

Knoll Workplace Research

# Office Ergonomic Standards

A Layperson's Guide

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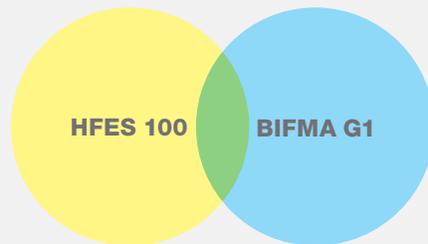
### Furniture designed using ergonomic principles can improve performance and reduce workplace injury

Because of the compelling benefits of ergonomic furniture, standards were developed to help organizations specify and purchase office furnishings that meet basic ergonomic requirements. These ergonomic guidance documents are written in a highly technical format—often challenging “non-experts” to correctly apply them when developing specifications. This primer clarifies popular misconceptions and explains how to use the two predominant ergonomic guidance documents, commonly referred to within the furniture industry as the **HFES 100** and **BIFMA G1**.

#### Two documents provide guidance in the ergonomic specification process

In 2008, the Human Factors and Ergonomics Society (HFES) released a sequel to its influential 1988 standards document, the “ANSI/HFES 100 – 2007 Human Factors Engineering of Computer Workstations.” Independently, the Business and Institutional Furniture Manufacturer's Association (BIFMA) published the “BIFMA G1—2002 Ergonomics Guideline for VDT (Visual Display Terminal) Furniture Used in Office Work Spaces.”

**Figure 1. Two key resources for workplace ergonomic guidance**



While HFES 100 is an ANSI-accredited standard and BIFMA G1 is a guideline from another organization, both resources share common themes and attributes.

#### HFES 100 is a national standard, BIFMA G1 is a guideline

Both the HFES and BIFMA organizations are ANSI-accredited standards developers. The HFES 100 is a true national standard, having gone through the ANSI accreditation process which includes a national review of the document. The BIFMA G1 is not a national standard, because it has not been through the external review and other steps required by ANSI for such certification. (However, other aspects of the BIFMA guidance document, such as the product testing requirements section, are certified by ANSI as a national standard.)

#### The specifications within both documents are voluntary, not enforceable by law

However, many organizations choose to use these guidance documents as a reference for workstation set-up or furniture evaluations, and enforce them internally.

#### The HFES 100 contains ergonomic conformance specifications for office furniture, displays, input devices, and the integration of all those components into a complete workstation

These standards accommodate at least 90% of the North American workforce. HFES 100 was created by a committee of academics, engineers, researchers and professional ergonomists, and draws upon a carefully considered foundation of published ergonomic research.

#### The BIFMA G1 Guideline is an industry guideline for ergonomic computer workstations

The BIFMA G1 provides recommendations for sizing furniture to accommodate the 5th percentile female to the 95th percentile male of the North American population. It was created primarily by representatives from the furniture industry. However, the committee also includes designers, furniture dealers, businesses, academics, ergonomists, consultants, and others.

#### What is ANSI?

Founded in 1918 the American National Standards Institute (ANSI) works with organizations to create and manage voluntary national standards for products.

The goal of ANSI is to enhance the global competitiveness of US business by facilitating the development of standards.

#### What is HFES?

Founded in 1957, the Human Factors and Ergonomics Society (HFES) is the world's largest interdisciplinary nonprofit professional organization covering the fields of human factors and ergonomics.

The Society's mission is to promote the discovery and exchange of knowledge concerning the characteristics of human beings that are applicable to the design of systems and devices of all kinds.

#### What is BIFMA?

The mission of the Business and Institutional Furniture Manufacturer's Association (BIFMA) is to lead, advocate, inform and develop standards for the North American office and institutional furniture industry. BIFMA develops voluntary product and industry standards that support safe, healthy and sustainable environments.

