



Designation: E2592/E2592M – 24

Standard Practice for Evaluating Response Robots: Logistics: Packaging and Setup Time¹

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INTRODUCTION

The robotics community needs ways to measure whether a particular robot is capable of performing specific missions in complex, unstructured, and often hazardous environments. These missions require various combinations of elemental robot capabilities. Each capability can be represented as a test method with an associated apparatus to provide tangible challenges for various mission requirements and performance metrics to communicate results. These test methods and practices can then be combined and sequenced to evaluate essential robot capabilities and remote operator proficiencies necessary to successfully perform intended missions.

The ASTM International Standards Committee on Homeland Security Applications (E54) specifies these standard test methods, practices, and guides to facilitate comparisons across different testing locations and dates for diverse robot sizes and configurations. These standards support robot researchers, manufacturers, and user organizations in different ways. Researchers use the standards to understand mission requirements, encourage innovation, and demonstrate break-through capabilities. Manufacturers use the standards to evaluate design decisions, integrate emerging technologies, and harden systems. Emergency responders and soldiers use them to guide purchasing decisions, align deployment expectations, and focus training with standard measures of operator proficiency. Associated usage guides describe how these standards can be applied to support various objectives.

Several suites of standards address these elemental capabilities including maneuvering, mobility, dexterity, sensing, endurance, communications, durability, proficiency, autonomy, and logistics.

This practice is part of the logistics suite of test methods and practices.

1. Scope

1.1 This practice covers the requirement that remotely operated robots and all necessary associated components or equipment (for example, operator control station, power sources, spare parts, sensors, manipulators, tools, extra batteries, and so forth) shall be included in the response organization's cache packaging and transportation systems.

1.2 Shipment by ground, air, or marine should be considered.

1.3 Volume, weight, shipping classification, and deployability of the robots and associated components are considered in this practice.

1.3.1 The deployability is considered through the determination of:

1.3.1.1 The length of time required to prepare the robot system for deployment, and

1.3.1.2 The types of tools required for servicing the robot system in the field.

1.3.2 Associated components or equipment include not only all the onboard sensors, tethers, and operator control station, but also any spare parts and specialized tools needed for assembly, disassembly, and field servicing.

1.3.3 Associated components also include power equipment necessary for the operation of the system, such as batteries, chargers, and power converters. Gasoline, diesel, or other types of liquid fuel are not included.

1.4 The packaged items should support the operational availability of the robot during a deployment of up to ten days or as determined by the organization. There may be no resupply within the first 72 h of deployment, or as determined by the organization.

1.5 No other standard currently exists except for those relevant to shipping (for example, CFR Title 49 and International Air Transport Association (IATA) documents).

¹ This practice is under the jurisdiction of ASTM Committee E54 on Homeland Security Applications and is the direct responsibility of Subcommittee E54.09 on Response Robots.

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1.6 The International System of Units (SI Units) and U.S. Customary Units (Imperial Units) are used throughout this practice. They are not mathematical conversions. Rather, they are approximate equivalents in each system of units to enable use of readily available materials in different countries. The differences between the stated dimensions in each system of units are insignificant for the purposes of comparing test method results, so each system of units is separately considered standard within this practice.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *Federal Standard.*²

CFR Title 49 Transportation

2.2 *ISO Standard.*³

ISO 6780:2003 Flat pallets for intercontinental materials handling—Principal dimensions and tolerances

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *cache, n*—approved complement of tools, equipment, and supplies stored in a designated location available for use during responses to emergencies.

3.1.2 *operator control unit (OCU), n*—a device used by an operator to teleoperate the robot.

3.1.3 *robot system, n*—response robot and all necessary associated components required for field operation and maintenance of the robot.

3.1.3.1 *Discussion*—Necessary associated components include, but are not limited to: the operator control unit (OCU), power sources, spare parts, sensors, consumables (such as lubricating oil, gasoline, etc.), accessories, and maintenance tools.

4. Summary of Practice

4.1 The number and types of cases required for packing the robot and all associated components are identified, along with the weight of each. This information will prepare the logistics manager to allocate space in the warehouse as well as in the transportation vehicle to the response site. Weight is taken into consideration in terms of transporting the equipment to and from the response site.

4.2 The length of time required to unpack and ready the robot for operation is measured. This provides the organization an estimate of how long to allocate to the preparation of the robot for deployment.

4.3 The tools that are required for servicing the robot in the field are identified. This will help the logistics manager determine whether additional, specialized tools will need to be packed along with the robot. It is preferable to avoid the use of specialized tools that are not typically available as part of the existing cache. Loss of a specialized tool may hamper the repair or use of a robot in the field.

4.4 The weight of the robot and OCU are measured. Responders carry an array of tools and equipment from the base of operation to the operational work site. The additional burden of carrying the robot and any associated equipment will need to be incorporated into their overall logistical planning. It is important that the weight of the robot and the additional equipment be factored into the response planning process.

5. Significance and Use

5.1 The addition of robots and the supporting equipment to the responder's cache may have an impact on the logistical planning for the response teams. Additional volume and weight should be stored and transported to the response site. Additional preparation time should be allotted to ready the robot for deployment. The tools that are taken to the field may need to be augmented to service the robots. Once the robot is ready for deployment, it should be transported from the base of operations to the work site.

5.2 This practice is designed to appraise the impact in terms of logistical considerations for a response organization.

6. Data Collection Form

6.1 A sample data collection form is shown in **Fig. 1**. This form is referenced throughout Sections **7 – 12**.

LOGISTICS

7. Volume of Cache Packaging

7.1 The robot system shall be compatible with the responder's cache packaging and transportation system, for example, three standard packing cases are used by the Federal Emergency Management Agency (FEMA) Urban Search and Rescue (USAR) task forces. Self-contained robot systems may also be loaded onto a pallet.

7.2 *Apparatus*—Packing cases or pallets.

7.2.1 *Packing Cases*—Packing cases are required for transport by FEMA task forces. Their equivalent dimensions are given in **Table 1**. Other organizations may not be constrained to use these specific brands or sizes. However, the process described in this practice can still be applied so as to provide consistent volumetric measures for robot systems.

7.2.1.1 *Hardigg Cases*⁴—Packed cases should weigh no more than 68 kg [150 lb]. For two people to carry, 90 kg

² Available from the U.S. Government Printing Office, Superintendent of Documents, Stop SSOP, Washington, DC 20402-0001.

³ Available from American National Standards Institute (ANSI), 1180 Avenue of the Americas, 10th Floor, New York, NY 10036, <http://www.ansi.org>.

⁴ Trademark of Hardigg Industries, Inc., 147 N. Main St., South Deerfield, MA 01373-0201.