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***E*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***F*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***G*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***H*** _____
⇦ Correct Exit?: "Y" "N"

⇨ *Time* Decision point ***I*** _____
⇦ Correct Exit?: "Y" "N"

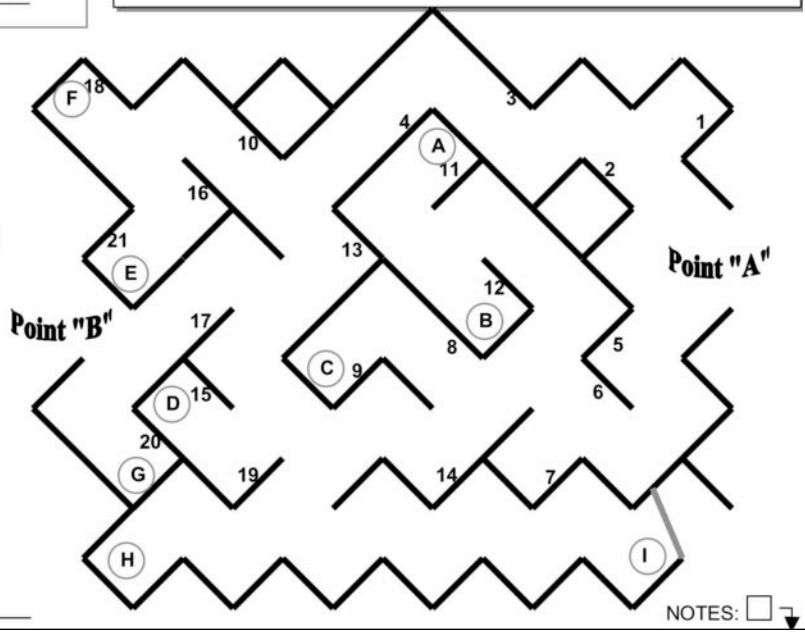
1 - 8 - 14 - 19

2 - 10 - 12 - 17

3 - 6 - 15 - 18 - 21

4 - 9 - 11 - 16


5 - 7 - 13 - 20



COMMENTS:

PROCTOR: _____

NOTES: ☐

- First maze experiment (Montgomery County exercise) addressed the 'theory' of using a maze as a test of telerobotic navigation, currently in press (see "Discussion" section on following page).

- Second experiment (Texas) addressed test validity (whether the resultant data answered research questions posed), and reliability (whether experimental results may be replicated).

- Measured during current exercise (i.e., Dependent Variables):

- TIME: Completion of maze, forward and reverse (two iterations each);

- TIME- SITUATION AWARENESS {decision making time}: Movement dwells, measured when encountering and negotiating methods out of designated isolation points (i.e., navigation 'traps', noted as circled letters on data collection form);

- ERRORS: Correct or incorrect direction of travel throughout (after having been given cue to use as 'mental model' for correct direction of traverse);

- ERRORS: Correct vs. incorrect direction of travel upon exiting 'traps';

- ERRORS: Erroneous wall encounters, causing interruption in direction of traverse, designated as "hits" on data collection form;

- DETECTION: Percentages of hazard warning label 'targets' located, and correctly recognized, noted as numbers on data collection form;

- DEMOGRAPHICS: Level of prior experience with robot manipulation, computer gaming, general office computer usage, age, education, current physical conditioning and alertness, and confidence in


07/06/20
AUX 2
03:20
Taken

Add checkboxes:
•For antenna type
•Signal type

Remove tether checkbox

Add slalom to catch latency issues in control channel

NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

Developing

Standard Test Methods For Response Robots

Version: 2007.4

RADIO COMMS (LINE-OF-SIGHT)

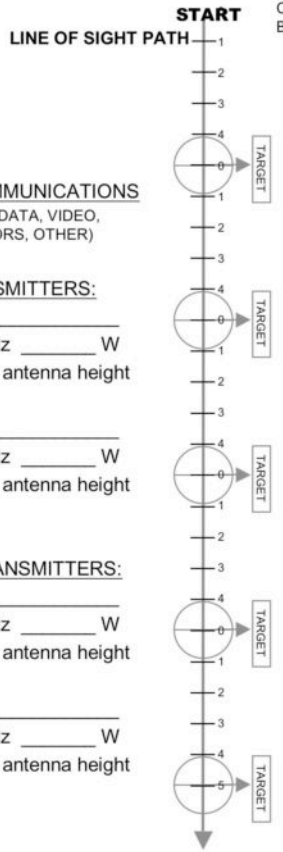
ROBOT: _____ ☐TETHER ☐RADIO

OPERATOR: _____ ORG: _____

TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: WHILE TRAVERSING THE PATH SHOWN, STOP AND READ THE SMALLEST COMPLETE LINE ON THE VISUAL ACUITY TARGETS UNTIL PERFORMANCE DEGRADES TO UNUSABLE. THEN RETURN READING ALL THE SAME TARGETS IN REVERSE ORDER. ANTENNA HEIGHT < 2 METERS.