**Table 1. Comparison of the HFES 100 Standards and BIFMA G1 Guidelines**

Similarities	Differences	
HFES 100 and BIFMA G1	HFES 100	BIFMA G1
<ul style="list-style-type: none"> <li>· Uses 4 standard reference postures</li> <li>· Based on 1988 ANSUR Army anthropometric database</li> <li>· Employs “shoulds” and “shalls” nomenclature</li> <li>· Accredited by ANSI as a standards developer</li> <li>· Standards development committee includes broad variety of stakeholders (industry reps, ergonomists, academics, government, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>· Exclusive focus on ergonomics</li> <li>· Emphasizes standards, requirements</li> <li>· Contains only standards approved by ANSI</li> <li>· Does not address ergonomic requirements of extremely large or small people</li> </ul>	<ul style="list-style-type: none"> <li>· Includes section on ergonomics, with additional sections on safety, durability, materials, testing procedures for furniture</li> <li>· Emphasizes guidelines, recommendations</li> <li>· Contains some standards not approved by ANSI (in addition to ANSI-approved requirements)</li> <li>· Provides a process for evaluating furniture needs of extremely large or small people</li> </ul>

The two guidance documents have much in common as well as important differences (see Table 1). They use the same reference postures and anthropometric data, present advice on the basis of requirements and recommendations, have sponsoring organizations that are accredited by ANSI to create standards, and consist of committees with members from a broad range of business and ergonomic backgrounds.

**There are some differences between the two guidance documents**

The spirit of the BIFMA G1 is to provide general recommendations and suggestions for good ergonomic furnishings (many of them drawn from the HFES 100), but avoids mandating ergonomic requirements. HFES 100 is the national ergonomics standard for workstations, and contains numerous specific requirements.

The BIFMA G1 contains some specifications that have been approved by their internal committee, but not by ANSI. The HFES 100 contains only ANSI approved requirements, reflecting its position as the national standard.

Unlike the HFES 100, the BIFMA G1 provides information and procedures to help fit exceptionally large or small people (those not covered under the “average” range of body sizes). HFES 100 provides no ergonomic guidance for individuals who fall outside the average range (sometimes referred to as “outliers”).

Beyond ergonomics, the BIFMA G1 contains numerous additional sections related to product testing, furniture durability, sustainability, and other aspects of product materials and construction that are of direct interest to furniture manufacturers. The HFES 100 does not have any product testing standards.

**To effectively use these documents it is critical to understand the difference between “shoulds” and “shalls”**

**A “shall” is a requirement for conformance, while a “should” is only a recommendation**

All “shall” statements must be achieved in order to conform to the standard. For example, a statement in a standard that “a chair *shall* have a backrest” requires that a chair must have a backrest in order to conform to that standard.

**“Should” statements are only recommendations and are not necessary to conform to the standard**

“Shoulds” are given when there are optional means of achieving the objective of a specification, or when there is no strong consensus regarding the specification (for example, if there are research studies that come to different conclusions in the matter).

**Poor understanding of “shoulds” and “shalls” can lead to unneeded requirements**

Faced with the many shoulds and shalls sprinkled throughout these documents, users sometimes take what they feel is the safe route—selecting an assortment of shoulds and shalls and making them *all* requirements. A recent Human Factors and Ergonomics Society (HFES) article refers to this phenomenon as “requirement creep,” and states that requirements not fully supported by ergonomics science should not be used in purchase specifications (Bradtmiller, Gordon and Albin, 2011).

**HFES 100 and BIFMA G1 differ in their use of “shalls”**

Table 2 provides a comparison of “shalls” (requirements) specified by the HFES 100 and the BIFMA G1 for seating. The HFES 100 has fourteen possible requirements for seating conformance, while BIFMA G1 has only four requirements. Thus,

the spirit of the BIFMA G1 is to provide recommendations, rather than to mandate the details of a specification.

