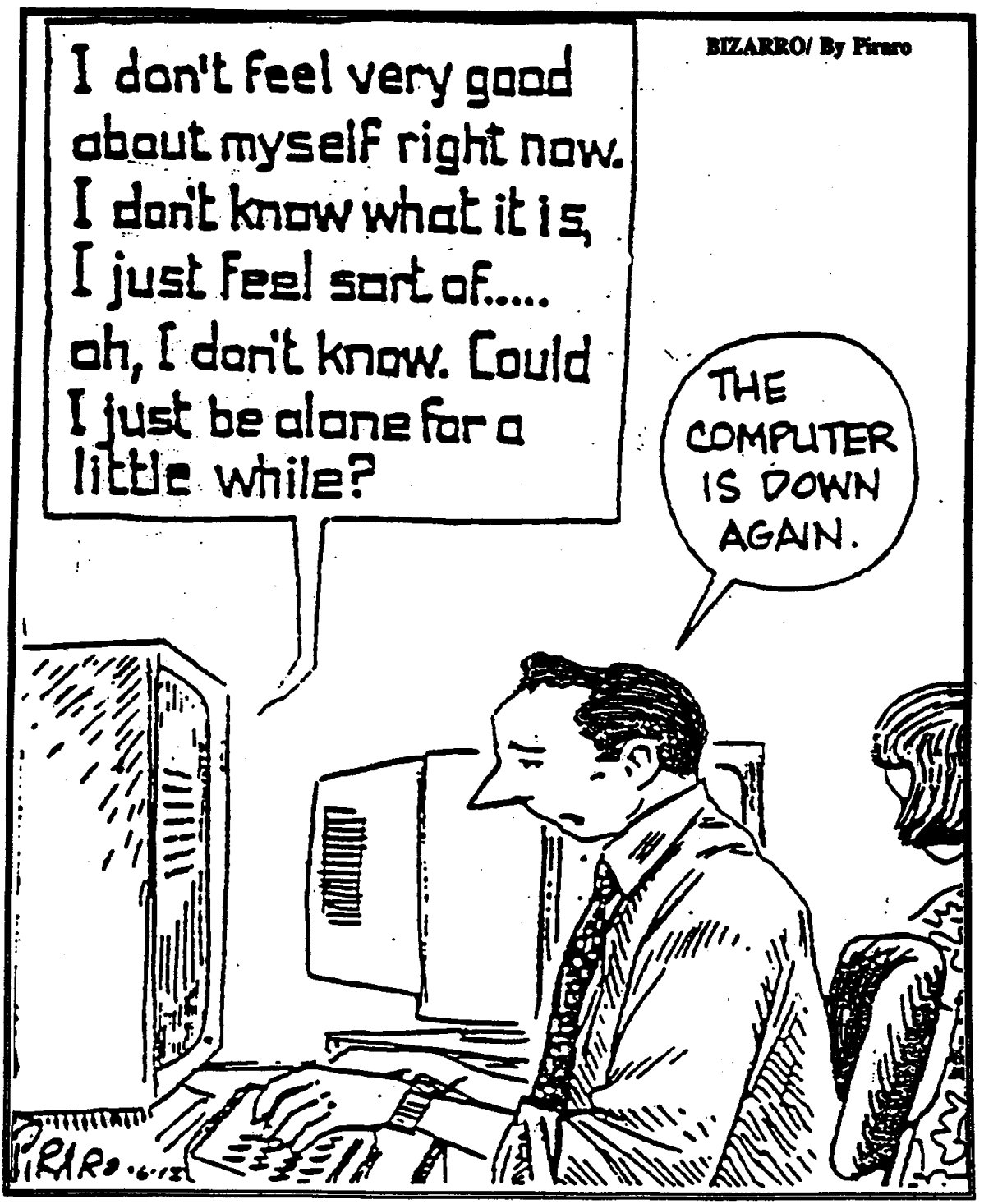
# *Office Ergonomics*
# *ANSI VDT Standard*

*Ergonomics Program*
*DSN 584-3928 or Commercial (410) 671-3928*


I don't feel very good about myself right now. I don't know what it is, I just feel sort of..... oh, I don't know. Could I just be alone for a little while?
BIZARRO/ By Piraro
THE COMPUTER IS DOWN AGAIN.
PIRARO

