CREATING A HEALTHY WORKSTATION ENVIRONMENT:

Workstation Ergonomics Made *Easy*

Important Health-Related Information About the Use of Your Computer Workstations

For more information on Workstation Ergonomics and Occupational Safety and Health within the Department of Energy, please see our website at:

www.hss.energy.doe.gov/CSA/CSP/feosh

If you need assistance in evaluating your workstation, contact your FEOSH Unit Coordinator, or the HSS FEOSH Program Manager at (301) 903- 4669

This booklet offers guidelines for choosing a desk and chair, positioning the keyboard and displays, and adjusting room lighting. It also includes suggestions for healthy work patterns, such as taking frequent rest breaks, and some exercises to relieve muscle strain.

Only you can tell what is comfortable for you, so you have the ultimate responsibility for adapting your workstation, within these guidelines, to meet your own needs. The guidance in this booklet is based on American and international ergonomics standards. We recommend that you read the entire booklet before setting up, evaluating, or modifying your workstation, because many factors are inter-related. A change to one may affect another — for example, changing the height of your chair will change the angle at which you view the display and type on the keyboard.

Health Concerns Associated With Computer Use

Much of the muscle soreness, eye fatigue, and other discomforts and injuries can occur from other activities. In fact, misuse of the same muscles and joints during multiple activities can make the problem worse. For example, if you engage in non-work activities that may involve repetitive stress on the wrist — such as playing the piano — and also use your computer keyboard improperly; you may increase the likelihood of developing wrist problems. Preventing health problems is a multi-faceted task that requires careful attention to the way you use your body every day.

The most common health effects associated with using a computer are muscularskeletal discomfort, eye fatigue, and repetitive stress injuries.

Musculoskeletal discomfort

As with any activity that involves sitting for long periods of time, using a computer can make your muscles sore and stiff. You can minimize these effects by setting up your workstation carefully (using the guidance in this booklet), by taking frequent breaks to rest tired muscles, and by doing some simple stretching exercises to relieve strain.

Another type of musculoskeletal concern is repetitive stress injuries (RSIs) also known as Cumulative Trauma Disorders (CTDs). These problems can occur when a certain muscle, joint, or tendon is repeatedly overused and forced into an unnatural position. The exact amount of stress that will cause RSI is still not known, but in addition to awkward postures, factors such as the amount of repetition, force used in the activity, and the individual's physiology and lifestyle may affect the creation of RSI.

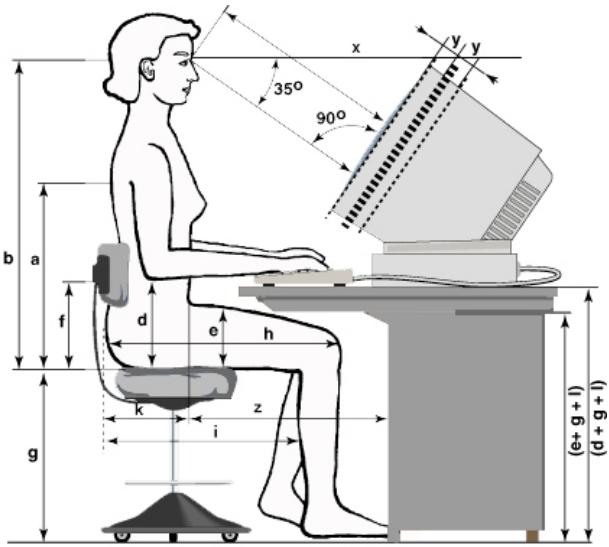
RSIs did not suddently arise with computer use; tennis elbow and writer's cramp are two well-known RSIs. Pianists have frequently suffered from RSIs, sometimes terminating very promising careers. One RSI discussed more often today, however, is a wrist problem called Carpal Tunnel Syndrome (CTS). It may be caused or aggravated by improper use of computer keyboards. This nerve disorder results from excessive pressure on the median nerve as it passes through the wrist to the hand.

This booklet offers advice on setting up your chair, desk, keyboard, and other parts of your computer workstation. Proper workstation ergonomics will help you to minimize the possibility of developing RSI. The effects of repetitive movements associated with using a computer can be compounded by other work or leisure activities to produce or aggravate physical problems, so proper use of your computer system must be considered as just one element, an imortant one, of a healthy lifestyle.

No one can guarantee that you won't have problems even when you follow the most expert advice on using computer equipment. You should always check with a qualified health specialist if muscle, joint, or eye problems occur.

