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Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing[1]

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INTRODUCTION

The selection of proper uniform size is important to fit and appearance for all users, but more importantly, it relates directly to garment function. In certain occupations, such as fire and rescue services, proper fit and function relates directly to the individual's ability to perform jobs that are often hazardous. Issues of proper fit are directly associated with the risk of injury. A work uniform that restricts movement or exposes the skin to hazardous environments will result in lost efficiency and may promote injury and illness. Proper sizing is a factor in the ability of a person to perform tasks that often involve life or death situations. A work uniform must also fit well to function properly when additional outer protective garments and safety equipment are worn.

This practice establishes a standard method for measuring body dimensions pertinent to the determination of a garment size which provides good fit. It also presents issues critical to garment size selection as it relates to fit. Functional methods are provided for determining proper fit of a uniform. Information is provided on garment shrinkage which results from the clothing being laundered. Maternity wear and unique sizing issues are addressed.

1. Scope

1.1 This practice is intended to assist in size selection of work uniforms for fire and rescue services personnel and workers who may be exposed to thermal hazards. Work uniform ensembles consist of a shirt and trouser apparel combination.

1.2 This practice is applicable to uniforms for both male and female personnel.

1.3 This practice provides a standard means for measuring human body dimensions for the selection and ordering shirts and trousers.

1.4 This practice provides a means for evaluating the fit of selected uniform sizes.

1.5 This practice provides a standard list of textile and apparel terminology specific to the clothing industry which is used in determining size and fit of garments. This vocabulary will be useful in communications between buyers and sellers.

1.6 The values stated in SI units are to be regarded as standard. The inch-pound equivalents given in parentheses are for information only and may be approximate.

1.7 This standard is not intended for use in evaluating the fire resistive performance or durability of work uniforms. In addition, this practice does not provide a means to quantify the likelihood of human injuries that may be related to the fit of uniforms or protective clothing.

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.* Specific precautionary statements are given in Note 1.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 123 Terminology Relating to Textiles

D 5219 Terminology Relating to Body Dimensions for Apparel Sizing

F 1154 Practice for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical-Protective Suit Ensembles

2.2 *AATCC Standards:*

AATCC 96 Dimensional Changes in Laundering of Woven and Knitted Textiles Except Wool[3]

AATCC 135 Dimensional Changes in Automatic Home

[1] This practice is under the jurisdiction of ASTM Committee F23 on Protective Clothing and is the direct responsibility of Subcommittee F23.60 on Human Factors.

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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] Available from American Association of Textile Chemists and Colorists, PO Box 12215 Research Triangle Park, NC 27709.

Laundering of Woven and Knit Fabrics[3]
AATCC 158 Dimensional Changes in Dry-Cleaning in Perchloroethylene: Machine Method[3]
2.3 *NFPA Standards:*
NFPA 1975 Standard on Station/Work Uniforms for Fire Fighters[4]
NFPA 1977 Standard on Protective Clothing and Equipment for Wildland Fire Fighting[4]

3. Terminology

3.1 *Definitions:* Definitions are provided to assist the user in understanding the language of human body measurements. In addition, other definitions have been added that are used by the apparel industry to identify garment designs, patterns and issues of fit.

3.1.1 *armhole*, *n—in garments construction*, the area of a garment through which the arm passes or into which a sleeve is fitted. (See **armscye**.)

3.1.2 *armscye*, *n—in garment construction*, the opening in a garment for the attachment of a fitted sleeve. (See **armhole**.)

3.1.3 *back waist length*, *n—in body measurements*, the vertical distance along the spine from the cervical to the waist.

3.1.4 *bartack*, *n—in garment construction*, a reinforcement at points of strain.

3.1.4.1 *Discussion*—This reinforcement point may consist of a bar-shaped line of small threads worked across several threads.

3.1.5 *body dimension*, *n—in garment construction*, a body measurement which can be used to build a sizing system or to select an appropriately sized garment.

3.1.6 *body measurement*, *n—in anthropometry*, a standardized distance between two specified points on the human anatomy.

3.1.7 *bust girth*, *n—in body measurements*, the circumference of the body over the fullest part of the breasts and parallel to the floor. (See **chest girth**.)

3.1.8 *cervical*, *n—in body measurements*, the most prominent bone at the base of the neck.

3.1.9 *chest*, *n—in garment construction*, a measurement taken from below each armhole seam straight across the garment while it is laid flat.

3.1.10 *chest girth*, *n—in body measurements*, the circumference of the body over the shoulder blades, under the arms and across the upper chest. (See **bust girth**.)

