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Standard Guide for Personal Protective Equipment for the Handling of Flat Glass[1]

This standard is issued under the fixed designation E2875/E2875M; 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 guide covers the minimum requirements for proper personal protective equipment (PPE) for the safe handling of flat glass.

1.2 *Purpose*—When engineering, administrative, and work practice controls are not feasible, the remaining hazard must be controlled with personal protective equipment (PPE). This guide will provide direction on what PPE should be utilized. Following this guidance will help to minimize the possibility or severity of injuries, or both, to personnel while working with or in the vicinity of flat glass.

1.3 Nothing in this guide shall be interpreted as requiring any action that violates any statute or requirement of any federal, state, or other regulatory agency.

1.4 This guide may be used by employers and employees. The required PPE shall be evaluated on a regular basis to determine suitability.

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 nonconformance 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]

C162 Terminology of Glass and Glass Products

E1542 Terminology Relating to Occupational Health and Safety

F1494 Terminology Relating to Protective Clothing

F1790 Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing with CPP Test Equipment

2.2 *Other Standards:*

ANSI/ISEA 105 American National Standard for Hand Protection Selection Criteria[3]

EN 388 Protective Gloves Giving Protection from Mechanical Risks[4]

3. Terminology

3.1 *Definitions*—For additional definitions and terms relating to this guide, please refer to Terminologies C162, E1542, and F1494.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flat glass, n*—general term covering glass in its annealed state, such as sheet glass, lite of glass, float glass, various forms of rolled glass, and raw products derived from glass.

3.2.1.1 *Discussion*—This definition is not intended to apply to heat-tempered or laminated glass products. With heat-tempered or laminated glass products, defer to your local risk assessment.

3.2.2 *lite, n*—another term for a pane or piece of glass. Sometimes spelled "light" in the industry literature, but spelled "lite" in this text to avoid confusion with light as in "visible light."

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[1] This guide is under the jurisdiction of ASTM Committee E34 on Occupational Health and Safety and is the direct responsibility of Subcommittee E34.10 on Industrial Safety.

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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 the International Safety Equipment Association, 1901 N. Moore St., Arlington, VA 22209-1762.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

4. Significance and Use

4.1 The goal of this guide is to aid in the selection of PPE for the handling of glass that will best protect the affected employee from the remaining hazards identified in the local hazard assessment process.

4.2 This guide assumes that a proper hazard assessment has been conducted, the hazards have been mitigated to the greatest extent possible by non-PPE means (engineering, administrative, or work practice controls), and a hazard still exists that can only feasibly be controlled by the use of PPE.

5. Level of Cut Protection

5.1 Cut-resistant clothing (gloves and body protection) is evaluated primarily by two standards: Test Method F1790 and EN 388.

NOTE 1—The two standards are not interchangeable and need to be distinguished as to their unique testing outcomes.

NOTE 2—Cut ratings are a starting point for selecting the proper PPE. In general terms, a higher cut level means better cut protection, but that is not always the case. There will be some tasks where a "thicker" material with a lower level of cut protection may actually protect better than a "thinner" material with a higher level of cut protection. Introducing a change (process, job, equipment, etc.) or new PPE for a task should include the proper assessment and trials to ensure the garment does indeed get the desired result.

5.2 In Test Method F1790, cut-resistant material is evaluated. The process of evaluation or cut protection performance test (CPPT) involves the amount of pressure or gram weight applied to a razor blade while moving the blade over the fabric without cutting through for at least 20 mm [0.8 in.]. The higher the load in gram weight applied to the blade without cut-through for the prescribed distance of travel, the better the cut resistance of the fabric. This result is termed the cut or rating force of the fabric. Test Method F1790 cut or rating force levels are listed in Table 1.

5.3 In EN 388 or the Couptest, cut-resistant material is evaluated. The process of the evaluation involves a constant weight on a circular blade that is moved back and forth across a test specimen by the test machine. The machine (Couptest) also rotates the blade against the direction that it is being moved, which intensifies the slicing action. The test indicates how many repetitive cuts on the same position are needed to cut through. The result of the test is termed the cut index, which informs of how much better the sample resists cut as compared to a reference cotton fabric. A performance level for the material is ranked from 0 to 5. The higher the number of cycles needed to cut through the material, the greater the cut resistance of the fabric. The EN 388 cut index levels are listed in Table 2.