# Office Ergonomics

## Cumulative Effects of Repetition, Force and Duration

Sitting around is not hard, so why is computer work getting so much attention these days? The chart below can give you some clues. Over the course of a year, the operators will exert up to 20 million pounds of force with just their fingers. Video display terminal (VDT) work is not overly demanding for any single task, but the tasks are repeated over and over, every day throughout the year. The cumulative effect can wear the body down.

| | Typing 60 WPM (5 characters/word) | Typical Pressure on Keys (8 oz/stroke) | Maximum Pressure on Keys (12 oz/stroke) |
|---|---|---|---|
| **Min.** | 300 characters | 150 lbs | 225 lbs |
| **Hour** | 18,000 characters | 9,000 lbs | 13,500 lbs |
| **Day** | 108,000 characters | 54,000 lbs | 81,000 lbs |
| **Month** | 2,340,000 characters | 1,170,000 lbs | 1,755,000 lbs |
| **Year** | 27,000,000 characters | 13,500,000 lbs | 20,250,000 lbs |

The most common problems associated with VDT work are eyestrain, back pain, neck and shoulder fatigue, and upper extremity cumulative trauma disorders. Repetition and static postures are two of the biggest contributors to these problems. The static, prolonged tensing of the muscles from sitting in the same position all day causes physiological changes:

- The blood vessels are compressed from muscle pressure.
- There is decreased blood flow to the muscle tissues.
- Metabolic waste builds up in the muscle (lactic acid and carbon dioxide).
- The oxygen supply is cut off.
- Fatigue develops in the muscle groups.

Sitting around can be hard work, and understanding what causes the resulting problems is critical to developing effective solutions.

### *Work Surface Height*

The work surface height influences the VDT monitor height, wrist position, elbow angle, thigh clearance, and chair height. The work surface must be at a height that allows the operator to keep the upper arms relaxed and the elbows close to the body and bent at approximately 90°. Many operators are able to type comfortably with hands held higher, but wrists should not be sharply angled, and the operator should not be in an unsupported reclining posture.

Government desks are frequently not adjustable. The use of a keyboard articulating arm with keyboard tray can help, but be aware of two potential problems:

- **The keyboard tray may be too small.** Too often, the keyboard tray is not large enough to accommodate an input device; therefore, the VDT operator must overextend his/her arms, causing shoulder and upper arm fatigue. Make sure the keyboard tray is large enough to accommodate an input device.

- **The keyboard tray may be too low.** When the desk height cannot be adjusted but the keyboard tray extends too low to allow adequate thigh clearance, one easy solution is to raise the desk with risers under the legs of the desk.

### *Document Holder*

A document holder should be:

- **At the same height as the monitor** to avoid stressing the neck by looking up and down between the monitor and the document.
- **Close beside the monitor** to avoid stressing the neck by looking from side-to-side between the monitor and the document.
- **The same distance away as the monitor** to reduce eyestrain from repetitive refocusing at different distances.

### *Keyboard*

Conventional keyboards force a non-neutral bend in the wrist (ulnar deviation - wrist bent toward little finger) which can be relieved with alternatively designed keyboards. However, operators must be willing to use them. Often people are reluctant to use equipment that is different from that to which they are accustomed.

## *Glare*

Glare can be a significant problem. People want windows, but bright sun coming in the window can cause glare on the monitor. Glare can also come from overhead lighting, or even the operator's own reflection when he or she are wearing light-colored clothes. Glare can reduce visibility by up to 84 percent depending on the proximity of the source of glare to the viewer. One way to test for glare is to turn the monitor off, and see if any reflections or bright spots are visible on the screen.

There are two types of glare:

- **Direct glare**, which is caused by a light source in the field of view such as a bright window.

- **Indirect glare**, which is caused by light sources which are reflected onto the face of the monitor. In environments with white or shiny walls, indirect glare is much worse than in environments where there are not as many reflective surfaces. Excessively bright lighting will contribute to indirect glare.