3.1.10.1 *Discussion*—A circumference measurement made around the fullest part of the chest keeping the tape parallel to the floor.

3.1.11 *crotch*, *n—in anatomy*, the body area adjacent to the vertex of the included angle between the legs.

3.1.12 *cuff*, *n—in garment construction*, a finished edge at the end of either a garment sleeve or trouser leg created by turning back or rolling up and stitching the fabric.

3.1.12.1 *Discussion*—Long sleeve shirts usually have an extended cuff which is a band of fabric stitched to the lower edge of the sleeve. The most common long sleeve shirt cuff is the barrel cuff which is a straight cuff stitched to form an open-band that laps and buttons at the wrist. A trouser leg cuff is formed by producing a deep hem which may require over 100 mm (4 in.) of fabric. Simple hems may also be used to finish trouser legs. (See **hem**.)

3.1.13 *ease*, *n—in garment construction*, the difference between garment measurement and body measurement.

3.1.13.1 *Discussion*—There are primarily two types of ease, wearing ease and design ease. Wearing or comfort ease, which allows for body flexing and movement, depends on a garment's standard for fit. Wearing ease relates to fit of a garment that does not impede the wearer from performing any function that requires dynamic movement. The amount of material added to a garment that exceeds human body measurements, to make garments more comfortable and to allow for human mobility. Design or style ease includes, in addition to wearing ease, what is built into a style to provide the look the designer wants.

3.1.14 *elbow*, *n—in anatomy*, the joint that articulates between the upper arm and the lower arm.

3.1.15 *fabric*, *n—in textiles*, a planar structure consisting of yarns or fibers.

3.1.16 *fit*, *n*—the quality, state or manner in which the length and closeness of clothing, when worn, relates to the human body.

3.1.17 *garment*, *n*—an article of clothing used to cover the body.

3.1.18 *girth*, *n—in body measurements*, a circumferential measurement around some part of the body, such as neck, chest, waist, etc.

3.1.19 *hem*, *n—in garment construction*, a simple finish in which the raw fabric edge is turned under and stitched to a garment. (See **cuff**.)

3.1.20 *hip*, *n—in anatomy*, the laterally projecting region formed by the lateral parts of the pelvis and the upper part of the femur together with the flesh covering them.

3.1.21 *hip girth*, *n—in body measurements*, the maximum circumference of the body at the level of maximum prominence of the buttocks.

3.1.22 *inseam*, *n—in garment construction*, with the trousers folded by mating the inside leg seams, measure from center of crotch to bottom edge of trouser's leg or cuff.

3.1.23 *inseam length*, *n—in body measurements*, from center of crotch to 25.4 mm (1 in.) below top of the shoe.

3.1.24 *knee*, *n—in anatomy*, the joint between the lower and upper leg.

3.1.25 *maternity wear*, *n*—clothing worn during pregnancy.

3.1.26 *neck base girth*, *n—in body measurements*, the circumference of the neck over the cervical at the back and at the top of the collar bone at the front.

3.1.27 *neck girth*, *n—in garment construction*, with shirt open in front and collar fully extended and laid out flat, measure from center of collar button to the far end of the button hole.

3.1.28 *placket*, *n—in garment construction*, a finished garment opening that is usually dependent on mechanical devices called closures to secure the opening.

[4] Available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269-9101.

3.1.28.1 *Discussion*—In shirt construction, a placket usually forms the front opening that may extend from the collar band's lower edge to the bottom edge of the shirt's hem. When the shirt is worn, the placket is generally overlapped and fastened by buttons. Plackets are normally designed into garments to make them easy to don. Fasteners used in placket closures are buttons, button holes, zippers, hooks, snaps, and other devices used to open, close, and secure garments.

3.1.29 *protective clothing*, *n*—an article of clothing used for isolating the human body or parts of the human body from a potential hazard.

3.1.30 *shirt*, *n*—a cloth garment for the upper part of the body made of either woven or knitted fabric usually having sleeves, a neck opening, a front opening and a tail long enough to be tucked inside trousers or skirt.[5]

3.1.31 *shirt back length*, *n—in garment construction*, a measurement centered below the collar band to bottom edge of shirttail.

3.1.32 *shirt front length*, *n—in garment construction*, a measurement from the placket top, below the collar band to the bottom edge of the shirt's hem in front.

3.1.33 *shirt sides*, *n—in garment construction*, a measurement of length from below armhole to the bottom hem.