TABLE 1 ANSI/ISEA 105 Cut Performance Levels

Performance	Weight in Grams[A]
0	0–199
1	200–499
2	500–999
3	1000–1499
4	1500–3499
5	3500–

[A] 1 g = 0.035 oz.

TABLE 2 EN 388 Cut Performance Levels

Performance	Average Cut Index
1	1.2–2.4
2	2.5–4.9
3	5.0–9.9
4	10.0–19.9
5	20–

5.4 Primary fabrics that are available to meet the needs and demands of cut resistance are:

5.4.1 *Aramid Fibers*—Aramid fibers are a class of heat-resistant and strong synthetic fibers. They are used in aerospace and military applications, for ballistics-rated body armor fabric, and as an asbestos substitute. The name is a shortened form of aromatic polyamide. They are fibers in which the chain molecules are highly oriented along the fiber axis so the strength of the chemical bond can be exploited.

5.4.2 *High-Density Polyethylene Fibers*—Ultra-high molecular weight polyethylene (UHMWPE), also known as high-modulus polyethylene (HMPE) or high-performance polyethylene (HPPE), is a subset of the thermoplastic polyethylene. It has extremely long chains, with molecular weight numbering in the millions, usually between 2 and 6 million. The longer chain serves to transfer load more effectively to the polymer backbone by strengthening intermolecular interactions. The result is a very tough material, with the highest impact strength of any thermoplastic presently made. It is highly resistant to corrosive chemicals with the exception of oxidizing acids. It has extremely low moisture absorption and is highly resistant to abrasion (15 times more resistant to abrasion than carbon steel).

5.4.3 *Composite or Engineered Yarns*—Composite or engineered yarns consist of two or more components. These yarns are constructed to offer a higher level of cut resistance (ASTM Level 3 and above). The addition of a steel or fiberglass core with a fiber wrapped around it allows for a greater rating force than a singular component standing alone. Features of such combinations are strength, hardness, lubricity or slickness, and rolling action (knit construction theoretically creating a ball-bearing effect as the blade meets the knitted fabric). These features increase the rating force to Levels 3 and above on the ASTM scale.

NOTE 3—Test Method F1790 CPPT tests for cut resistance only.

NOTE 4—The EN 388 test results in Table 2 describe more than cut resistance. The test also describes puncture, tear and abrasion of the fabric, or physical and mechanical aggressions.

5.5 Working conditions will differ when examining the available cut-resistant fabrics currently on the market. Essentially, the differences are as follows:

5.5.1 *Para-Aramids:*

5.5.1.1 Natural and indoor light will reduce the "out of the box" cut level;

5.5.1.2 Laundering with bleach will nullify the cut level of para-aramids;

5.5.1.3 Para-aramids will abrade more rapidly than HPPE; and

5.5.1.4 Para-aramids are best for uses in which thermal issues exist.

5.5.2 *HPPE:*

5.5.2.1 Natural and indoor light have no impact on the reduction of cut level;

5.5.2.2 Can be laundered with bleach or solvents without impact to cut level;

5.5.2.3 Cannot be exposed to heats above 62.7 °C [145 °F]; and

5.5.2.4 High resistance to abrasion.

6. Recommended Protection Based on Frequency and Severity (as Determined by the Risk Assessment Process)

6.1 The selection of PPE for employees performing tasks related to glass handling without first conducting a risk assessment is difficult and should not be standard practice. For example, it is wrong to make a general assumption that simply putting a mid-level cut rated leg protector is the correct solution to a potential sharp object hazard related to the lower body. There is no guideline that will guarantee success simply by following a few recommendations, and this one is no exception. The risk frequency and severity must first be considered and only then can an educated decision on the proper level/type of cut protection be made. Some of the other variables that assessments should consider are: potential force of impact, weight of the glass, puncture versus swipe cut, and the injury potential associated with various jobs and tasks involving the handling of glass or the worker's proximity to glass (machinery and storage), or both, in the work environment. When conducting a risk assessment for a glass-handling task, all parts of the body potentially exposed to sharp edges of the glass should be considered. Both routine exposures and reasonably foreseeable exposures (glass breakage, freefalling glass from breakage in stored glass packs, and so forth) should be considered.