To combat glare, the following techniques may be useful:

- To minimize glare from bright sources like windows, put the monitor at a 90° angle to the glare source. When glare is caused by rows of overhead lights, position the workstation between the rows rather than directly under them.

- Cover windows and reposition sources of reflections.

- Put baffles over the fixture to reduce glare from overhead lights. These direct the light straight down, preventing it from being reflected from objects off to the side.

- Use indirect lighting, which is light reflected off adjacent ceilings and walls. This type of "up-lighting" produces less glare and is more comfortable to work under than direct lighting. However, since indirect lighting is reflected, more initial illumination is required to achieve the same illumination as direct lighting. Because of this, indirect lighting is more costly than direct lighting.

- In general, use reverse video (dark characters on a light background) because it provides optimal resolution stimuli for the eye.

- Tilt the monitor away from overhead lights or windows which are causing glare.

## *Lighting*

The recommended illumination level for VDT work is from 200 to 500 lux (20 to 50 footcandles), but if the operator has paper tasks in addition to VDT work, he or she may need task lighting of 500 to 1500 lux. Levels of general illumination greater than 50 footcandles are not recommended because it produces glare and is expensive.

**Remember:** Being able to see a hazard is a prerequisite to dealing with it. Appropriate illumination can reduce accident rates.

The amount of light needed for maximum visual efficiency varies with the operator's age.

1 lux = 0.0929 footcandle

| Footcandles | Activity |
|---|---|
| 10-20[a] | Working spaces where visual tasks are performed only occasionally |
| 20-50[b] | Performance of visual tasks of high contrast or large size (e.g., reading printed material, typed originals, handwriting in ink and xerography; ordinary inspection; rough assembly, rough bench and machine work). |
| 50-100[b] | Performance of visual tasks of medium contrast or small size (e.g., reading medium pencil handwriting, poorly printed or reproduced material; medium bench and machine work; difficult inspection; medium assembly). |
| 100-200[b] | Performance of visual tasks of low contrast or very small size (e.g., reading handwriting in hard pencil on poor-quality paper and very poorly reproduced material; highly difficult inspection; medium bench and machine work; mail sorting; accounting and bookkeeping; kitchen food preparation). |
| 200-500[c] | Performance of visual tasks of low contrast and very small size over a prolonged period (e.g., fine assembly; very difficult inspection; fine bench and machine work; cartography; designing; detail drafting). |
| 500-1000[c] | Performance of very prolonged and exacting visual tasks (e.g., the most difficult inspection; extra fine bench and machine work; extra fine assembly). |
| 1000-2000[c] | Performance of very special visual tasks of extremely low contrast and small size (e.g., surgical procedures). |

[a] General lighting throughout the room
[b] Illuminance on task
[c] Illuminance on task through a combination of general and local lighting

## *Lighting*

The type of lighting is important because an object will render different colors depending on the type of light source. Poor color rendering can distort color perception, increase eye fatigue, and decrease productivity.

| | |
|---|---|
| **Fluorescent Lamps** | Provides good color rendering, second only to sunlight. |
| **Incandescent Lamps** | Provides good color rendering, but are less efficient and produce more heat than fluorescent lamps. |
| **Mercury Vapor or Metal Halide Lamps** | More efficient but cause a mild distortion of color perception. |
| **Low-pressure Sodium Lamps** | Most efficient bulbs available; however, they produce a golden orange light which significantly distorts color perception. |

There is a clear cost-benefit tradeoff in the choice of light sources. The more efficient lamps do not provide the best quality of light. The hidden costs of eye fatigue, decreased productivity and decreased quality of work often justify the investment in higher quality lighting.

An adjustable task lamp can compensate for unfavorable overhead lighting and window lighting. The extra lighting can also help in reading documents. Be careful to locate the task lighting so that it does not create a glare on the VDT monitor.

# Office Ergonomics

## ANSI/HFS 100 - 1988

The American National Standards Institute (ANSI) and the Human Factors and Ergonomics Society (HFES) developed a valuable reference for evaluating the appropriateness of equipment for VDT work. Published in 1988, ANSI/HFS 100-1988, *American National Standard for Human Factors Engineering of Visual Display Terminal Workstations* is a voluntary, technical standard that regulatory agencies may use as a guideline to write laws or mandate as law. Unlike an OSHA standard, however, ANSI standards do not carry the force of the law.

