Designation: F3614 – 22

Standard Practice for Recording the Exoskeleton User Information[1]

This standard is issued under the fixed designation F3614; 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 describes a means to record the exoskeleton user information when testing. The practice provides a method for recording exoskeleton user: general information, measurements, activity level, experience with exoskeletons, prior injuries, and other pertinent information that may impact exoskeleton testing.

1.2 This practice is intended to be used with other exoskeleton test methods and practices to provide a clear representation of the exoskeleton user being tested; provides a basis for comparison of the test circumstances across different exoskeletons, users, tests, or all three; and allows a test to be recreated.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are not precise mathematical conversions to imperial units. They are close approximate equivalents for the purpose of specifying exoskeleton characteristics while maintaining repeatability and reproducibility of the test method results. These values given in parentheses are provided for information only and are not considered standard.

1.4 *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.*

1.5 *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]

D5219 Terminology Relating to Body Dimensions for Apparel Sizing

D6240/D6240M Tables of Body Measurements for Mature Men, ages 35 and older, Sizes Thirty-Four to Fifty-Two (34 to 52) Short, Regular, and Tall

D6960/D6960M Tables for Body Measurements for Plus Women's Figure Type, Size Range 14W – 40W

D7878/D7878M Tables for Body Measurements for Adult Female Misses Petite Figure Type, Size Range 00P – 20P (Withdrawn 2022)[3]

D8077/D8077M Tables for Body Measurements for Mature Big Men Type, Size Range 46–64

D8241/D8241M Tables of Body Measurements for Young Men Type, Size Range 32 – 48

E3003 Practice for Body Armor Wearer Measurement and Fitting of Armor

F1731 Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing

F3323 Terminology for Exoskeletons and Exosuits

F3613 Practice for Recording the Exoskeleton Fit to the User

2.2 *ISO Standards:*[4]

ISO 7250-1 Basic human body measurements for technological design–Part 1: Body measurement definitions and landmarks

ISO 15537 Principles for selecting and using test persons for testing anthropometric aspects of industrial products and designs

[1] This practice is under the jurisdiction of ASTM Committee F48 on Exoskeletons and Exosuits and is the direct responsibility of Subcommittee F48.03 on Task Performance and Environmental Considerations.

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[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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

3. Terminology

3.1 Terms used within this practice refer to Terminology F3323 and Terminology D5219.

4. Summary of Practice

4.1 This practice describes a method for recording the exoskeleton user information when performing tests described in exoskeleton test methods. Considering the variability of users, fitting users to exoskeletons and performing exoskeleton tests requires knowledge of the user, including many parameters. For example: gender; size; shape; head, limb and trunk sizes; user activities; exoskeleton and task experience; prior surgeries and pains. User variability can therefore cause varying exoskeleton performance, for example:

4.1.1 Users at the upper or lower size limits of the exoskeleton manufacturer specification may have different performance than users more centered on the specification; or

4.1.2 A rectangular-shaped user may have different exoskeleton fit than a pear- or triangle-shaped user (see Fig. 1). Not following the manufacturer-suggested exoskeleton component alignment to the body can cause user instability, lower than expected exoskeleton performance, or other unexpected test results.

4.1.3 A user that performs moderate-to-high daily activity may have different exoskeleton performance than a user who performs low daily activity.

4.2 This practice also provides a standard method to report the exoskeleton user information, which allows comparison of exoskeleton test results among various users when considering similar user parameters.

4.3 This practice does not consider the exoskeleton fit to the user nor the hardware and software configuration of the exoskeleton. These are also two important exoskeleton safety and performance areas that are currently being developed in Practice F3613 and the Practice for Recording the Exoskeleton Test Configuration,[5] respectively.

[5] Standard designation for this practice is to be added after the standard is approved and published.

5. Significance and Use

5.1 The significance of the information to be recorded in a test report allows for exoskeleton safety and performance to be contextualized with the exoskeleton user. Exoskeleton test results can be compared across users to determine exoskeleton usefulness, exoskeleton capability for particular users or groups of users, and standardized reporting of user information allows organizations to better replicate tests.

5.2 Limitations of the practice are that not all exoskeletons can or have the same fit to all users and therefore may change the exoskeleton capabilities. For example, as users vary in size, shape, gender, etc., an exoskeleton that fits one user may allow an increase or decrease in torque applied to the arms, legs, etc. as compared to another user, especially users at the upper and lower limits of manufacturer-suggested exoskeleton sizing. Another example is that prior surgeries or pain may affect measured exoskeleton performance as the user may, for example, favor use of one limb to another or may move different when tested with the exoskeleton versus without the exoskeleton.

5.3 Additional user measurement information may be found in the following references:

NOTE 1—The measurements in these references may not consider measurements of the user when dressed in appropriate clothing (for example, shoes – see 6.3.12 – 6.3.14) that will be worn when using an exoskeleton.

5.3.1 2012 Anthropometric Survey (ANSUR II[6]) of U.S. Army Personnel: Methods and Summary Statistics,

5.3.2 United States Air Force Research Laboratory Civilian American and European Surface Anthropometry Resource (CAESAR[7]) Final Report,

5.3.3 Tables D6240/D6240M,

[6] Gordon, Claire C.; Blackwell, Cynthia L.; Bradtmiller, Bruce; Parham, Joseph L.; et. al. "2012 Anthropometric Survey of U.S. Army Personnel: Methods and Summary Statistics," *Technical Report NATICK/TR-15/007*, U.S. Army Natick Research, Development and Engineering Center, December 2014.

[7] Kathleen M. Robinette, et. al., *United States Air Force Research Laboratory Civilian American and European Surface Anthropometry Resource (CAESAR) Final Report*, Volume I: SUMMARY AFRL-HE-WP-TR-2002-0169.

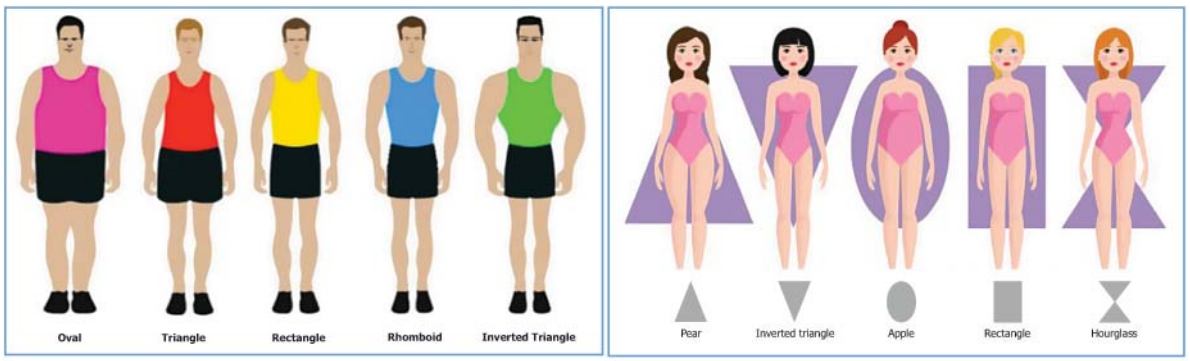

FIG. 1 Body Shapes for (a) Men and (b) Women