ADMINISTRATOR: 1) NOTE ALL RADIO INFORMATION. 2) NOTE THE DISTANCES FROM THE START POINT TO EACH EQUALLY SPACED TARGET. 3) NOTE THE TIME ON TARGET TO POINT TO AND READ THE SMALLEST CORRECT LINE. 4) CIRCLE LAST LINE MARKER IF FARTHEST RANGE IS BETWEEN TARGETS.



START TIME: _____

	OUTBOUND		INBOUND	
1ST TARGET:	_____	meters		
ARRIVAL TIME:	_____		_____	m:s
TIME ON TARGET:	_____		_____	m:s
SMALLEST ACUITY:	_____		_____	(decimal)
2ND TARGET:	_____	meters		
ARRIVAL TIME:	_____		_____	m:s
TIME ON TARGET:	_____		_____	m:s
SMALLEST ACUITY:	_____		_____	(decimal)
3RD TARGET:	_____	meters		
ARRIVAL TIME:	_____		_____	m:s
TIME ON TARGET:	_____		_____	m:s
SMALLEST ACUITY:	_____		_____	(decimal)
4TH TARGET:	_____	meters		
ARRIVAL TIME:	_____		_____	m:s
TIME ON TARGET:	_____		_____	m:s
SMALLEST ACUITY:	_____		_____	(decimal)
5TH TARGET:	_____	meters		
ARRIVAL TIME:	_____		_____	m:s
TIME ON TARGET:	_____		_____	m:s
SMALLEST ACUITY:	_____		_____	(decimal)

RADIO COMMUNICATIONS
(COMMANDS, DATA, VIDEO, AUDIO, SENSORS, OTHER)

OCU TRANSMITTERS:
Content: _____
_____ MHz _____ W
_____ cm antenna height

Content: _____
_____ MHz _____ W
_____ cm antenna height

ROBOT TRANSMITTERS:
Content: _____
_____ MHz _____ W
_____ cm antenna height

Content: _____
_____ MHz _____ W
_____ cm antenna height

TEST LEADER DATE NOTES ☐

Add checkboxes:
•For antenna type
•Signal type

Remove tether checkbox

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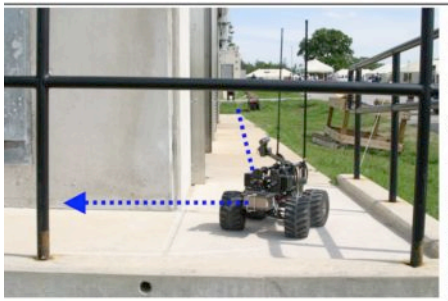


RADIO COMMS (NON-LINE-OF-SIGHT)

ROBOT: _____ ☐TETHER ☐RADIO

OPERATOR: _____ ORG: _____

TRAINING TIME: ☐ 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS

INSTRUCTIONS: WHILE TRAVERSING THE PATH SHOWN, STOP AND READ THE SMALLEST COMPLETE LINE ON THE VISUAL ACUITY TARGETS UNTIL PERFORMANCE DEGRADES TO UNUSABLE. THEN RETURN READING ALL THE SAME TARGETS IN REVERSE ORDER. ANTENNA HEIGHT < 2 METERS.

ADMINISTRATOR: 1) NOTE ALL RADIO INFORMATION. 2) NOTE THE DISTANCES FROM THE START POINT TO EACH EQUALLY SPACED TARGET. 3) NOTE THE TIME ON TARGET TO POINT TO AND READ THE SMALLEST CORRECT LINE. 4) CIRCLE LAST LINE MARKER IF FARTHEST RANGE IS BETWEEN TARGETS.

START (STANDOFF = _____ meters)

BUILDING OR OTHER LARGE OBSTACLE

RADIO COMMUNICATIONS
(COMMANDS, DATA, VIDEO, AUDIO, SENSORS, OTHER)

OCU TRANSMITTERS:
Content: _____
_____ MHz _____ W
_____ cm antenna height

Content: _____
_____ MHz _____ W
_____ cm antenna height

ROBOT TRANSMITTERS:
Content: _____
_____ MHz _____ W
_____ cm antenna height

Content: _____
_____ MHz _____ W
_____ cm antenna height

TARGET

START TIME: _____

	OUTBOUND	INBOUND
1ST TARGET:	_____ meters	
ARRIVAL TIME:	_____	_____ m:s
TIME ON TARGET:	_____	_____ m:s
SMALLEST ACUITY:	_____	_____ (decimal)
2ND TARGET:	_____ meters	
ARRIVAL TIME:	_____	_____ m:s
TIME ON TARGET:	_____	_____ m:s
SMALLEST ACUITY:	_____	_____ (decimal)
3RD TARGET:	_____ meters	
ARRIVAL TIME:	_____	_____ m:s
TIME ON TARGET:	_____	_____ m:s
SMALLEST ACUITY:	_____	_____ (decimal)
4TH TARGET:	_____ meters	
ARRIVAL TIME:	_____	_____ m:s
TIME ON TARGET:	_____	_____ m:s
SMALLEST ACUITY:	_____	_____ (decimal)
5TH TARGET:	_____ meters	
ARRIVAL TIME:	_____	_____ m:s
TIME ON TARGET:	_____	_____ m:s
SMALLEST ACUITY:	_____	_____ (decimal)

