



# Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing<sup>1</sup>

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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:

D 123 Terminology Relating to Textiles<sup>2</sup>

D 5219 Terminology Relating to Body Dimensions for Apparel Sizing<sup>3</sup>

F 1154 Practice for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical-Protective Suit Ensembles<sup>4</sup>

### 2.2 AATCC Standards:

AATCC 96 Dimensional Changes in Laundering of Woven and Knitted Textiles Except Wool<sup>5</sup>

AATCC 135 Dimensional Changes in Automatic Home

<sup>1</sup> 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. Current edition approved August 10, 1996. Published October 1996.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 07.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 07.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 11.03.

<sup>5</sup> Available from American Association of Textile Chemists and Colorists, PO Box 12215 Research Triangle Park, NC 27709.

Laundering of Woven and Knit Fabrics<sup>5</sup>  
 AATCC 158 Dimensional Changes in Dry-Cleaning in Perchloroethylene: Machine Method<sup>5</sup>

### 2.3 NFPA Standards:

NFPA 1975 Standard on Station/Work Uniforms for Fire Fighters<sup>6</sup>

NFPA 1977 Standard on Protective Clothing and Equipment for Wildland Fire Fighting<sup>6</sup>

## 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.

<sup>6</sup> 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.<sup>7</sup>

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.<sup>7</sup>

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.<sup>7</sup>

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

<sup>7</sup> 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),  $\frac{1}{16}$  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  $23 \pm 3^\circ\text{C}$  ( $73 \pm 5^\circ\text{F}$ ) 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

that all critical body measurements are taken that relate to proper sizing of uniforms. The standard form is shown in Fig. 1.

*7.6 Taking Measurements*—All measurements shall be taken by a person trained in making accurate body measurements. Measurements shall not be done by the person being measured. To obtain accurate dimensions, take all measure-

ments with the measuring tape pulled snug around the subject. Do not compress body tissue by a tight measuring tape. The subject being measured shall stand in front of a full-length mirror while being measured. If it is suspected that a measurement has been done incorrectly, release the measuring tape, check the body position and clothing of the subject, and then remeasure.

**STANDARD MEASUREMENT FORM  
FOR UNIFORM SIZING**

Date: \_\_\_\_\_

Subject's Name: \_\_\_\_\_

Sex, circle one:            **Male**            **Female**

Subject's Organization: \_\_\_\_\_

Work Phone Number: \_\_\_\_\_

Units of Measurement, circle one:            **Metric (mm)**    **English (In.)**

<b>Neck Girth/Collar</b>	_____
<b>Sleeve Length</b>	_____
<b>Upper Arm Girth</b>	_____
<b>Wrist Girth</b>	_____
<b>Chest/Bust Girth</b>	_____
<b>Waist Girth</b>	_____
<b>Back Waist Length</b>	_____
<b>Waist Height</b>	_____
<b>Total Crotch Length</b>	_____
<b>Crotch Height</b>	_____
<b>Inseam</b>	_____
<b>Hip Girth</b>	_____
<b>Thigh Girth</b>	_____

**Special needs and comments:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Measurer's Name:** \_\_\_\_\_

NOTE 1—This form is to be used for recording human body measurements for sizing of work uniforms. Locations for body measurements are shown in Fig. 2. Measurements recorded on this form shall be produced by a person trained in the measurement techniques specified in this practice.

**FIG. 1 Standard Measurement Form**

7.6.1 All measurements shall be immediately recorded on the standard measurement form. See Fig. 1.

7.6.2 *Measuring Techniques for the Human Body*—Locations for all body measurements are shown in Fig. 2.

7.6.3 *Shirt:*

7.6.3.1 *Neck Girth or Collar*—Measure around the neck below the projection in front of the neck formed by the largest cartilage of the larynx. Related garment measurement, collar: On a shirt that fits well, lay the collar flat against a hard surface. Measure from the center of the collar button to the far end of the buttonhole.

7.6.3.2 *Arm or Sleeve Length*—Measure from middle of the back of neck across the shoulder around elbow, bent at 1.57 rad (90°), to wrist bone.

7.6.3.3 *Upper Arm Girth*—With the subjects arms relaxed and at their sides, measure girth horizontally without constriction at a point midway between the shoulder and the elbow.

7.6.3.4 *Wrist Girth*—Measure around the largest dimension of the wrist with the measuring tape snug against the skin.