**HFES 100 and BIFMA G1 differ in how they accommodate “outliers”**

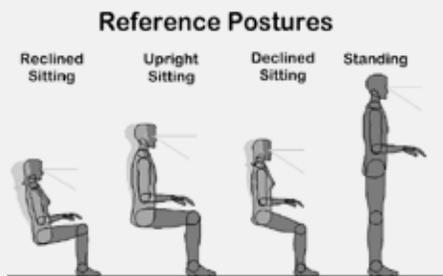
There is an emerging need to accommodate the ergonomic requirements of outliers in

*When creating a standard for your organization, remember that the only required specifications are shalls.*

## Figure 2. A range of potential positions

In the 1988 version of the HFES 100, only one reference posture, upright sitting, was included. As the standard evolved, it expanded to four reference postures: reclined sitting, upright sitting, declined sitting, and standing.

Illustration of Reference Postures. (From ANSI/HFES 100 – 2007 Human Factors Engineering of Computer Workstations © 2007)



**Table 2. Comparison of HFES 100 and BIFMA G1 requirements (“shalls”) for seating conformance**

Seating element	HFES 100	BIFMA G1
Chair	<p>Shall support user’s back and thighs.</p> <p>Shall have a backrest that reclines.</p> <p>Shall support 2 of 3 seated postures: reclined, upright, declined.</p> <p>Shall be stable during typical use.</p> <p>Shall conform to ANSI/BIFMA X5.1 - 2002.</p>	<p>The type of caster shall suit the properties of the floor surface.</p> <p>The work chair shall not move away easily when unoccupied.</p>
Chair seat height	<p>Shall be user adjustable over a range of 4.5 in. between 15 and 22 in.</p>	<p>Work chairs designed to accommodate a specified user population shall achieve fit for the range suitable for the intended user population.</p> <p>Within a selected range of adjustability, the seat height shall be user adjustable.</p>
Seat width	<p>Shall be at least 17.7 in. wide.</p>	<p><i>not required</i></p>
Seat pan depth	<p>If fixed, shall be no more than 16.9 in.</p>	<p><i>not required</i></p>
Seat pan tilt	<p>Shall have a user-adjustable range of at least 4°, must include 3° rearward.</p>	<p><i>not required</i></p>
Seat pan-backrest angle	<p>Shall have an adjustment range of 15° or more within the range of 90° and 120° from horizontal.</p> <p>Shall not constrain user’s torso forward of vertical.</p> <p>Shall not force a torso-thigh angle less than 90°.</p>	<p><i>not required</i></p>
Lumbar support	<p>Shall have a lumbar support.</p>	<p><i>not required</i></p>

employee populations in the US. The BIFMA G1 recognizes that no single standard will accommodate all people within the intended user population. Rather, a percentage of users are statistical “outliers” from the average—taller, shorter, or heavier than the general population. This is especially true of seating for people who are significantly heavier than the average population. There are no current ergonomic standards for this type of office chair, referred to as “bariatric seating.” To create good ergonomic solutions for outliers, the BIFMA G1 defines a process for accommodating individual users, referred to as the Ultimate Test of Fit.

### The BIFMA G1 Ultimate Test of Fit provides a common-sense approach to fitting outliers that considers ergonomic issues

This test includes assessments of worksurface height for input devices and monitors, and seating. For example, when using this process to fit a user for a work chair, a total of six shoulds are specified, relating to seat height, depth and width; seat pan angle; and backrest height and width.

The evaluation of these shoulds is based on direct observation of the user in the chair. For example, when fitting proper seat height the guideline states that “users should be able to sit with their feet comfortably on the floor or footrest without undue pressure on the underside of the thighs. The thigh-to-torso angle should not be less than 90°.” The balance of the shoulds read much the same, emphasizing visual examination of an actual user in the furnishing or setting.

