

Wave 1 Requirements Discussion (26 total):

This document summarizes the candidate Wave 1 Tests for Urban Search and Rescue Robot Performance Standards. At the end of the list of 26 candidate requirements/tests, there is a description of a draft test method (real-time vision system acuity).



All 1st Tier requirements (21) are included.
Several 2nd Tier requirements (5) are included due to their close connection with 1st Tier requirements, allowing inclusion in the same standard test methods.

Number: 03
Type: CHASSIS
Sub-Type: ILLUMINATION
Requirement: ADJUSTABLE
Metric: YES/NO
Description: This requirement captures the responders' expectation to use video in confined spaces and for short-range object identification, which can wash out from excessive illumination of the scene.
Test Method: SEE REAL-TIME VISION SYSTEM ACUITY TEST

Number: 06 *
Type: COMMUNICATIONS
Sub-Type: N/A
Requirement: RANGE – BEYOND LINE OF SIGHT
Metric: METERS
Description: This requirement captures the responders' expectation to project remote situational awareness into compromised or collapsed structures. They specifically noted that the robot should be able to ingress a specified number of meters into the worst case collapse, which was further defined as a reinforced steel structure. This requirement also covers operations around corners of buildings and other locations beyond line of sight. The responders made no distinction regarding tethered or wireless implementations to address this requirement.
Test Method: SEE REAL-TIME VISION SYSTEM ACUITY TEST

Number: 07 *
Type: COMMUNICATIONS
Sub-Type: N/A
Requirement: SECURITY
Metric: SCALE 1-5
1 = No security
3 = Command security only
5 = Both data and command security

Description: This requirement captures the responders' expectation to use this system in sensitive public situations where maintaining control of remotes systems is imperative and limiting access to video images and other communications to authorized personnel is prudent. They added that the system should be shielded from jamming interference and encrypted for security, but made no distinction regarding tethered or wireless implementations to address this requirement.

Test Method: **SEE REAL-TIME VISION SYSTEM ACUITY TEST**

Number: **08**
Type: **COMMUNICATIONS**
Sub-Type: **N/A**
Requirement: **RANGE – LINE OF SIGHT**
Metric: **METERS**
Description: This requirement captures the responders' expectation to project remote situational awareness down range within line of sight. The responders made no distinction regarding tethered or wireless implementations to address this requirement.

Test Method: **SEE REAL-TIME VISION SYSTEM ACUITY TEST**

Number: **11 ***
Type: **HUMAN-SYSTEM INTERACTION**
Sub-Type: **N/A**
Requirement: **INITIAL TRAINING**
Metric: **HOURS**
Description: This requirement captures the responders' expectation to minimize the initial training necessary to become proficient in operation of the system. This training should include supporting material sufficient for training in the specified period and culminate in certification.

Test Method: **SEE ACCEPTABLE USABILTY TEST**

Number: **12 ***
Type: **HUMAN-SYSTEM INTERACTION**
Sub-Type: **N/A**
Requirement: **PROFICIENCY EDUCATION**
Metric: **HOURS ANNUALLY**
Description: This requirement captures the responders' expectation to minimize the annual proficiency training necessary to maintain certification.

Test Method: **SEE ACCEPTABLE USABILTY TEST**

Number: **13 ***
Type: **HUMAN-SYSTEM INTERACTION**
Sub-Type: **N/A**
Requirement: **OPERATOR RATIO**
Metric: **NUMBER OF OPERATORS PER ROBOT**
Description: This requirement captures the responders' expectation to minimize the number of operators necessary to operate any given system and perform the associated tasks effectively.

Test Method: **SEE ACCEPTABLE USABILTY TEST**

Number: **14 ***

Type: HUMAN-SYSTEM INTERACTION
Sub-Type: N/A
Requirement: ACCEPTABLE USABILITY
Metric: EFFECTIVENESS (PERCENT); USER SATISFACTION (RATING SCALE 1-5)
Description: This requirement captures the responders' expectation to operate any given system to perform the associated tasks effectively. The metric will measure the percent of timed tasks operators can successfully complete. This metric is discussed in greater detail in the Test Methods: Human-System Interaction section of this report.
Test Method: SEE ACCEPTABLE USABILITY TEST