Eye fatigue

Eye fatigue can occur when the eyes are focused on a nearby object for a long time. This occurs because the eye muscles must work harder to view an object that is closer than about 20 feet (about 6 meters). Improper lighting can hasten the development of the problem. Although eye fatigue is annoying and can cause temporary vision changes, there is no evidence that it causes a permanent vision change or damage. Therefore, the monitor should be set as far from the eye as comfortable. According to ISO 9241 pt. 3, the optimum distance between the visual display and the user's eyes is dependent on several factors. The design viewing distance (by the monitor manufacturer) is set to >400 mm, the optimum viewing distance for office work in the seated position is 600 mm. Most users select distances between 450 - 750 mm. Viewing distances in this range require character heights that subtend 20' to 22'. The first figure illustrates distances for monitor placement.



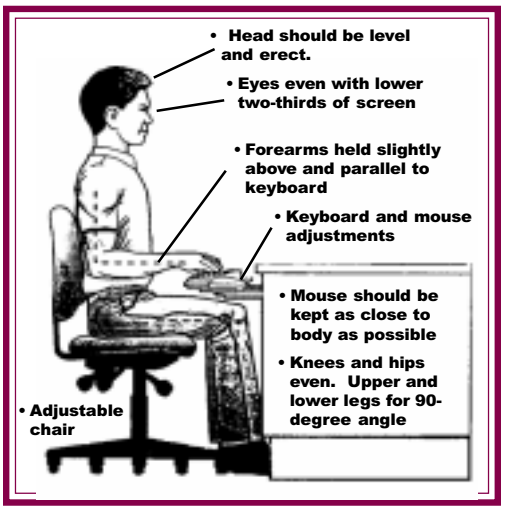
	DIMENSION	WORKSTATION DIMENTISON (CM)	5%ILE FEMALE	95% MALE
a	Shoulder height, sitting (Acromaile)		66.2	85.6
b	Eye height, sitting	Design location for monitor positioning, -35%	67.2	84.8
c	Hip breadth, sitting (not pictured)	Chair width	32.9	43.2*
d	Elbow rest height	Armrest position	17.6	27.4
e	Thigh clearance	With g minimum height of underside of workstation	10.4	19.0
f	Lumbar height sitting	Chair back		
g	Seat height (Popliteal)	Seat positioning	35.1	47.6
h	Buttock-knee length	Depth of workstation with seat pan	54.2	66.7
i	Buttock-Popliteal length	Seat pan depth	44.0	54.6
j	Forearm-to-forearm breadth, sitting (not pictured)	Armrest positioning	41.5	62.1
k	Buttock to abdomen (waist) depth (not pictured)	Armrest length	34.1	
l	Thigh clearance from floor (not pictured)	Minimum height of underside of workstation desk (e + g)	45.6	66.6
x	Viewing distance (horizontal LOS)		40	40
y	Variation in viewing distance		45-75	45-75

***Woman's data used for hip breadth.**

Whenever you are engaged in an activity that involves close-up work, such as reading a magazine, doing craft work, or using a computer, be sure to have sufficient glare-free lighting, give your eyes frequent rest breaks by looking up and focusing on distant objects, and remember to have your eyes examined regularly. Heavy computer users should consult with their eye care professional and consider getting glasses with a focus area at the distance of the computer screen.