The ANSI/HFS 100 specifies requirements for VDTs, the associated furniture, and the office environment that are recommended to be used when computer work is a substantial part of the work performed. Computer technology and the workplace have changed considerably since the standard was first published. As a result, the standard is undergoing revisions, and publication of the final version of the revised ANSI standard is expected at the end of 1997.

The ANSI/HFS 100-1988 standard is based on anthropometric ranges and numerous research findings. There are five main sections: working environment, visual display, keyboard, furniture, and measurement techniques. The following specifications are examples of the type of information covered by the standard (**Note:** The recommendations are subject to change when the updated standard is published):

# Office Ergonomics

## ANSI/HFS 100 - 1988

| Monitor Features |
|---|
| Resolution and luminance controls |
| Ratio of 3:1 character to background |
| Continuous reading 7 x 9-character matrix |
| Space distance is 1 stroke-width character |
| Viewing distance (eye to screen) 12 in minimum, 24 in preferred |
| Viewing area at or 60° below eye level |

| Accessories | Recommended Specifications |
|---|---|
| Footrest | Provided when range of adjustability of chair and/or worksurface does not permit operator's feet to be placed flat on the floor |
| Footrest height | Minimum 2.0 in (5.0 cm) |
| Articulated keyboard arm height (depending on preference) | Range in height from 23.0 to 28.0 in (58.5 to 71.0 cm) |
| Other accessories (depending on preference) | *Palm rests* - support of hands and forearms at the keyboard<br>*Document holders* - for data entry and text processing tasks<br>*Task light* - provides higher level of light in a specific area |

| Clearance Under Worksurfaces | Recommended Specifications |
|---|---|
| Depth at knee level | Minimum 15.0 in (38.0 cm) |
| Depth at toe level | Minimum 23.5 in (59.0 cm) |
| Width | Minimum 20.0 in (50.8 cm) |
| Height | Minimum 26.2 in (66.5 cm) |

# Office Ergonomics

## General Workplace Questions*

### Bodily posture (sitting, standing, stooping)

| Yes | No | |
|---|---|---|
| ☐ | ☐ | Does the posture minimize static muscular effort? |
| ☐ | ☐ | Is the working height correct (i.e., at operator's elbow height)? |
| ☐ | ☐ | Is the range of movement of grips and handles anatomically correct? |
| ☐ | ☐ | Is there enough room to move about? |
| ☐ | ☐ | Can the work be seen clearly and can any instruments be read with the body in a natural position? |
| ☐ | ☐ | Are there opportunities to get up once in awhile to move around or to work in a standing position? |

### Seating

| Yes | No | |
|---|---|---|
| ☐ | ☐ | Is the seat correctly adjusted to the working height? |
| ☐ | ☐ | Is the seat comfortable (i.e., does not cause aches or pains)? |
| ☐ | ☐ | Are the feet supported on the ground or on a footrest? |
| ☐ | ☐ | Is there adequate clearance for feet and legs under the desk? |

### VDT Work

| Yes | No | |
|---|---|---|
| ☐ | ☐ | Is the line of sight 15° below the horizon? |
| ☐ | ☐ | Is the keyboard height (floor to home row) between 23 and 28 in? |
| ☐ | ☐ | Is the keyboard angle between 5° to 25°? |
| ☐ | ☐ | Is the angle at the elbow approximately 90°? |
| ☐ | ☐ | Are the hands in approximately a straight line with the forearm? |
| ☐ | ☐ | Is the screen height from the floor between 24.4 and 35 in? |
| ☐ | ☐ | Is the screen angle to vertical at least +/- 7° (ideal is +/- 20°)? |
| ☐ | ☐ | Does the desk provide ample space for the operator? |
| ☐ | ☐ | Is the eye-to-screen distance between 15 and 32 in? |
| ☐ | ☐ | If hard-copy documents are referenced, are they located close beside the monitor, at the same height as the monitor, and the same distance away from the operator as the monitor? |