6.2 *Critical Areas*—There are certain "critical" areas of the human body that, when exposed to the sharp edge of a lite of glass, significantly increase the chance of a serious or fatal injury. Those body parts are illustrated in Figs. 1 and 2 and should be a focal point of any risk assessment. The goal/result of the assessment and associated PPE controls should be to minimize the chance that these "critical" body parts are directly exposed to the sharp edges of the glass during normal handling or any expected failures during handling such as fracturing lites, improper handling, falling glass, and so forth. Protection for these "critical" areas should also be considered for tasks requiring employees to work directly adjacent to lites of glass where their exposed edges pose the likelihood that contact is probable.

6.2.1 *Neck*—The neck area is often understressed during the risk assessment process. During "normal" handling of glass, the neck may not be directly exposed to the sharp edges of a lite; as a result, it is often not considered for needed protection.

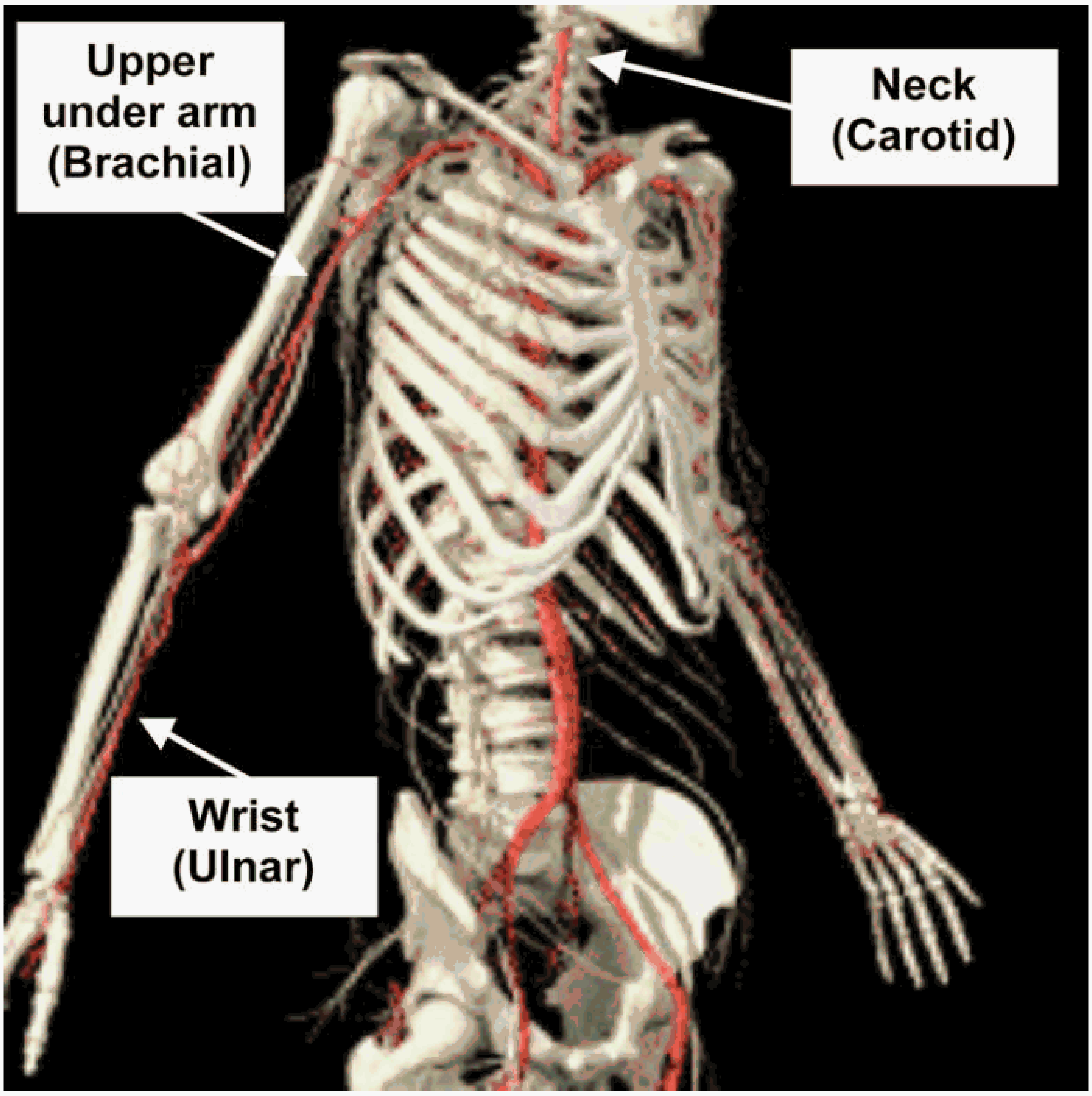

FIG. 1 Critical Areas of the Human Body (Upper)

