



Designation: F3444/F3444M – 20

Standard Practice for Training Exoskeleton Users¹

This standard is issued under the fixed designation F3444/F3444M; 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 establishes the minimum training requirements, including general knowledge, skills, and abilities, for personnel who use an exoskeleton as part of their duties.

1.2 This practice applies only to exoskeletons and exosuits.

NOTE 1—For more advanced exoskeletons, those that are powered, or with IT data connections/links for data transfer, or combinations thereof, upload/download requirements, ensure exoskeleton user and system operators training includes addressing all precautions so they can quickly identify and resolve any data transfer problems experienced with a fully operational exoskeleton.

1.3 It is recognized that organizations and job responsibilities vary widely among military, medical, industrial, and emergency response communities. It is the responsibility of the user of this practice to identify the appropriate subject matter for its program and its specific needs.

1.4 Users of this practice should consult with the exoskeleton manufacturer to ensure they have the latest and most relevant information on the exoskeleton. In addition, all training should comply with laws and regulations regarding user safety and health as well as the safety of individuals in close proximity to the user.

1.5 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.6 *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.*

1.7 *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 *ASTM Standards*:²

F3323 Terminology for Exoskeletons and Exosuits

F3392 Practice for Exoskeleton Wearing, Care, and Maintenance Instructions

2.2 *U.S. Code of Federal Regulations (CFR)*:³

29 CFR 1910 Occupational safety and health standards

21 CFR 890.3480 Powered lower extremity exoskeleton

2.3 *Other Standards*:

ISO/IEC Guide 37:2012 Instructions for use of products by consumers⁴

ISO 01.110 Technical product documentation including rules for preparation of user guides, manuals, product specifications, etc.⁴

3. Terminology

3.1 *Definitions*—See Terminology F3323 for latest definitions:

3.1.1 *exoskeleton, n*—wearable device that augments, enables, assists, or enhances, or combinations thereof, physical activity through mechanical interaction with the body.

3.1.2 *organization, n*—depending upon the application and user community, the entity deploying exoskeleton technology.

4. Significance and Use

4.1 This practice establishes the minimum training criteria for exoskeleton users.

4.2 This practice does not supersede any established laws or regulations of international, national, federal, state, tribal, local, or regional governments.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, <http://www.access.gpo.gov>.

⁴ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

¹ This practice is under the jurisdiction of ASTM Committee F48 on Exoskeletons and Exosuits and is the direct responsibility of Subcommittee F48.02 on Human Factors and Ergonomics.

Current edition approved June 1, 2020. Published June 2020. DOI: 10.1520/F3444_F3444M-20.

4.3 A commonly used training practice is for a competent, qualified, or certified trainer to provide to the student with written, visual, and verbal training materials that elementally breakdown the intended subject matter into a series of achievable modules. The trainer describes and demonstrates each module, and then interactively has the exoskeleton student user repeat and demonstrate specified knowledge, skills, and abilities to verify and validate the complete transfer of that knowledge, skills, and abilities.

4.4 This practice by itself is not a training document. It is an outline of the topics required for training or evaluating exoskeleton users for competence, proficiency, certification, or license.

4.5 The knowledge, skills, and abilities presented in the following sections are not in any particular order and do not represent a training sequence.

5. General Exoskeleton User Training

5.1 An exoskeleton user should be trained to perform the following basic skills:

- 5.1.1 Donning and doffing the exoskeleton in a normal situation and in emergency situations;
- 5.1.2 Proper fitting adjustments;
- 5.1.3 Routine inspection, repairs, cleaning, decontamination, sanitation, and maintenance following manufacturer's instruction. See Practice F3392 for further guidance;
- 5.1.4 How to turn on/off, charge, swap power sources, switch settings, and modes, and all other settings necessary and applicable for safe routine use;

NOTE 2—During the exoskeleton set-up ensure that users and system operators take the same precautions they would for any computer based system. They should be aware and looking out for malicious attachments, phishing e-mails, spoofing; do not plug in unknown disks to machines, proper authentication practices, and understand the minimum requirements for expected connections and interactions, as applicable, in normal use and how a user may be able to test these or report anomalous behavior.

- 5.1.5 Identification of safe environments for use;
- 5.1.6 Use of all safety features of the device; and
- 5.1.7 Ability to safely don and navigate through the planned use environment.

5.2 After training, an exoskeleton user or licensed operator should be competent and be able to explain or demonstrate, or both, as it relates to the intended use of the exoskeleton, the following:

- 5.2.1 The known limitations of mobility, movement, and range of motion;
- 5.2.2 The load safety limits;
- 5.2.3 Utilization around other people;
- 5.2.4 Appropriate duration of exoskeleton usage;
- 5.2.5 Recommended acclimation process and period of usage;
- 5.2.6 Under what conditions should the user stop using the exoskeleton;
- 5.2.7 What inspection, repair, cleaning, decontamination, sanitation, and maintenance should be performed by the user or operator, or both, and when. See Practice F3392 for further guidance;

5.2.8 What should the user or anyone assisting, or both, do in an emergency situation;

5.2.9 How should the exoskeleton be stored;

5.2.10 What clothing or PPE, or both, should be worn with the exoskeleton;

5.2.11 How to report problems, adverse events, wear/tear, and potential hazards; and

5.2.12 Cleaning, decontamination, and sanitation of the exoskeleton after use and prior to storage.

5.3 After training and explaining, an exoskeleton user should demonstrate the ability to safely do the following:

5.3.1 Assemble the device in all available configurations, and verify the exoskeleton is in the proper configuration for its intended use;

5.3.2 Don and doff the exoskeleton in both routine and emergency situations;

5.3.3 Adjust the exoskeleton so that it is properly fitted, if necessary, with or without the assistance of another person;

5.3.4 Doff the exoskeleton with human assistance, if appropriate and necessary;

5.3.5 Move in a manner that is safe and appropriate for their intended use environment;

5.3.6 Perform a representative set of activities that the exoskeleton is intended to be used for;

5.3.7 Inspect and identify needed repairs, cleaning, decontamination, sanitation, or maintenance, or combinations thereof, following manufacturer instructions; and

5.3.8 Utilize the controls to turn on/off the exoskeleton, charge, swap power sources, switch modes, or similar activities necessary to perform their intended activities while wearing the exoskeleton.

6. General Non-User Exoskeleton Training

6.1 If individuals other than the exoskeleton user, such as a medical doctor, therapist, clinician, companion or assistant, or combinations thereof, is needed for safe and effective use of the exoskeleton, these individuals should be able to explain or demonstrate, or both, the ability to do the following:

6.1.1 Identify that an exoskeleton user is an appropriate candidate based on known or demonstrated, or both, physical or cognitive limitations;

6.1.2 Identify safe environments of use;

6.1.3 Assemble the device in all available configurations;

6.1.4 Effectively assist in donning and doffing of the exoskeleton on the user;

6.1.5 Effectively assist with fitting the exoskeleton to the user;

6.1.6 Effectively program the device to operate at all modes;

6.1.7 Describe when each mode should be used if the individual responsible for or assists in operation of the exoskeleton;

6.1.8 Use of all safety features that are within their control;

6.1.9 Proper cleaning, decontamination, sanitation, and maintenance of the exoskeleton;

6.1.10 Proper storage of the exoskeleton.