3.1.34 *shrinkage*, *n*—a decrease in one or more dimensions of an object or material.

3.1.35 *shrink*, *vt*—to cause to contract, to compact cloth by causing to contract when subjected to washing, boiling, steaming or other processes.[5]

3.1.36 *size*, *n*—one of a series of graduated measurements in manufactured articles of clothing conventionally identified by numbers, letters, or words.

3.1.37 *sleeve length*, *n—in body measurements*, from center of cervical across back and around outside of bent arm, to below wrist bone and above hand.

3.1.38 *sleeve length*, *n—in garment construction*, a measurement from center of shirt's back below collar band along the sleeve to the end of the sleeve or cuff.

3.1.39 *station/work uniform*, *n*—a nonprimary protective clothing ensemble consisting of a shirt and pants that is intended to be worn by members of the fire and rescue services while on duty.

3.1.40 *thigh*, *n—in garment construction*, with trouser leg laid out flat, measure from crotch seam straight across to leg side seam.

3.1.41 *thigh girth*, *n—in body measurements*, the maximum circumference of the upper leg close to the crotch.

3.1.42 *torso*, *n*—the human trunk.[5]

3.1.43 *torso*, *n—in garment construction*, a measurement from center of neck to end of shirttail.

3.1.44 *total crotch length*, *n—in body measurements*, the distance from the waist level at center front through the crotch to the waist level at center back.

3.1.45 *trousers, n, pl*—an outer garment extending from the waist to the ankle covering each leg separately. (Syn. pants.)

3.1.46 *trouser back rise*, *n—in garment construction*, a measurement from the crotch seam to bottom edge of waistband at center of the back.

3.1.47 *trouser front rise*, *n—in garment construction*, a measurement from the crotch seam to the bottom edge of waistband at center front.

3.1.48 *trouser hips*, *n—in garment construction*, the garments circumference measured at the bottom of pockets or bartack on fly.

3.1.49 *trouser waist*, *n—in garment construction*, with trousers folded in half by the crease or mating the leg inseams, measure across waist-band's width and double the measurement.

3.1.50 *waist*, *n—in anatomy*, the part of the body at the location between the lowest rib and hip identified by bending the body to the side.

3.1.51 *waist girth*, *n—in body measurements*, the circumference of the waist immediately below the lowest rib.

3.1.51.1 *Discussion*—Circumference around the body where the trouser waistband would normally be worn.

3.1.52 *wrist*, *n—in anatomy*, the joint which articulates between the end of the lower arm and the hand.

3.1.53 *wrist girth*, *n—in body measurements*, the circumference over the prominence of the inner and outer forearm bones.

3.1.53.1 *Discussion*—Circumference around the largest part of the wrist.

3.2 Other definitions relative to this practice can be found in Terminology D 123 and D 5219.

4. Summary of Practice

4.1 This practice standardizes apparatus for making human body measurements and provides a standardized approach to methods of measuring human body dimensions relevant to the selection of properly sized uniforms. Accurately measured body dimensions are recorded on a standard measurement form which is used by a buyer and seller in the selection of uniform size. Size selection for uniforms to be worn during pregnancy is considered. Issues of fit related to garment ease and laundry induced garment shrinkage are discussed. Recommendations are made relative to the evaluation of garment shrinkage. Potential fit problems are identified by having a consumer don a representative sample uniform and then perform a standardized series of dynamic movements. Uniform size is selected based on an individual's compatible body measurements relative to a garment's dimensions/size and the evaluation of a garment's construction, shrinkage, and its response to fit during the dynamic performance evaluation.

5. Significance and Use

5.1 Sizing is a critical factor that must be considered when selecting and using protective clothing. Properly sized garments add to the safety and performance of wearer by not restricting movement. A work uniform that restricts movement or exposes skin to hazardous environments will result in lost efficiency and may promote injury.

5.2 In those cases where work uniforms become an element of a multi-layered protective ensemble, it is essential that

[5] *Webster's New Collegiate Dictionary*, 1977.

uniform fit does not restrict the wearer's movements or interfere with the fit and use of other safety related clothing and equipment.

5.3 This practice can be used for selecting the proper size and fit of work uniforms for fire and rescue personnel and personnel in other occupations where hazardous thermal exposures may exist.

6. Apparatus

6.1 The following equipment is required for making accurate measurements when using this practice:

6.1.1 *Measuring Tape*—A 1.52 m (60 in.) long flexible tape with metal tips, made from reinforced fiberglass or waterproof oilcloth. It shall be reversible with numbers and markings printed on both sides.