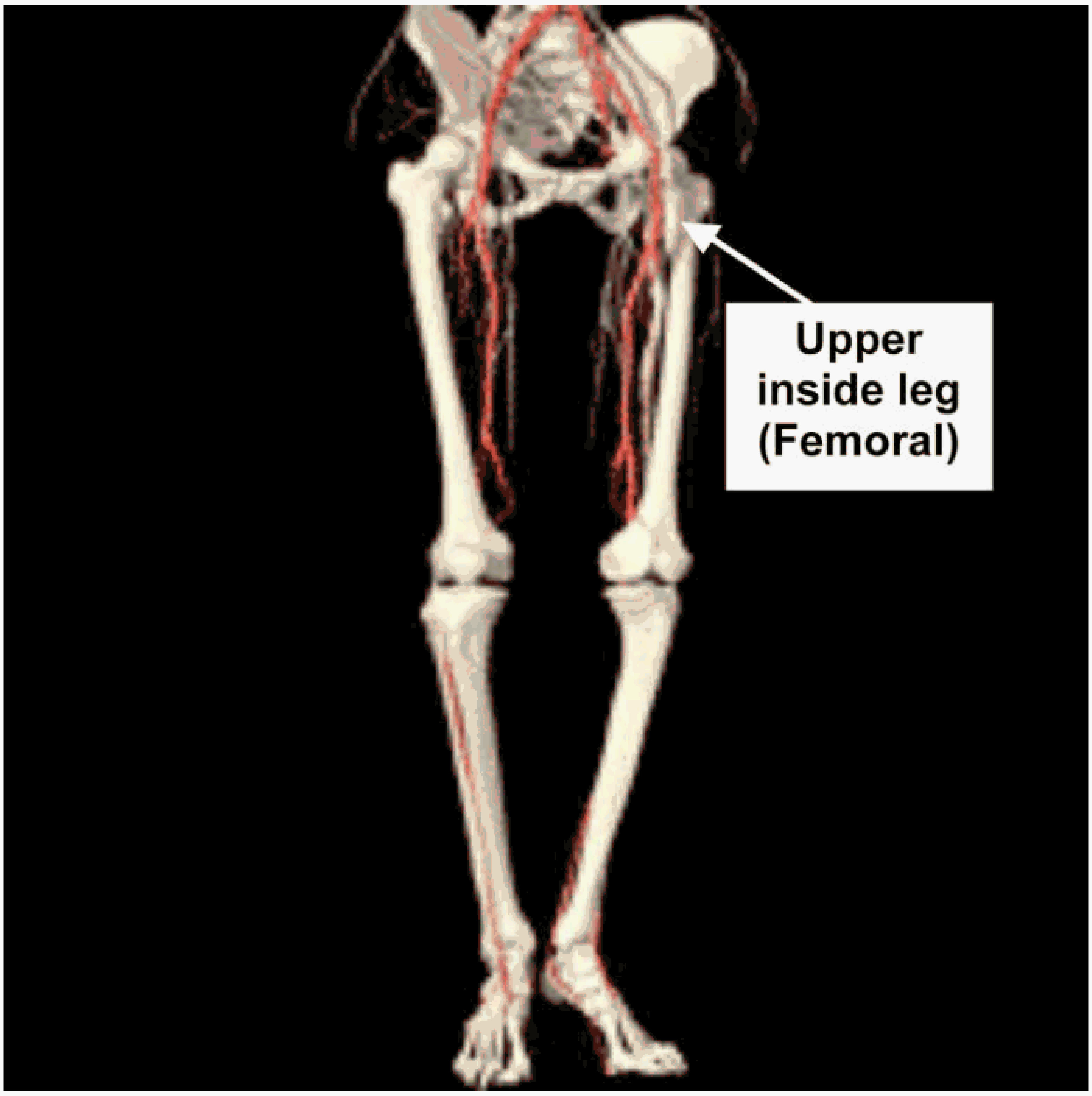

FIG. 2 Critical Areas of the Human Body (Lower)

However, because of the high potential severity associated with a laceration to the carotid artery, it should be a focal point of the assessment. Factors such as the unexpected fracture of a lite, a stumble while carrying a lite, or a falling lite of glass should all be considered. Because of the high potential severity, if it is determined through the assessment that neck protection should be a control, a strong evaluation to determine the proper PPE and level of necessary cut protection should be conducted.