*** Any question answered NO indicates a potential problem area.**

# Office Ergonomics

## Troubleshooting Pain and Discomfort

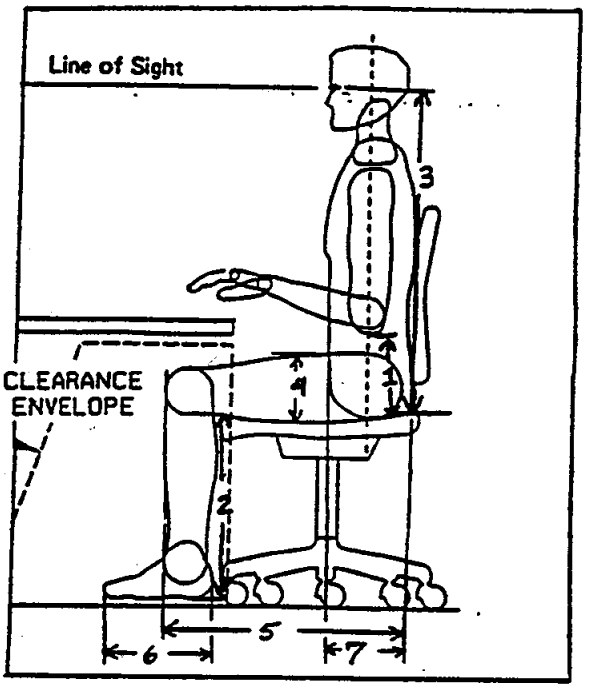
The following chart can be used as a quick reference to highlight potential causes of operator discomfort and ways to eliminate or reduce discomfort.

| Condition | Probable Cause | Correction |
|---|---|---|
| Neck, upper back, and shoulder tightness, tension, or discomfort | a. Head is too far forward during reading, writing or viewing the VDT screen. | a. Elevate work surface, reading materials, and VDT screen so as to keep the head and trunk relationship more vertical. |
| | b. Hands and arms are not supported while typing, inputting data, writing, or using hands in manipulating or holding work. | b. Use armrest, palm rest, or work surface to counterbalance and support the weight of the hands and arms. For typing tasks, allow the upper arms to hang naturally at the side and use palm rests or wrist rests. |
| | c. Head is too far back during reading, writing, or viewing the VDT screen. | c. Tilt the seat and backrest forward so as to keep the head and trunk relationship more vertical. |
| | d. Leaning forward on the work surface and supporting the weight of the head and trunk. | d. Use chair and backrest as support instead of the arms. Lower the work surface to support the arms. |
| | e. Head and neck are tilted in a lateral direction holding the telephone between the shoulder and ear. | e. Use a headset. |
| Hand, wrist, and lower arm discomfort | a. The wrist is deviated in an unnatural position. | a. Arrange the keyboard (or other input device) to produce a neutral wrist position. |
| | b. Excessive application of force during typing/keying. | b. Reduce excessive force through training and practice. |

# Office Work

## Individualized Workstation Arrangement
## Anthropometric Measurements

| Factor | Measurement |
|---|---|
| 1. Elbow Rest Height | |
| 2. Popliteal Height | |
| 3. Eye Height | |
| 4. Thigh Clearance Height | |
| 5. Buttock-Knee Length | |
| 6. Foot Length | |
| 7. Torso Depth | |
| 8. Wears Heels* | +.8 inch |
| 9. Slouches* | -.8 inch |




**FORMULA:**

1. Chair seat height = Desk height - Elbow rest height.
2. Foot rest height = Chair seat height - Popliteal height.
3. Top of monitor = Eye height - Elbow rest height (from desk top)
4. Mid back rest position = Elbow rest height.
5. Arm rest = Desk height.
6. Insure thickness of desk does not exceed: Elbow rest height - Thigh clearance height.
7. Insure desk leg clearance depth is not less than: Buttock-Knee length + Foot length - Torso depth.