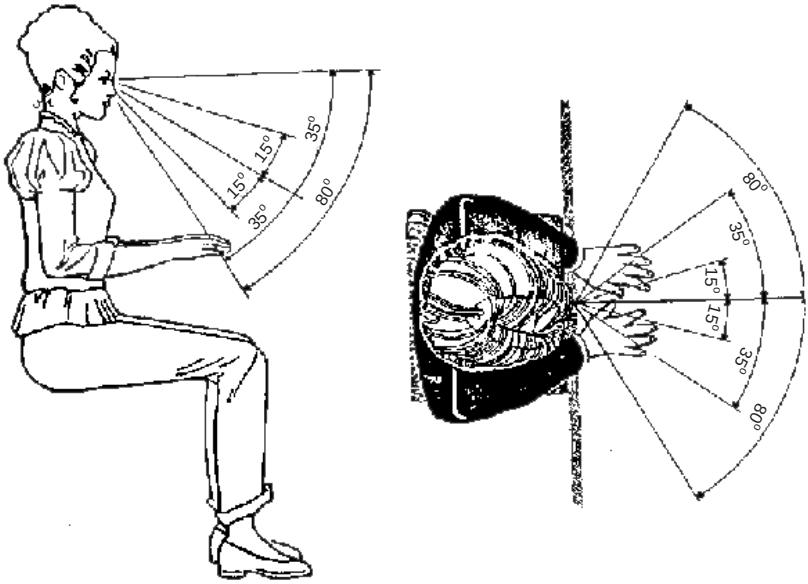
Selecting a Computer Desk

A desk that is an an ideal height for using a pen and paper is often too high for comfort when using a keyboard or looking at a display. Proper angles between your arms and hands, and between your head and your body are important in reducing the likelihood of the physical disorders discussed in previous sections. For this reason, the ideal situation is to place your computer on a desk specifically designed for computers, and is adjustable to fit a wide range of of the population. If you need help, your local ergonomist can assist you in doing this.



One such solution is to use a modular desk system that allows you to set the work surface at any of several heights. This type of desk lets you raise or lower

either or both the monitor and the display. Another option is to use a desk with a keyboard tray that's lower than the main work surface. Even if the tray height isn't adjustable, careful adjustment of the chair may enable you to find a comfortable working position. In the United States, the ANSI Standard (ANSI/HFES 100-1988) recommends a height of 23 to 28 inches from the floor for keyboard height to accommodate all but the smallest 5% of women and the tallest 5% of men.



Since excessive monitor height is a major factor in neck, back, and shoulder discomfort, your alternative is to select the lowest table available (low CRT table) and build components up from there. Before selecting a computer desk, consider your height, the height needed for the keyboard and

mouse, the height for comfortable viewing of the display, and the range of chair height.

The desk should allow for proper monitor placement, with the monitor centered approximately 35^{o} below horizontal, and for the keyboard to be placed at elbow height as illustrated.

Selecting and Adjusting Your Chair

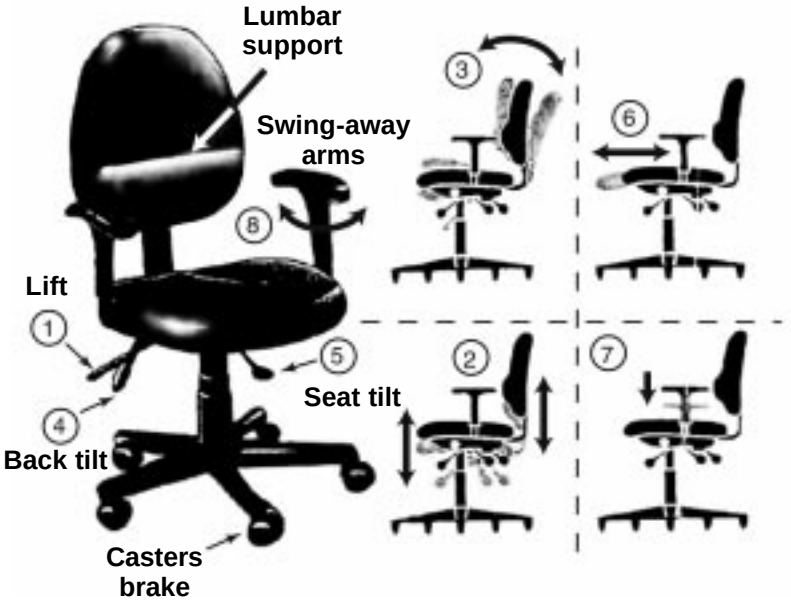
The chair you sit in must be comfortable and provide firm support. Your chair needs to be adjustable to your needs.

Select a chair that is adjustable in height so that your feet can be flat on the floor (5). You should also be able to hold your forearms and hands horizontal or nearly horizontal to the floor when at the keyboard or mouse. If the keyboard is still too high, put something under your feet until you are able to sit with your forearms and hands in the proper position. If you still are unable to do this, consider a lower computer desk or table.

The seat pan of the chair should have at least one inch of padding (1 1/2 inch preferred), and the length of the seat pan sould be a couple of inches less than the length of your upper leg—measured to

the inside of the knee (also called the buttock-popliteal length). It is desireable that the seat pan be adjustable so that a slight tilt forward is possible (1-3^{o}) in order to take pressure off the bottom of the thighs.

FEATURES AND ADJUSTMENT OPTIONS



The chair should provide good support to the lower back lumbar region. This entails both adjustment of seat back for height-to-position (2) at the lumbar region, and forward-backward (3) movement to position it, and provide comfortable support without having to push back uncomfortably or be pushed out of the chair.

