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Standard Practice for Evaluating the Cache Packaging Weight and Volume of Robots for Urban Search and Rescue[1]

This standard is issued under the fixed designation X XXXX; 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.

1. Scope

1.1 This practice covers the requirement that urban search and rescue robots and all necessary associated components (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 deployabilty 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 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] 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 packaging shall support the operational availability of the robot during a deployment of up to ten days. There shall be no resupply within the first 96 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 given in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.8 *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]

CFT 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 Specific to This Standard:*

3.1.1 *cache, n*--approved complement of tools, equipment, and supplies stored in a designated location available for emergency use.

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

[3] Available from the American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

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.

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*--in this practice, refers to the 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 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 prepare the robot for deployment 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 carried 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 set of test methods 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 in the test methods given in Sections 7-11.

LOGISTICS

7. Volume of Cache Packaging

7.1 This section addresses the requirement that the robot system shall be compatible with the responders' 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*

7.3.1 *Packing Cases or Pallets*--These packing cases are required for transport by FEMA task forces. Other organizations may not be constrained to use these specific brands or sizes. However, the process described in this test method can still be applied so as to provide consistent volumetric measures for robot systems.

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

TABLE 1 Model Numbers and Outer Dimensions for FEMA USAR Task Force Hardigg Cases

	Outside Dimensions		
Model Name	**Length, m (in.)**	**Width, m (in.)**	**Height, m (in.)**
AL-3418-1005	0.94 (37.2)	0.53 (21.0)	0.44 (17.3)
AL-3124-1204	0.78 (30.8)	0.50 (19.6)	0.43 (17.0)

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

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 box as noted in Table 1.

7.3.1.3 *Ropack*[6] *Cases*--These cases are plastic collapsible bulk containers. One model is approved for use by FEMA USAR task forces. Its dimensions are given in 7.3.1.3 (*1*).

(*1*) *Model #4048*--The dimensions of this model (or for an equivalent) are 101.6 by 121.9 cm (40 by 48 in.) to fit under a 243.8-cm (96-in.) wide truck side by side. 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.

7.3.1.4 *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. These ISO dimensions are listed in Table 2.

TABLE 2 ISO Pallet Dimensions

Dimensions, mm	Dimensions, in.	Region
1200 by 1000	47.24 by 39.37	Europe, Asia
1200 by 800	47.24 by 31.50	Europe
1219 by 1016	48.00 by 40.00	North America
1140 by 1140	44.88 by 44.88	Australia
1100 by 1100	43.30 by 43.30	Asia
1067 by 1067	42.00 by 42.00	North America, Europe, Asia

7.4

[5] Available from Pelican™ Products, Inc., 23215 Early Ave., Torrance, CA 90505.
[6] Available from Ropack Inc. 10801 Mirabeau St., Montreal, QC H1J 1T7 Canada.

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.

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

8. Weight of Cache Packaging

8.1 This section addresses the requirement on the part of the responders that they be able to move and store all equipment using existing methods and tools.

8. 8.2 *Apparatus*--A scale shall be available to weigh the entire robotic system.

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 lbs). For two people to carry 90 kg (200 lbs) is the absolute maximum. The empty cases should each weigh no more than 13.6 kg (30 lbs).

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) may be also reported in inch-pound units (pounds) in addition to SI units.

8.7 Determination of weights to within 0.25 kg (0.55 lb) will be adequate.

9. Setup Time

9.1 This section measures 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.

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

9.4.2 The start time is noted.

9.4.3 The robot and all of its necessary components are removed from the packing crates.

9.4.4 The robot and all of its necessary components are assembled as required to attain readiness for deployment.

9.4.5 Any necessary initialization, powering on, testing, or other preliminary procedures required to ensure a state of readiness for deployment shall be conducted.

9.4.6 The end time is noted. At this time, the robot is fully functional.

9.4.7 The elapsed time (in minutes) is noted.

9.4.8 It is expected that there will be variability in the length of time required depending on circumstances in the field and the experience level of the person preparing the robot. This measure should reflect the time required by a user with moderate experience. If desired, the testing organization may choose to average the times of multiple users performing the setup.

9.5 Measurement of time to a resolution of 1 minute will be adequate.

10. Tools Requirement

10.1 This section addresses the requirement on the part of responders to know what types of tools are required for servicing a robot in the field.

10.2

10.3

10.3 The following three choices of tools are possible:

10.3.1 No special tools are needed. In this case, the robot parts snap together or can otherwise be disassembled and assembled without any external tools.

10.3.1 Tools that typically reside in a cache toolbox are needed. It is assumed that responder caches already include basic tools such as screwdrivers, allen wrenches, socket wrenches, and circuit testers. Whether the robot system requires SI or inch-pound tools shall be noted.

10.3.1 Specialized tools that may not reside in a cache toolbox are needed. If this is the case, each special tool shall be described. Note that all specialized tools that are needed shall be included in the cache packaging considerations for volume, packaging, and weight.

11. Downrange Weight

11.1 *Scope*--This section captures the weight of the robot, the OCU, and any components that are necessary for operation when the robot is deployed. Additional components may include, for example, sensors or mission packages that are mounted on the robot.

11.3 *Apparatus*--A scale shall be available to weigh the entire robotic system.

11.4 The robot is placed on the scale and its weight is noted. SI units (kilograms) are preferred, but inch-pound units (pounds) may also be noted. The OCU is placed on the scale and its weight is noted. SI units (kilograms) are preferred, but inch-pound units (pounds) may also be noted.

11.5 Determination of weights to within 0.25 kg (0.55 lb) will be adequate.

12. Keywords

12.1 cache packaging volume; cache packaging weight; setup time; tools; urban search and rescue; urban and search rescue robot

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

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 96 hours

Number of packages _____ Pelicans _____ kg or _____ lb
plus total weight for _____ Hardiggs _____ kg or _____ lb
each type of package _____ 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

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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 ☐

FIG 1 Sample Data Collection Form for Test Methods