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Standard Practice for Evaluating ~~Cache Packaged Weight and Volume of Robots~~ Response Robot Capabilities: Logistics: Packaging for Urban Search and Rescue Task Force Equipment Caches[1]

This standard is issued under the fixed designation E2592; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Anyone interested in developing or deploying response robots for hazardous environments needs ways to quantitatively measure whether a particular robot is capable of performing and reliable enough to perform specific missions. These missions decompose into sets of elemental robot tasks that can be represented individually as standard test methods and repeatedly tested to gain confidence and proficiency. They provide a tangible language to communicate mission requirements and demonstrate robot capabilities.

The ASTM International Standards Committee on Homeland Security Applications, Operational Equipment Subcommittee, Robots Task Group (E54.08.01) specifies standard test methods, practices, and guides for evaluating response robots. These standard test methods measure individual robot capabilities to facilitate comparisons among different robot models or different configurations of a particular robot model. The overall set of standards addresses the robotic logistics, terminology, safety, maneuvering, terrains, obstacles, dexterity, sensing, communications, energy/power, durability, proficiency, and autonomy.

These standards support robot researchers, manufacturers, and user organizations in different ways by enabling testing of chosen combinations that address envisioned mission tasks. Researchers use them to understand mission requirements, refine innovative approaches, and demonstrate breakthrough capabilities. Manufacturers use them to evaluate design decisions, integrate payloads and emerging technologies, and harden systems. Responder organizations use them to guide purchasing, align with deployment objectives, and focus training with measures of operator proficiency.

1. Scope

1.1 This practice covers the requirement that urban search and rescue robots and all necessary associated components or equipment (for example, operator control station, power sources, spare parts, sensors, manipulators, tools, and so forth) shall complement 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.

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[1] This practice is under the jurisdiction of ASTM Committee E54 on Homeland Security Applications and is the direct responsibility of Subcommittee E54.08 on Operational Equipment.

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1.4 The packaged items shall support the operational availability of the robot during a deployment of up to ten days. There shall be no resupply within the first 72 h of deployment.

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

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

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*—computer(s), accessories, and data link equipment that an operator uses to control, communicate with, receive data and information from, and plan missions for one or more robots.

[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), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.1.2.1 *Discussion*—

Also referred to as operator control interface (OCI), operator control station, or human interaction control unit.

3.1.3 *robot system, n*—robot platform and all necessary associated components required for field operation and maintenance of the robot, which includes, but is not limited to, the operator control station, power sources, spare parts, sensors, manipulators, 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 of a response team to allocate space in the warehouse as well as in the transportation vehicle to convey the robot to and from 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 responder 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, special tools will need to be packed along with the robot. It is preferable to avoid using specialized tools that are not typically available in toolboxes that are part of the existing cache. If a specialized tool is missing, there may be no recourse in resolving the problem with the robot in the field, and the robot may be rendered inoperable.

4.4 The weights of the robot and OCU are measured. The responders already have to carry an array of tools and equipment from the base of operation to the operational work site. Part of their new logistical planning when robots are deployed will be the additional burden of carrying the robot and any associated equipment, such as the OCU. It is important that the weight of the robot and the OCU be factored into the response planning process on site.

5. Significance and Use

5.1 Introduction of robots to the responder's cache for use in urban search and rescue missions may have an impact on the logistical planning for the response teams. Additional volume and weight shall be stored and transported to the response site. Additional preparation time shall 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 shall be transported from the base of operations to the mission zone. Responders may have to carry the robot and its controller or may have to provide some other transportation mechanism if it is too heavy.

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 – 11.

Logistics

7. Volume of Cache Packaging

7.1 The robot system shall be compatible with the responder's cache packaging and transportation system.

7.2 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.

7.3 *Apparatus*—Packing cases or pallets.

7.3.1 *Packing Cases*—These 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.

7.3.1.1 *Hardigg Cases*[4]—Packed cases should weigh no more than 68 kg (150 lb). For two people to carry, 90 kg (200 lb) is the absolute maximum. The empty cases should each weigh no more than 13.6 kg (30 lb). Two models are used by FEMA USAR task forces. Their model numbers and outer dimensions are shown in Table 1.

7.3.1.2 *Pelican Cases*[5]—These cases are molded plastic containers that may have an airtight and watertight gasket. Any model Pelican that will fit into a Hardigg case in 7.3.1.1 is allowed. Packed Pelican cases shall, therefore, fit into, and not exceed, the weight limit of a Hardigg case as noted in Table 1.

7.3.1.3 *Orbis BulkPak Cases*[6]—These cases are plastic collapsible bulk containers. One model (#4048) is approved for use by FEMA USAR task forces. Its dimensions (or for an equivalent) are 101.6 by 121.9 cm (40 by 48 in.). Maximum height is 114.3 cm (45 in.). Lids, doors, and other options are permissible. The weight limit is up to the rating of the container.

7.3.2 *Pallets*—Pallets are flat structures used to transport items via forklifts or other mobile devices. If a pallet is used to transport the robot system, its dimensions should conform to ISO standards like ISO 6780:2003. These ISO dimensions are listed in Table 2.

7.4 Determine whether the robot system can fit within the packing cases available to the FEMA task forces. It is not required that all of the equipment associated with the robot fit within a single packing case. Other organizations may not have the same restrictions as FEMA task forces; however, the volume and weight required to transport the robot system shall be determined.

7.4.1 Enumerate the number of packing cases (by type) required for transport of the entire robot system.

8. Weight of Cache Packaging

8.1 Responders shall be able to move and store all equipment using existing methods and tools.

8.2 *Apparatus*—A scale shall be available to weigh each package.

8.3 Place the robotic system within the required packing case(s) (see Section 7). For each case that is required for transporting the robotic system, determine the weight in kilograms. Enter the value in the data collection form (Fig. 1).

8.4 For Hardigg cases, the packed cases should weigh no more than 68 kg (150 lb). For two people to carry, 90 kg (200 lb) is the absolute maximum. The empty cases should each weigh no more than 13.6 kg (30 lb).

8.5 The weight of the entire robotic system is to be computed by summing the weights of the individual cases for the robotic system.

8.6 The weight(s) should be also reported in inch-pound units (pounds) in addition to SI units.

8.7 Determine weights to within 0.25 kg (0.55 lb).

9. Setup Time

9.1 Measure the amount of time (on average) that it takes for the robot system to be set up and ready to operate at the deployment site.

9.2 *Apparatus*—A timing device shall be available. A watch or timer may be used.

9.3 *Protocol for Measuring Setup Time:*

9.3.1 The robot system shall be inside its packing crate(s) or on pallets at the beginning.

9.3.2 Note the start time.

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

[5] Trademark of Pelican Products, Inc., 23215 Early Ave., Torrance, CA 90505.

[6] Trademark of Orbis Corporation, http://www.orbiscorporation.com/o/o/Products/BulkContainers/ORBIS_BulkPak_4840/ (formerly Ropak 4048 containers).