The chair and the desk should be complementary so that the proper posture is possible.

Positioning the Keyboard and Mouse

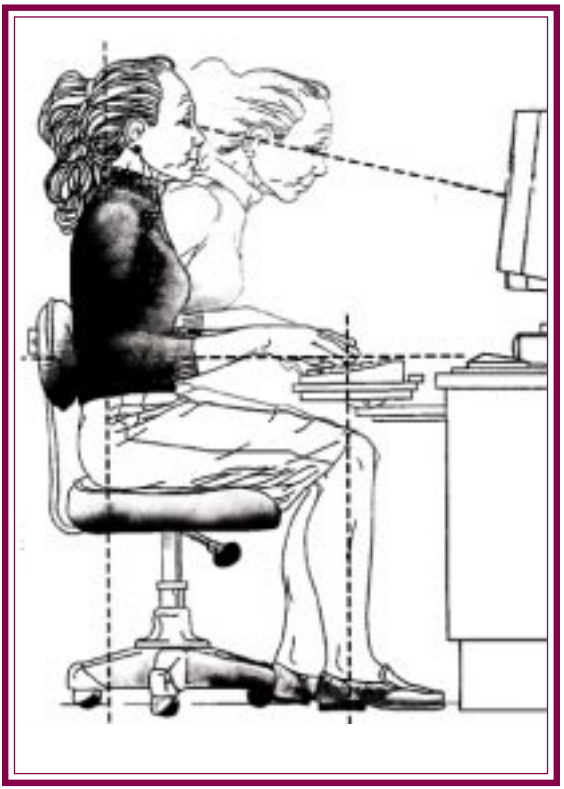
The more you use a computer, the more important it is to position the keyboard properly. Muscle strain to the neck and arms is a common physical complaint that may be aggravated by excessive computer use. If you work with your computer for many hours each day, even the best setup may lead to some muscle strain and discomfort. A break in

BODY POSTURE AFFECTS KEYBOARD POSITION

In spite of the attention keyboards receive in the campaign to reduce workplace cumulative trauma disorders, how a person addresses his or her workstation is proving to be just as important.

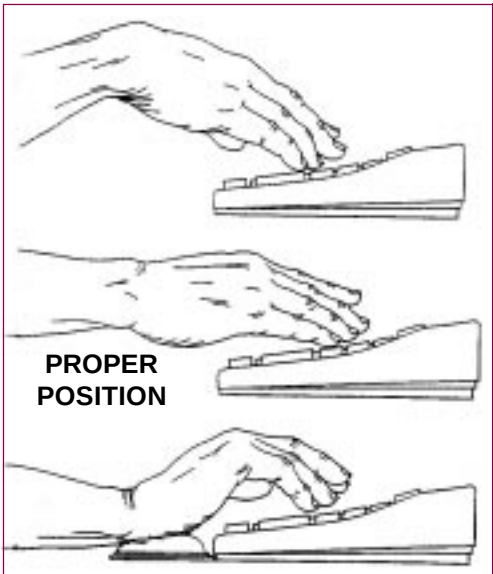
At the right, the typical, stressful posture of a computer user slouching forward is compared to an ergonomically correct posture. By leaning forward, users can, among other things cause neck and upper back strain and force the wrists to arch, leading to potential median nerve compression (carpal tunnel) and increase stress on the fingers.

With the mouse on the desktop and not at the same height as the keyboard, the user will reach to use the mouse and risk additional neck and upper back fatigue and wrist injury.



computer use is recommended every so often, with perhaps some stretching exercises to pull out cramps.

You can create the best position for typing by adjusting the height of both your chair and the keyboard. Everything is adjusted correctly if, when you bend your arms at the elbow and hold your forearms straight ahead and parallel to the floor, your elbows are the same height as the keyboard. That is, the line from your elbow to your hand is straight and has no or very little upward tilt of the wrist. The mouse should be at the same level as the keyboard. Having it higher causes strain on the shoulder, and results in shoulder or neck pain. Consider the hand position for keyboard use also.



The Arch
Computer users leaning forward often assume this posture. It tends to produce pain in the back of the hand and wrist. The hand's strong functional curve also is lost.

The Natural
The hands work at their best mechanical advantage when the wrist is straight and the fingers fall into a gentle curve.