7.6.3.5 *Chest or Bust Girth*—With the subject's arms relaxed and at their sides, measure around the fullest part of the chest or bust, keeping the tape up under the arms and level across the back, sides and front of the body.

7.6.4 *Trousers:*

7.6.4.1 *Waist Girth*—If the subject is wearing trousers, they are to be opened and loosened at the top to allow for the measure to be made. Measure over underwear and normal work uniform shirt if available. **DO NOT MEASURE OVER TROUSERS.** Measure smallest part or natural waistline keeping the tape level and firm, but not tight. Natural waistline may be determined by having the subject bend at the waist to one or both sides. Observe where the natural bending takes place.

7.6.4.2 *Back Waist Length*—While the subject is standing in a relaxed upright position with both arms down to the sides,

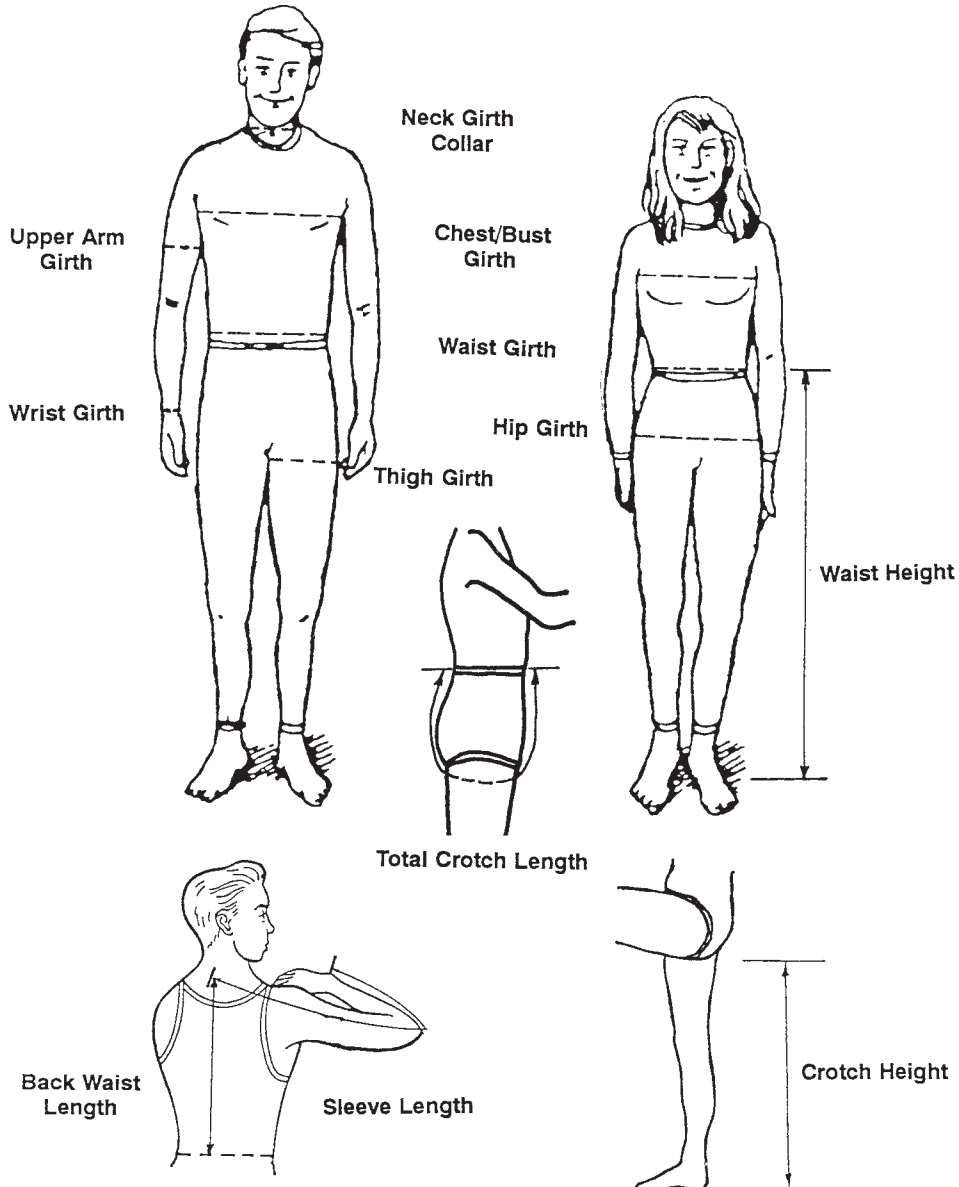


FIG. 2 Body Measurements and Their Locations

measure from middle of the most prominent bone at the base of the neck down the center of the back to the waistline.