TEST LEADER DATE NOTES ☐

AERIAL - VTOL STATION KEEPING

ROBOT: _____ TETHER ☐ RADIO ☐

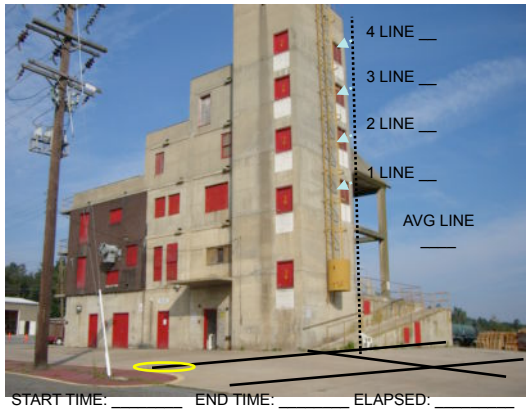
OPERATOR: _____ ORG: _____

TRAINING TIME: 0-24 HRS ☐ 24-100 HRS ☐ > 100 HRS ☐

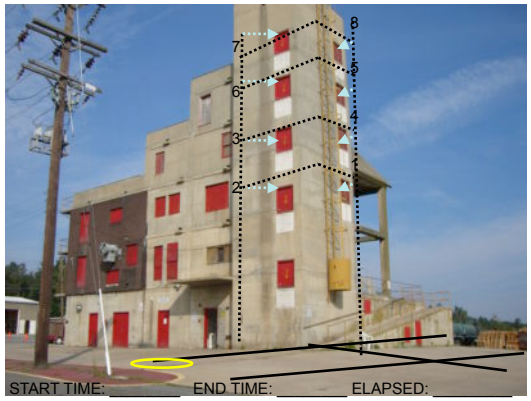
INSTRUCTIONS: TRAVERSE THE PATH SHOWN AND STATION KEEP IN FRON T OF EACH WINDOW TO READ FLUSH MOUNTED AND RECESSED VISUAL ACUITY CHARTS.

ADMINISTRATOR: 1) START WITH THE OPERATOR IN THE YELLOW CIRCLE SHOWN AND DO NOT LET THE HELO PASS THAT LINE UNTIL TOTAL CONTROL IS DEMONSTRATED. 2) FOLLOW THE PATHS SHOWN WITH THE OPERATOR LOCATIONS NOTED. 3) NOTE THE SMALLEST COMPLETE LINE.

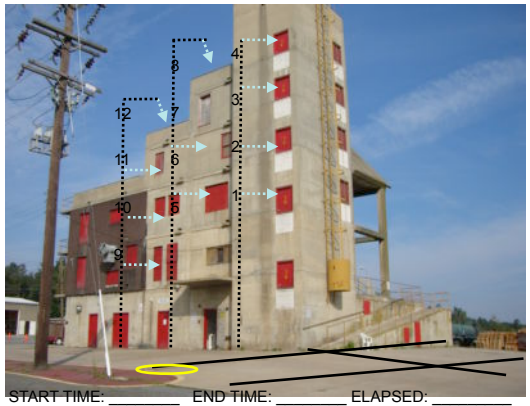
START TIME: _____ END TIME: _____ ELAPSED: _____



START TIME: _____ END TIME: _____ ELAPSED: _____



START TIME: _____ END TIME: _____ ELAPSED: _____



START TIME: _____ END TIME: _____ ELAPSED: _____

Requirements Addressed in Wave 1

Requirement #‡	Requirement
38	Logistics-Cache Packaging-Volume
34	Logistics-Cache Packaging-Weight
36	Logistics-Cache Packaging-Setup Time
96	Sensing-Vision System-Acuity, Near
99	Sensing-Vision System-Acuity, Far
101	Sensing-Vision System-Field of View
14	Human-System Interaction - Acceptable Usability
3	Chassis - Adjustable Illumination
6	Communications-Range NLOS
8	Communications-Range LOS

‡ References original requirements in Preliminary Report. See http://www.isd.mel.nist.gov/US&R_Robot_Standards

Requirements Addressed in Wave 1

Requirement # ‡	Requirement
59	Payload-Manipulation
65	Payload-Retrieval
60	Payload-Manipulation-Sensor Manipulation
45-47	Mobility-Locomotion-sustained speed
44	Mobility-Aerial-Stationkeeping
new	*Mobility-Vertical Climbing*
new	*Mobility-Locomotion-Random Step Fields*
new	*Mobility-Stair Climbing*
new	*Mobility-Ramps*
new	*Mobility-Confined Space Access*
new	*Sensing-Vision System-Acuity, Aerial*

‡ References original requirements in Preliminary Report. See http://www.isd.mel.nist.gov/US&R_Robot_Standards

For More Information

Project Web Site:

http://www.isd.mel.nist.gov/US&R_Robot_Standards

Email

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