Number: 26 *
Type: HUMAN-SYSTEM INTERACTION
Sub-Type: CONTEXT
Requirement: LIGHTING CONDITIONS
Metric: SCALE 1-5
1 = Complete darkness
3 = Daylight without direct glare
5 = Direct glare on interface
Description: This requirement captures the responders' expectation to view and use the operator console in different lighting conditions. They noted that special emphasis should be placed on "no light" conditions and "direct glare" onto operator displays (from sunlight, helmet lights, etc.).
Test Method: SEE ACCEPTABLE USABILITY TEST

Number: 29
Type: HUMAN-SYSTEM INTERACTION
Sub-Type: CONTEXT
Requirement: PROTECTIVE CLOTHING
Metric: SCALE 1-5
1 = No protection
3 = Minimum protection (threshold)
5 = Complete protection (objective)
Description: This requirement captures the responders' expectation to be operating the system while wearing personal protective equipment such as gloves, helmet, eye protection, ear protection, etc. The operator should be able to maintain acceptable usability (discussed in greater detail in the Test Methods: Human-System Interaction section of this report) of the system while wearing the stated level of personal protective equipment
Test Method: SEE ACCEPTABLE USABILITY TEST

Number: 30 *
Type: HUMAN-SYSTEM INTERACTION
Sub-Type: DISPLAY
Requirement: DASHBOARD
Metric: YES/NO ; EFFECTIVENESS (PERCENT)
Description: This requirement captures the responders' expectation to monitor general system health and status (e.g. orientation, communication strength, power level, etc.). They identified two types of information: Display of organic information: 1) system health status, i.e. power, motors, sensors, comms, etc.; 2) robot pose, i.e. absolute (x,y,z) or relative location from a start point; 3) constraints imposed by

environment, i.e. inhibitors, manipulator problems, occluded or blocked sensors. Also, display of external information: 1) Hazmat; 2) Temperature; 3) Other payload sensors. In addition to determining if the information is present, it is advisable to perform a series of empirical tests to determine if the operator(s) can accurately interpret the displayed information.

Test Method: SEE DASHBOARD CHECKLIST; SEE ACCEPTABLE USABILITY TEST

Number: 34 *

Type: LOGISTICS

Sub-Type: CACHE PACKAGING

Requirement: WEIGHT

Metric: KILOGRAMS PER CONTAINER

Description: This requirement captures the responders' expectation to move and store all equipment using existing methods and tools.

Test Method: TBD

Number: 35 *

Type: LOGISTICS

Sub-Type: N/A

Requirement: MEAN TIME BEFORE FAILURE (MTBF)

Metric: OPERATING HOURS

Description: This requirement captures the responders' expectation to use all equipment for the entire duration of a deployment (10 days maximum). Failure means major repairs of integrated components that need to be addressed by the manufacturer or other technical expert.

Test Method: TBD

Number: 36 *

Type: LOGISTICS

Sub-Type: CACHE PACKAGING

Requirement: SETUP TIME

Metric: MINUTES

Description: This requirement captures the responders' expectation to move and store all equipment using existing methods and tools. The setup time is from on-site delivery to operation.

Test Method: TBD

Number: 38 *

Type: LOGISTICS

Sub-Type: CACHE PACKAGING

Requirement: VOLUME PER CONTAINER

Metric: SCALE 1-5

1 = Pelican 1650 box

3 = Hardigg box checkable on commercial aircraft

5 = Ropack model 4048, 4039 with drop door

Description: This requirement captures the responders' expectation to move and store all equipment using existing methods and tools.

Test Method: TBD

Number: 39 *
Type: LOGISTICS
Sub-Type: FIELD MAINTENANCE
Requirement: SPARES AND SUPPLIES
Metric: PERCENT OF ROBOT WEIGHT
Description: This requirement captures the responders' expectation to be self-sustaining for 72 hours without re-supply. Field maintenance can be performed at the base of operations.
Test Method: TBD

Number: 40 *
Type: LOGISTICS
Sub-Type: FIELD MAINTENANCE
Requirement: DURATION
Metric: MINUTES
Description: This requirement captures the responders' expectation to minimize the amount of time required to perform routine maintenance operations in the field, potentially in-situ on a rubble pile or other awkward location.
Test Method: TBD

Number: 41 *
Type: LOGISTICS
Sub-Type: FIELD MAINTENANCE
Requirement: TOOLS
Metric: SCALE 1-5
1 = Requires special tools
3 = Simple tools (e.g., screw driver)
5 = No tools required
Description: This requirement captures the responders' expectation to minimize the need for specialized tools to perform field maintenance at the base of operations.
Test Method: TBD