7.6.4.3 *Waist Height*—With the subject standing in a relaxed upright position, measure from the waist to the soles of the feet.

7.6.4.4 *Total Crotch Length*—With the subject standing in a relaxed upright position, measure from the waist level at center front through the crotch to the waist level at center back.

7.6.4.5 *Crotch Height*—With the subject standing upright in a relaxed position and one hand holding on to a rail for balance, the subject lifts one leg to a horizontal position to the front. The foot of the raised leg may be placed on a support to assist in maintaining the proper position. With the measuring tape pressed firmly against the lower edge of the buttock, measure to the sole of the foot on the standing leg.

7.6.4.6 *Inseam (the Garment Measurement Related to Crotch Height)*—If a subject has a pair of trousers that provides a functional leg length, this measurement may be used to specify length for new garments. Inseam is measured using the following technique: Take a pair of trousers that fit well and provides appropriate ease, fold the trouser legs together by mating the inside leg seams, lay trousers out straight, flat and smooth on a flat surface with one outside leg seam against the flat surface and the other outside leg seam facing up. Fold the upper leg back and measure flat leg from center of crotch, at the inside seam, down to bottom edge of trouser leg or cuff.

7.6.4.7 *Hip Girth*—Measure around the fullest part of the hips keeping the measuring tape level and snug to the body but not tight.

7.6.4.8 *Thigh Girth*—Measure horizontally around the fullest part of the thigh.

## 8. Garment Performance Characteristics

8.1 Performance of protective clothing is critical to the success of personnel during the execution of their jobs. Sizing and fit are basic to the interaction between a garment and the worker during the performance of a task. Other factors critical to performance are garment style and construction, closures and fasteners, and the fabrics and threads used to make a garment. Each of these factors related directly to the basic qualities of fit and performance.

8.2 *Garment Ease and Performance*—Ease is an important consideration in the performance of any work clothing. Because humans must move in their clothing, dimensions of apparel designs must exceed actual human body measurements and include ease. Functional design is generally achieved by incorporating special stretch materials or extra material in areas of movable body parts. Human mobility involves expansion and compression of garment parts where the body bends. Design features such as pleats, tucks, gathers and flair are methods which provide extra material needed for accommodating mobility. Gussets are extra material sections sewn in garment areas to obtain maximum expansion comfort during human movement. Garment features such as slits or openings also allow the body to expand past clothing dimensions. It is difficult to specify standard amounts of ease. The amount of ease needed in a garment depends on the accumulation of motions required for tasks the garment wearer must accomplish. Too much ease restricts material compression in acute

angles formed during bending movements. Greater ease is needed for human bodies that are heavy or muscular, or both, because muscles in motion take up more room. The more a body part bends or twists during a task, the more ease is needed in a garment to cover the expansion. Greater garment ease for maternity wear in the bust, waist, hips and thighs must be considered to allow for morphological changes produced in personnel during rapid fetal growth.

8.3 *Garment Shrinkage*—The potential for shrinkage in protective clothing is dependent upon several factors including fiber content, fabric structure, tensions placed on the fabric during manufacturing or garment construction, and the type of end use cleaning. Shrinkage is most apparent after cleaning processes such as laundering. Fabrics that have not been preshrunk prior to garment construction may develop changes in dimensions that make the garment unsuitable for use.

NOTE 2—Because some woven fabrics will shrink 3.5 % in length and width after being laundered several times a change in fit will occur. For example, shrinkage of 3.5 % for a size 40 waist will result in a loss of 36 mm (1.4 in.).

8.3.1 Because of an ability to stretch when worn, knitted fabrics can generally tolerate shrinkage values of up to 10 %. The acceptable amount of shrinkage may be affected by the design of the work uniform, especially in those instances when a high amount of ease has been incorporated into the uniform style.

8.3.2 The potential for shrinkage is an important consideration in specifying care procedures for protective clothing. It is the responsibility of the manufacturer to provide reasonable basic care instructions for protective clothing. In addition, the garment manufacturer shall provide the user with information on laundry related shrinkage for the fabric and style of garments being purchased. To maintain the implied warranty of a care label, it is the responsibility of the uniform wearer to follow those care instructions.