### A common misconception of the reference postures used by both HFES 100 and BIFMA G1 is that there are only four “correct” postures

The illustration of these reference postures (see Figure 2) sometimes leads to the mistaken conclusion that there are only four “correct” working postures. In reality, these four reference postures depict “snapshots” within a range of potential positions—not a list of four discrete acceptable postures. In fact, both guidance documents acknowledge that computer users frequently change postures to maintain comfort and productivity. These postures simply represent the endpoints of motion within ranges of movement, not individual positions.

## Next steps for HFES 100 and BIFMA G1

Both HFES 100 and BIFMA G1 are being reviewed. The committees of both share a concern about whether the vintage 1988 military anthropometric data they use accurately represents the North American civilian population. Consequently both committees are reviewing different anthropometric databases in order to achieve better representation of the civilian population.

Both committees are investigating the use of sophisticated statistical techniques which will yield more precise and accurate descriptions of the anthropometric dimensions used. This will affect dimensions, such as the height of the eyes above the floor while seated, which have not been directly measured. The resulting dimensions will be easy to understand and apply with greater certainty that the dimensions are correct.

## For best results, blend carefully

Proper understanding and use of the HFES 100 and BIFMA G1 are the first step to achieving a healthy and safe work environment. The HFES 100 and BIFMA G1 are not mutually exclusive documents. In fact, used together they provide a useful resource for supporting the broadest range of users.

- ▶ If you want your furniture product specification to be in full compliance with the national standard, then use the HFES 100 and incorporate all applicable shalls for the furnishing you are specifying.
- ▶ If you see some benefits of specifications within BIFMA G1 that are not approved by ANSI but make sense for your particular organization, then incorporate them. However if you take this approach we suggest you also use all HFES 100 shalls for that product. And, recognize that when you start to add unapproved specifications or shoulds to your standard, it may be possible that there is not an existing product that meets your standard.
- ▶ If you want to create ergonomic standards to support the needs of extremely large or small people, we suggest employing the Ultimate Test of Fit within the BIFMA G1.

**Through research, Knoll explores the connection between workspace design and human behavior, health and performance, and the quality of the user experience. We share and apply what we learn to inform product development and help our customers shape their work environments. To learn more about this topic or other research resources Knoll can provide, visit [www.knoll.com/research/index.jsp](http://www.knoll.com/research/index.jsp)**

## References

Bradt Miller, B., Gordon, C.G. and Albin, T.J. (April 2011). User Trial for ANSI/HFES 100. HFES Bulletin, Volume 54, Number 4.

## Additional Resources

### ***International standards are available for companies with a global footprint***

The International Organization for Standardization (ISO), with members in 162 countries, develops international standards for needs, including workstation ergonomics. Users with responsibility for computer workstation specifications outside North America should consult the ISO standards. Users with computer workstation responsibilities in Canada should consult the guidelines published by the Canadian Standards Association (CSA).

- ▶ CSA-Z412-00 (R2005) - Guideline on Office Ergonomics (Canadian Standards Association)
- ▶ ISO 9241-5 1998 - Workstation layout and postural requirements (ISO)

### ***Copies of the HFES 100 and BIFMA G1 are available online***

The BIFMA G1 Guideline can be obtained from BIFMA at its website: <http://www.bifma.org/standards/index.html>

The HFES 100 Standard can be obtained from the Human Factors and Ergonomics Society at its website: <http://www.hfes.org/Publications/ProductDetail.aspx?ProductID=69>

## Author's Bio

As Senior Director of Workplace Research for Knoll, Dr. Michael O'Neill conducts research projects with leading companies to assess how workspace design affects employee performance and health. Previously, as a professor of interior design and industrial engineering at the University of Wisconsin, he taught and conducted workplace ergonomics research.

O'Neill is the author of several books, including *Ergonomic Design for Organizational Effectiveness* (1998), and *Measuring Workplace Performance* (2007). He is a co-author of the ANSI/HFES 100-2007 workstation standards and is a member of the current ANSI/HFES 100 Workstation Standards revision committee. In 1993, Michael was an early recipient of the Board Certified Professional Ergonomist (CPE) designation.

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