Number: 42 *
Type: LOGISTICS
Sub-Type: FIELD MAINTENANCE
Requirement: INTERVALS
Metric: SCALE 1-5
1 = 12 hours
3 = 24 hours
4 = 72 hours
5 = 10 days
Description: This requirement captures the responders' expectation to minimize the mean time between required field maintenance performed at the base of operations.
Test Method: TBD

Number: 57 *
Type: OPERATING ENVIRONMENT
Sub-Type: N/A
Requirement: WATER
Metric: SCALE 1-4

- 1 = Not water resistant
- 2 = Wash down
- 3 = Submersible
- 4 = Water resistant to 12 meters

Description: This requirement captures the responders' expectation for the system to maintain operations in wet environments.

Test Method: TBD

Number: 67 *

Type: POWER

Sub-Type: N/A

Requirement: WORKING TIME

Metric: SCALE 1-5

- 1 = 1 hour
- 3 = 4 hours
- 5 = 12 hours

Description: This requirement captures the responders' expectation to maintain operations beyond basic mobility requirements within a given terrain type (see mobility requirements within terrain types). The system must have sufficient power to operate for the specified number of hours, assuming one power charge for one out and back mission.

Test Method: TBD

Number: 68 *

Type: POWER

Sub-Type: N/A

Requirement: SUSTAINMENT

Metric: SCALE 1-5

- 1 = 12 hours
- 3 = 24 hours
- 4 = 72 hours
- 5 = 10 days

Description: This requirement captures the responders' expectation to maintain operations in the field before re-supply is needed. The system must have sufficient power to operate for the specified number of hours/days before needing re-supply.

Test Method: TBD

Number: 69 *

Type: POWER

Sub-Type: N/A

Requirement: RUNTIME INDICATOR

Metric: YES/NO

Description: This requirement captures the responders' expectation to manage power resources to effectively plan mission durations, points of no return, and other important power considerations. The operator display must inform the operator of the remaining power level as a percentage of total runtime.

Test Method: TBD

Number: 96

Type: SENSING

Sub-Type: REAL-TIME COLOR VIDEO
Requirement: SYSTEM ACUITY - NEAR
Metric: MILLIMETERS
Description: This requirement captures the responders' expectation to use 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 responders made no distinction regarding tethered or wireless implementations to address this requirement.
Test Method: SEE REAL-TIME VISION SYSTEM ACUITY TEST

Number: 99 *
Type: SENSING
Sub-Type: REAL-TIME COLOR VIDEO
Requirement: SYSTEM ACUITY - FAR
Metric: METERS
Description: This requirement captures the responders' expectation to use video for key tasks such as maneuvering (hence the real-time emphasis), object identification (hence the color emphasis), and path planning (hence the emphasis on long-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 the limiting case for long-range system acuity is probably assessment of structural integrity of buildings. This requires identifying and measuring cracks in walls, inspecting the tops/bottoms of load bearing columns, and generally assessing the squareness of walls, ceilings, and floors. The responders made no distinction regarding tethered or wireless implementations to address this requirement.
Test Method: SEE REAL-TIME VISION SYSTEM ACUITY TEST

Number: 101
Type: SENSING
Sub-Type: REAL-TIME COLOR VIDEO
Requirement: FIELD OF VIEW
Metric: DEGREES
Description: This requirement captures the responders' expectation to use real-time video for a variety of tasks. The responders noted that this requirement is closely tied to requirements addressing independent pan/tilt capabilities.
Test Method: SEE REAL-TIME VISION SYSTEM ACUITY TEST

DRAFT TEST METHOD: REAL-TIME VISION SYSTEM ACUITY

This test protocol (Figure 1) and results reporting sheet (Figure 2) show an example of how to test the performance of the robot's vision system. The test as shown could address requirements listed in Table 1.