8.3.3 Depending on garment care instructions, laundering may be either machine wash, using water and detergent, or dry cleaning. Shrinkage evaluations for laundering may use either home washing and drying machines or commercial washing and drying machines. Garments tend to shrink more when subjected to cleaning by commercial laundry machines than to home laundering.

8.3.4 If uniforms are to be cleaned by a commercial laundry, the garment manufacturer shall be notified upon ordering so that potential additional allowances may be made for shrinkage.

8.3.5 The amount of shrinkage in a uniform is determined by measuring a garment's dimensions before laundering and then measuring again after multiple laundry wash and dry cycles. Garments shrink most during the initial washing and drying cycles, and the shrinkage rate gradually slows with additional washing and drying exposures. For users that require a detailed evaluation of laundry-related garment-shrinkage for a selected uniform style and fabric, see recommendations in the appendix. Discuss the shrinkage requirements and evaluation method with the garment manufacturer.

8.3.6 As a standard practice before uniform procurement, the purchaser and supplier should agree to written terms that



clearly define the amount of shrinkage allowed for the garments being purchased.

8.4 *Fit of Thermal Protective Clothing*—Work uniforms must fit while performing a wide variety of tasks. The following body motions provide a basic means for assessing fit of uniform components. Rigorous exercises are required to access the fit of fire and rescue services and other thermal protective work uniforms which are expected to be used under demanding conditions.

NOTE 3—In shirts, armhole or armhole size may be important where individuals possess a large muscle mass at the biceps. Improper armhole sizing may result in a fit which significantly restricts movement.

8.4.1 *Shirt*—Raise arms to the sides of the body to shoulder height, extending fully away from body, cross arms fully across the chest. Upper back of shirt should not be so tight that it either tears, feels uncomfortable, or restricts movement.

8.4.2 Fully extend one arm to the side and above the head, bend torso toward opposite side (left arm up, bend torso to right side) until ribs are stretched. Shirt should not come out of trousers. Evaluate for other side of shirt by repeating range of motions on the opposite side of body.

8.4.3 Relax both arms at side. Shirt sleeve should neither extend beyond the junction of the thumb to hand nor rest above wrist bone.

8.4.4 Raise arms to the sides of the body to shoulder height, extending fully away from body. Reach with arms towards back, arch back moving chest forward. Shirt should not gap or pull uncomfortably across center opening.

8.4.5 Standing upright and relaxed, all front buttons should close without pulling or causing the shirttail to ride up.

8.5 *Trousers*—In a relaxed stance with feet about 300 mm (12 in.) apart. Pants legs should fall between the top of the ankle bone and 40 mm (1.5 in.) above the floor while wearing work shoes.

8.5.1 Fully squat without first gathering pants up at each thigh. A 50 mm (2 in.) support may be placed under heels to provide stability. Pants should allow this movement across the seat, through the thighs and knees with comfort and ease of movement.

8.5.2 When standing in a natural relaxed position, waistband should be comfortable and still allow for expansion of girth due to eating, or other natural causes as well as additional underclothing and shirttails.

8.6 *Other Fit and Function Tests*—One test which may be useful in evaluating fit of a thermal protective clothing ensemble is Procedure B in Practice F 1154. This procedure may be used in the evaluation of ease, flexibility, and dynamic functionality.

## 9. Considerations for Size Selection

9.1 Fit of a thermal protective clothing ensemble may vary as a result of several different factors. The factors discussed above for ease, shrinkage and dynamic performance are primary to the selection of garment size. Other factors must also be taken into consideration when selecting sizes and ordering uniforms:

9.1.1 Different manufacturers produce garments from their own patterns. As a result, their garments will generally have a unique fit, even though they may use the same methods as other manufacturers for classifying their garment sizes.

9.1.2 Manufacturers generally produce several different styles or cuts of a single class of garment. These differences in style or cut typically result in garments having a different fit.

9.1.3 Because manufacturers produce different styles of the same garment class, it gives the purchaser an opportunity to select styles based on personal or organizational preference. Changing of uniform style must be done with caution, since fit will often be affected.

9.1.4 The type of fabric used in a garment will often influence size selection and fit. Some fabrics provide more freedom of movement than others. Fabrics also possess a quality of softness which relates to fit and comfort. Knit fabrics offer more give, but woven fabrics require that ease be incorporated into the design and size.

9.1.5 Where work uniforms are constructed from fabrics that provide some minimum level of protection from heat or flame, fit can be affected. Ease in these uniforms is generally accomplished through pattern modifications which allow for body expansion and compression.