6.2.2 *Wrist*—The wrist area is one of the most vulnerable body parts during manual glass-handling activity. It is usually very near the glass during the handling process and a small laceration can sever the ulnar artery running through the wrist. This area should be considered for high-level cut protection during all manual glass-handling activities.

6.2.3 *Inner Leg*—The inner leg is another "critical" body part deserving focused attention during the risk assessment process. While not as directly exposed as the wrist and neck, the inner leg (femoral artery), being part of the lower body, could be impacted not only during the normal handling process but also by falling or fractured glass as it passes on the way to the ground. For this reason, it should be considered for at least mid-level cut protection for most manual glass-handling tasks.

6.2.4 *Underarm*—This area of the body (location of the axillary artery) is another that should be of focus during the risk assessment process. An underarm exposure during the handling activities should require at least mid-level protection.

6.3 *Noncritical Areas*—Other areas of the body are less critical but still shall be protected to prevent injuries. There are many types and styles of "standard" glassworkers' PPE that are used widely within the glass industry to provide basic protection from laceration and puncture injuries. Except for hard hats, safety glasses, face shields, and safety shoes, equipment chosen for glass handling should be manufacturer tested for its anti-lacerative and anti-puncture performance.

6.4 *Hands Deserve Extra Attention*—By far the most frequently cut area of the body during glass handling is the hands. Whether carrying, pushing, pulling, inspecting, cleaning, or any other task requiring the employee to be close to the glass, the hands are either directly on or very close to the glass. Even the most careful glass handlers will have their protective gloves prevent a laceration numerous times per week. There are several key things to remember when investigating protective equipment for the hands. It is very important to determine exactly what the hazard is before selecting a glove—abrasion risk, puncture risk, swipe cut risk, chemical risk, contusion risk, etc. A higher cut level does not always mean better protection. If the hazard is primarily a swipe cut risk, then a higher level of cut protection may be better. However, if contusions or abrasions or puncture risks are the primary hazard, then perhaps a thicker material versus a higher cut level material may be the correct choice. Sometimes, the best solution can mean layered protection. For example, some companies use cut-resistant gloves (often called "liners") and use a separate glove on top of the cut-resistant glove for gripping the glass. In any case, if you are looking to change or add protection for the hands, a risk assessment, data analysis, and task trials are very important to the success of the control.

6.5 To deal with routine exposures, most companies in the glass industry have adopted "minimum" requirements for PPE, as well as PPE requirements for each job or task, or both. Minimum requirements for all work in a factory in which raw glass is manufactured or processed usually includes safety glasses with side shields and safety shoes. For those actually working with or around raw glass, hand and wrist protection is usually a standard minimum. As the size of the glass and interaction with it increases, protection to other parts of the body also must increase. Requirements for specific jobs or tasks or both are specified based on the exposure identified in the risk assessment.

6.6 Glassworkers' PPE is available from many suppliers. A list of commonly used PPE is provided in the following, along with the parts of the body that they are designed to protect.

6.6.1 *Safety Glasses with Side Shields*—Eyes;

6.6.2 *Gloves/Glove Liners*—Hands;

6.6.3 *Cuffs*—Wrists;

6.6.4 *Gloves with Wrist Gauntlets*—Hands and wrist;

6.6.5 *Bib Apron*—Chest, waist, and legs;

6.6.6 *Apron*—Waist and upper legs;

6.6.7 *Chaps*—Waist and legs;

6.6.8 *Sleeves*—Arms;

6.6.9 *Jacket*—Chest and arms;

6.6.10 *Jacket with Built-In Neck Protection*—Arms, torso, neck;

6.6.11 *Dickey*—Neck;

6.6.12 *Neck Protector*—Neck;

6.6.13 *Hard Hat*—Head;

6.6.14 *Face Shield*—Face;

6.6.15 *Steel-Toed Shoes*—Toes; and

6.6.16 *Metatarsal Shoes*—Toes and metatarsal area of the foot.

7. Keywords

7.1 cut protection; glass; handling; personal protective equipment; PPE