Table 1: Requirements Addressed by Example Test

3.	Chassis	Illumination	Adjustable
6.	Communications		Range: Beyond Line of Sight
7.	Communications		Security
8.	Communications		Range: Line of Sight
96.	Sensing	Real-Time Video	Real time remote video system (near)
99.	Sensing	Real-Time Video	Real time remote video system (far)
101.	Sensing	Real-Time Video	Field of View

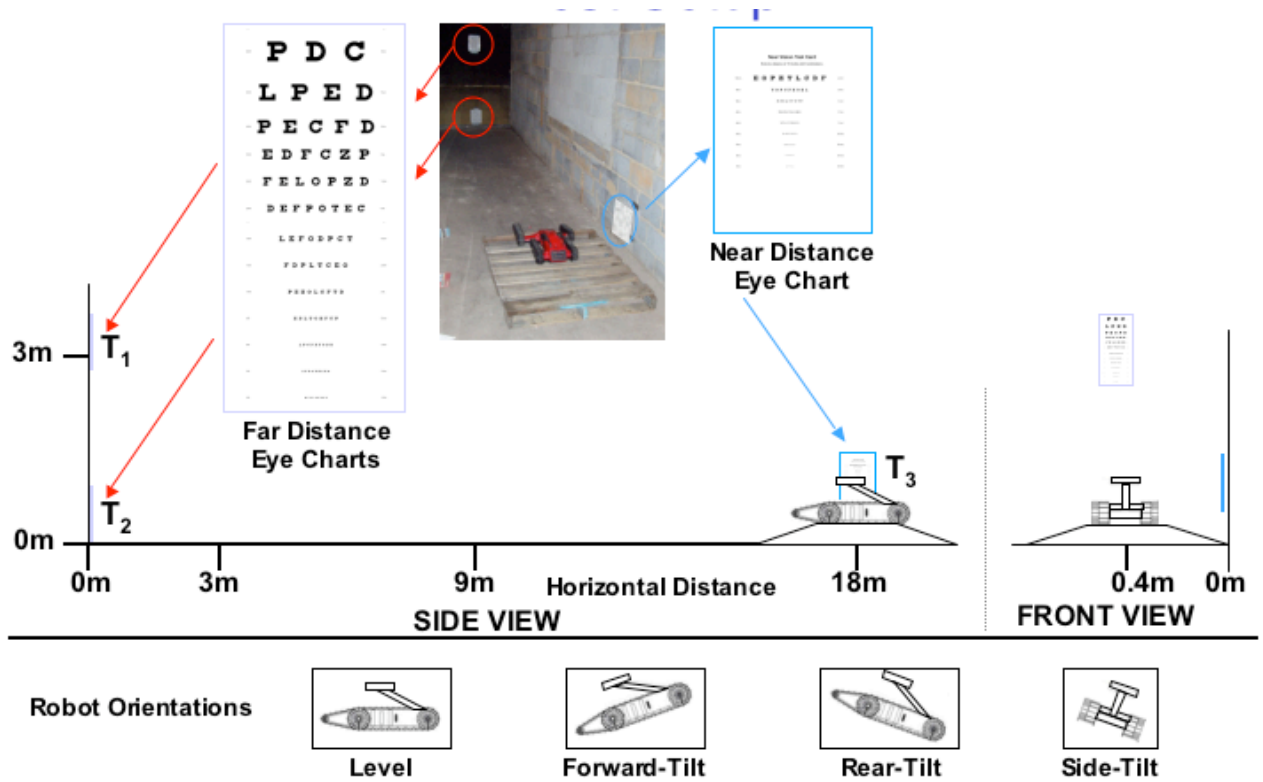


Figure 1: Set up for Test













SYSTEM VIDEO RESOLUTION TESTING						DATE:			
						TEST LOCATION:			
Communication Mode (Circle One)						TEST LEADER:			
						OPERATOR:			
Tethered Wireless						ROBOT:			
Horizontal Distance	Orientation	Lights On				Lights Off			
		T1 Acuity	T2 Acuity	T3 Acuity	Time	T1 Acuity	T2 Acuity	T3 Acuity	Time
18m		/18	/18	/0.4		/18	/18	/0.4	
		/18	/18	/0.4		/18	/18	/0.4	
		/18	/18	/0.4		/18	/18	/0.4	
		/18	/18	/0.4		/18	/18	/0.4	
9m		/9	/9	/0.4		/9	/9	/0.4	
		/9	/9	/0.4		/9	/9	/0.4	
		/9	/9	/0.4		/9	/9	/0.4	
		/9	/9	/0.4		/9	/9	/0.4	
3m		/3	/3	/0.4		/3	/3	/0.4	
		/3	/3	/0.4		/3	/3	/0.4	
		/3	/3	/0.4		/3	/3	/0.4	
		/3	/3	/0.4		/3	/3	/0.4	
NOTES:									

Figure 2: Test Results Report Sheet