9.1.5.1 Tight fitting protective clothing usually reduces the level of thermal protection.

9.1.6 Special uniform sizes may be obtained from most manufacturers.

## 10. Special Considerations

10.1 At times, individuals may require work uniforms with a special fit or construction. In these cases, the standard measurement form, referenced in 7.5 and shown in Fig. 1, has a section entitled “Special Needs”. This space is used to identify unique sizing and fit issues. The following are example cases where special needs are addressed: unique differences in body or appendage dimensions, changes due to pregnancy, or cases where an individual is recovering from an injury and requires special clothing. When an individual is determined to have a special need in sizing and fit, detailed information must be obtained for manufacturers to respond. Under these circumstances, it would be desirable to work closely with the manufacturer to attain the necessary garments and proper fit.

## 11. Using the Standard Measurement Form for Ordering Uniforms

11.1 The standard measurement form is used for placing orders with manufacturers of work uniforms. A copy of this form is maintained by the employee’s purchasing agency. An additional copy is given to the subject being measured. Copies may be provided to the manufacturer when special needs exist or a special order is placed.

## 12. Keywords

12.1 body measurements; fire and rescue services; garments; protective clothing; sizing; thermal hazard; uniforms



**APPENDIX**
**(Nonmandatory Information)**
**X1. RECOMMENDATIONS FOR EVALUATING GARMENT SHRINKAGE**

X1.1 This appendix covers a listing of options that may be used to evaluate shrinkage of garments. Shrinkage will vary with the type of wash and dry cycles chosen, the garment fabric, and style of garment. It is recommended that woven fabrics shrink no more than 3 %, knit shirt fabrics should shrink no more than 8 % and knit sweatshirts shrink no more than 10 %.

X1.2 Laundering or cleaning conditions used to determine shrinkage should be representative of the actual laundering or cleaning procedures recommended for the garment. The type of wash and drying cycles used will influence the amount of shrinkage experienced in a garment. Generally, garments shrink more with longer wash and dry cycles, and shrinkage will generally increase as dryer volume and temperatures increase. Shrinkage is greatest in garments during the first five wash and dry cycles, and the rate of shrinkage decreases as additional wash and dry cycles are experienced. If a shrinkage evaluation is to be conducted, one of the following standard test procedures may be used. Footnotes 5 and 6 provide addresses for obtaining copies of the standards.

X1.2.1 *Shrinkage Determination Using Home Laundry Procedures:*

X1.2.1.1 *AATCC 135, Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics*—This practice offers several different home laundry wash and dry options to choose from. In addition, the number of washing and drying cycles are left to the discretion of the parties requesting the shrinkage evaluation.

X1.2.2 *Shrinkage Determination Using a Combination of Home and Commercial Laundry Procedures:*

X1.2.2.1 *AATCC 96, Dimensional Changes in Laundering of Woven and Knitted Textiles Except Wool*—This test method is intended for determining the dimensional changes in clothing subjected to laundering procedures commonly used in the commercial laundry and the home. Several washing, drying

and garment restoration procedures are available for conducting a shrinkage evaluation.

X1.2.3 *Shrinkage Determination Using Commercial or Industrial Laundry Procedures*—Currently, there is no standard test procedure in North America that evaluates garment shrinkage or dimensional changes after being washed, using water and detergents, in commercial or industrial laundry machines. The only procedure that approximates a wash shrinkage procedure using an industrial laundry machine and industrial dryer is that found in NFPA 1975.

X1.2.3.1 *NFPA 1975, Standard on Station/Work Uniforms for Fire Fighters*—Garment specimens that are designated by the manufacturer on the product label to be machine washed shall be subjected to ten cycles of washing and drying using the washing and drying cycles and industrial laundry machines specified in the standard. This method shall use the garment specimen conditioning, marking, measuring and restoration procedures specified in AATCC 135.

X1.2.4 *Shrinkage Determination Using Dry Cleaning Procedures:*

X1.2.4.1 *AATCC 158, Dimensional Changes in Dry-Cleaning in Perchloroethylene: Machine Method*—This practice may be used for work uniform garments that are designated by the manufacturer on the product label to receive commercial dry-cleaning.

X1.3 In all of the shrinkage test procedures listed above, the percent shrinkage is calculated to the nearest 0.1 % using Eq X1.1:

$$S = 100 (A - B)/A \quad (X1.1)$$

where:

$S$  = shrinkage, %,

$A$  = initial measurement, and

$B$  = final measurement.

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