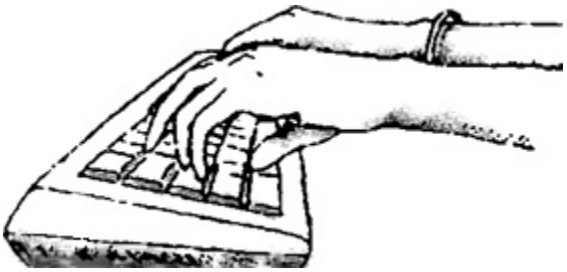
The Lazy
Resting on a rest or table forces the hand from its natural curvature and places stress on the fingers and wrist tendons.

As much as possible, the hands should not be twisted.

When typing, your forearms do not have to be exactly parallel to the floor; some variation is acceptable. If, however, there is more than a 15º deviation, you should readjust your chair or desk. Because reducing the tilt of the wrist is desirable to reduce strain and carpal tunnel syndrome, the keyboard should be as flat as possible, and not more than a 15º angle.

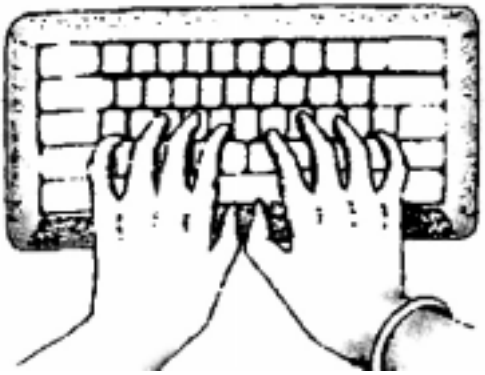
Another of the causes of CTS is banging the wrist on a hard surface during keyboarding. Most of us use the area in front of the keyboard to support our forearms and wrist. This may be constant, or only during resting, but this constant stress on the cartilage of the wrist can damage it, causing CTS. The simplest way to combat this is to put a wrist pad in this area in front of your keyboard or mouse. The

CONSIDER YOUR KEYBOARD



Wrists should remain straight, and float above the surface of the keyboard. Use a wrist rest if you need to. Keep your fingers rounded and loose.

Unnatural Hand Position



Don’t bend your wrists or keep hands at an uncomfortable angle.

Hands in a Natural Line

Keep your hands in a natural line when typing.

pad should be at least as thick as the keyboard, and you may want it as thick as the height of the middle keys.

A note about split keyboards. There is some research evidence to support the idea that split keyboards reduce strain on the wrist. The value of the split keyboard however, is small, and the evidence is not conclusive. There is a general feeling that there is some value to split keyboards if the design does not cause other problems, such as space problems on computer desks, the ability to cushion the wrist against trauma, etc. If the split keyboard design does not create other problems, and you are willing to "relearn" your keyboarding skills due to the different keyboard orientations, do not hesitate to use one. If you only have a straight keyboard, to not be nervous about it causing problems.

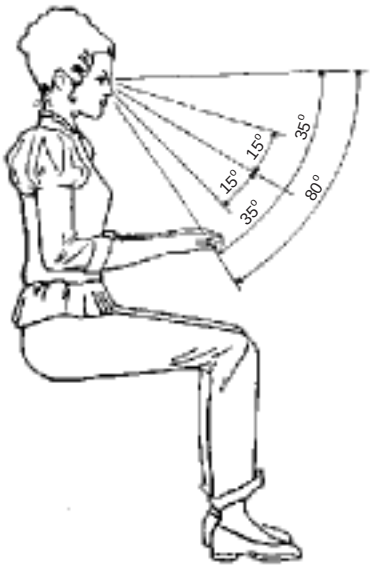
Display Placement and Settings

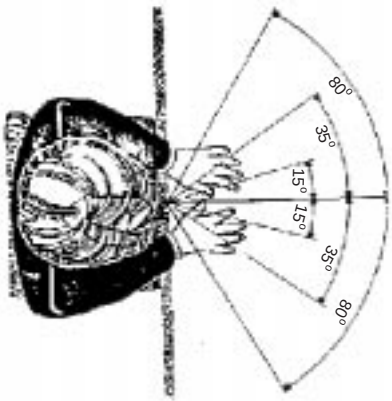
Display Placement. The most important factors in setting up the display are placing it at the proper height and positioning it at the proper angle. You should set it at a comfortable distance for viewing and adjust the brightness and contrast controls properly.