6.1.2 *Measuring Stick*—A 1 m (36 in.) long stainless steel measuring stick with metric (SI), 1 mm, and inch-pound (English), 1/16 in., graduations clearly and accurately marked along its length.

6.1.3 *Full-Length Mirror*, measuring a minimum of 0.6 m (24 in.) wide and 2 m (84 in.) high. The mirror is used by the measurer to confirm the proper placement of the measuring tape on the subject during the measurement process.

6.2 *Calibration*—Each new measuring tape shall be checked for proper length.

6.2.1 This is done by comparing the measuring tape to a standard stainless steel measuring stick which has graduations traceable to the National Institute of Standards and Technology (NIST). This measuring stick shall be maintained solely for checking the calibration of measurement equipment and shall be protected from damage. New measuring tapes that do not meet this basic calibration should be returned to the supplier.

6.2.2 With time and use, measuring tapes may become stretched or shrink. This can result from use or exposure to unusually hot or cold environments. With some tapes, humidity can affect the tapes condition. Measuring tapes shall be evaluated on a regular basis to ensure they have not lost their calibration. Cut, frayed, stretched or shrunken measuring tapes must be discarded. In addition, if the measuring tape's metal end protectors become loose or damaged, the tape must be replaced.

7. Methods for Measuring

7.1 A standard method for measuring critical human dimensions is necessary for the proper sizing of garments. This section provides guidelines for making proper measurements, insight into the cause of measurement errors and a detailed description of measurement techniques.

7.2 *Measurement Skill*—Individuals making sizing measurements must have a complete understanding of this practice, demonstrate their ability to make accurate measurements and demonstrate proper care and maintenance of the required measuring equipment.

7.3 *Measurement Accuracy*—Sizing measurement accuracy requires proficiency in three areas, (*1*) skill of the person doing the measuring, (*2*) condition of the equipment being used for making measurements and (*3*) level of cooperation from the subject being measured. Lack of proficiency in any one of these three areas can lead to significant measurement errors. Reliable measurements can only be made when all of the above variables are controlled. Accurate body measurements cannot be made on oneself. No quantitative results are currently available for measurement accuracy using this practice. Deviations from these measurement techniques may result in improperly sized garments.

7.4 *Conditions for Measuring*:

7.4.1 *Environment*—Maintain the measuring tape and other equipment at a constant temperature. Variations in temperature can cause measuring tapes to shrink or expand. This shrinkage and expansion is predominantly along the tape's length. Sizing measurements shall be made in a 23 ± 3°C (73 ± 5°F) environment.

7.4.2 *Underclothing and Footwear*—The number and type of under garments can significantly influence measurement results. Make measurements for uniforms while the subject is wearing the number and type of undergarments that are to be worn while on the job. Under garments that cause figure bulges or feels tight must not be worn when making body measurements. Midriff, waist, abdomen and thigh measurements can be significantly affected by tight garments. For women, control-top garments or other support garments should not be worn during the measurement process unless they are normally worn on the job.

NOTE 1—**Warning:** Pantyhose or other undergarments constructed of fabrics which are subject to melting upon exposure to heat are not recommended for use with fire and rescue services uniforms or garments which may be exposed to a thermal hazard.

7.4.2.1 Footwear of the type and heel height normally worn in the performance of job duties shall be worn when body measurements are taken. For fire and rescue services personnel, this footwear would be that which is normally worn with a station/work uniform.

7.4.3 *Human Condition*—Avoid making sizing measurements after large meals or when a person is enlarged by digestive gases. Dehydration can cause normal human tissue to shrink. This is particularly noticeable in humans in some arid and winter environments. Illness can also cause dehydration. Tissue shrinkage is particularly noticeable at the wrists and ankles. This can also result in waist measurement errors.

7.4.3.1 Excess, retention of body fluids can also result in body measurement errors. This is often recognized by puffy tissue on the face, hands and ankles.

7.4.3.2 Pregnant women's measurements for bust, waist, hips and thighs change throughout the pregnancy, and they may experience retention of body fluids. Prior to pregnancy measurements shall be used to attain appropriate size.

7.4.4 *Posture*—When taking body measurements, the subject shall be standing in a normal, upright, relaxed position looking forward. The body shall not be turned or bent but shall be exhibiting the normal upright posture of the subject. The subject being measured must breath normally without holding their breath, and they shall not stand in a stiff manner.

7.5 *Standard Form Used For Taking Measurements*—A form for recording human body measurements is provided by this practice to standardize the recording process and to ensure