The normal line of sight is 15^{o} below horizontal. This is an adaptation that allows you to see the ground in front of you when you walk, look down at table tops and other normal things in the environment. For many years, the guidance for primary display placement (the display for computers) was to put it directly in front, and center it 15^{o} below the horizontal line of the eyes. This

was questioned by Hill and Kroemer in 1986. They allowed people to set up the display so that they wre most comfortable, using an adjustable workstation. They reported that the “comfortable” display

The display should be located at least 50 cm from the eye, at a down angle of 35^{o} from the horizontal of the eye, and set perpendicular to the line of sight. This may require you to adapt the angle of the monitor with a book, board or other device. Don’t be afraid to adapt your monitor angle.





placement was 35^{o} below the horizontal line. This finding has been confirmed by measuring the stress on back and neck muscles with eletromyalgrams and are now accepted in ISO 9241-5. The display should be located at least 20 inches from your eyes, but this is partially a function of your vision and comfort.

Display Settings. Eye strain can result from excessive use of the eyes, especially if the display is not set properly for visual work. These settings must consider the lighting levels, the user's visual acuity and the detail needed for the work. For the most part, the important display settings are adjustable with monitors in use today. When properly adjusted to optimize brightness, most monitors in use today are sufficient for visual work.

An acceptable visual contrast level is also well within the parameters of most of today's monitors. Both of these should be adjusted to give a clear, easily read picture. In 1986, the IBM scientists tackled the problem of why reading performance on a computer monitor was not as good as reading from paper. In a series of studies, they focused on the problem being poor contrast and insufficient display resolution (pixels). They reported that a display resolution of approximately 1000 x 800 pixels was needed for good visual performance.

Small characters are another cause of visual strain. Most guidance for character size recommends a

minimum character of 20’ of visual arc, about 10 point or less will cause eye strain. Larger characters should be used.

There is an interaction of character size and display resolution on most monitors. If you set the monitor at 1024 x 768, the closest setting to that recommended by the IBM studies, the characters become too small to read easily. Because of this, most users reduce the resolution in favor of character size. An alternative solution is possible with most software, you may set the display resolution at 1024 x 768, and set the display size, not at 100%, but at 150% (or where it is comfortable). This will allow you to maximize the resolution, and not sacrifice character size.

Image Polarity

Early computer displays had negative polarity (light letters against a dark background). This led to eyestrain. Today’s display is normally set for positive polarity (dark letters on a light background). While specific tasks may lend themselves to the negative polarity, most tasks are best with the positive polarity.

Using Documents with the Computer

If you use other documents with the computer, a document holder placed right next to (or attached

to) the monitor at the same level as the monitor is desirable.

LIGHTING

Lighting for your work area must provide enough illuminiation for your keyboard, screen and paper documents without causing problems of reading your display due to glare, relection or washout.

Don’t set up the display right in front of a window, or if you must, use blinds or curtains to reduce or soften the incoming light. Similarly, sunlight coming from directly behind you can cause undesirable glare or reflection. If possible, set up your workstation so that the overhead lights are to the left or right of the monitor and are at right angles to it.

Position lamps so they don’t shine directly into your eyes or reflect off the screen. High light levels can “wash out” the display’s image, and because displays are self-illuminating, you might need less light when using your computer than in reading or working with pen and pencil or typewriter. You should not have to strain to read the screen, keyboard or documents. If the general office lighting is causing a problem, consider turning it off and getting focused task lighting (a separate lamp).

If you need to refer to paper documents while typeing, they should be well illuminated. Position them so that any light directed on them doesn't reflect off the screen and send glare to your eyes. A document holder may help with correct placement.

Keeping a screen clean helps to reduce unwanted reflections.

References

1. ISO 9241, *Ergonomics Requirements for Office work with Visual Display Terminals (VDTs): Part 5: Workstation Layout and Postural Requirments.* International Organization for Standarization, Geneva, Switzerland, 1998.

2. ISO 9241, *Ergonomics Requirements for Office Work with Visual Display Terminals (VDTs): Part 6: Guidance on the Work Environment.* International Organization for Standardization, Geneva, Switzerland, 1999.

3. DOD-HDBK-743A; MILITARY HANDBOOK ANTHROPOMETRY OF U.S. MILITARY PERSONNEL (METRIC) U.S. Army, 1991.

4. *Draft* ANSI/HFES 100-199x; *American National Standard for Human Factors Engineering of Computer Workstations, Pre-canvass Version 1.0*, Human Factors and Ergonomics Society, Santa Monica, CA, September 1996.

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