**Add .8 inches to Popliteal Height if worker wears heels. Subtract .8 inches from Elbow Rest Height if worker slouches.

## Appendix - A

**Checklist for Evaluation of Ergonomic Stress in Industrial Shops**

| | | Yes | No | N/A |
|---|---|---|---|---|
| 1. | **Physical Stress:** | | | |
| 1.1 | Does the job require contact of fingers or wrist with sharp edges? | ____ | ____ | ____ |
| 1.2 | Do hand tools or process equipment vibrate the worker's hands, arms, or whole body? | ____ | ____ | ____ |
| 2. | **Force:** | | | |
| 2.1 | Does the job require more than 10 pounds of force? | ____ | ____ | ____ |
| 2.2 | Does the job require using a pinch grip (between thumb and finger)? | ____ | ____ | ____ |
| 2.3 | Are gloves used, increasing the force needed for motion of the fingers? | ____ | ____ | ____ |
| 2.4 | Does the job require frequent heavy lifting (> 18 kg or 40 lb, 2 hours per day)? | ____ | ____ | ____ |
| 2.5 | Does the job require occasional very heavy lifting (> 23 kg or 50 lb)? | ____ | ____ | ____ |
| 2.6 | Does the job require handling items that are difficult to grasp? | ____ | ____ | ____ |
| 3. | **Posture:** | | | |
| 3.1 | Does the job require bending (up or down) of the wrist? | ____ | ____ | ____ |
| 3.2 | Does the job require rotating the wrist side to side? | ____ | ____ | ____ |
| 3.3 | Is the worker seated while performing the job? | ____ | ____ | ____ |
| 3.4 | Does the job require "clothes wringing" motion? | ____ | ____ | ____ |
| 3.5 | Does the job require extended reaches, beyond normal arm reach? | ____ | ____ | ____ |
| 3.6 | Does the job require awkward lifts or carries that are near the floor, above the shoulders, or far in front of the body? | ____ | ____ | ____ |
| 3.7 | Does the job require exertion of pushing, pulling, lifting, or lowering forces in awkward positions to the side, overhead, or at extended reaches? | ____ | ____ | ____ |
| 3.8 | Do workers sit on the front edge of their chairs? | | | |
| 3.9 | Is the worker required to maintain the same posture, either sitting or standing, all of the time? | ____ | ____ | ____ |

| | | | Yes | No | N/A |
|---|---|---|---|---|---|
| 4. | **Workstation hardware**: | | | | |
| | 4.1 | Is the orientation of the work surface non-adjustable? | ____ | ____ | ____ |
| | 4.2 | Does the work surface appear to be too high or too low for many operators? | ____ | ____ | ____ |
| | 4.3 | Is the location of the tool non-adjustable? | ____ | ____ | ____ |
| | 4.4 | Does the job require handling oversized objects that require two-person lifting? | ____ | ____ | ____ |
| | 4.5 | Is there an absence of material handling aids, such as air hoists and scissors tables? | ____ | ____ | ____ |
| | 4.6 | Do workers attempt to modify their chairs or work surfaces by adding cushions or pads? | ____ | ____ | ____ |
| 5. | **Repetitiveness**: | | | | |
| | 5.1 | Does the job require that one motion pattern be repeated at a high frequency? | ____ | ____ | ____ |
| | 5.2 | Is the cycle time for repetitive operations less than 30 seconds? | ____ | ____ | ____ |
| | 5.3 | Is the work pace rapid and not under the operator's control? | ____ | ____ | ____ |
| 6. | **Tool design**: | | | | |
| | 6.1 | Is the handle too large for the thumb and finger to slightly overlap around a closed grip? | ____ | ____ | ____ |
| | 6.2 | Is the span of the tool's handle less than 5 cm (2 inches)? | ____ | ____ | ____ |
| | 6.3 | Is the handle of the tool made of metal? | ____ | ____ | ____ |
| | 6.4 | Is the weight of the tool greater than 10 lbs? | ____ | ____ | ____ |
| | 6.5 | Are heavy tools lacking devices to suspend some of their weight? | ____ | ____ | ____ |
| | 6.6 | Does use of the tool require bending the wrist (up or down)? | ____ | ____ | ____ |
| | 6.7 | Does the tool require rotating the wrist (side to side)? | ____ | ____ | ____ |
| 7. | **Work environment**: | | | | |
| | 7.1 | Are housekeeping practices poor, e.g., aisles cluttered, waste on the floor? | ____ | ____ | ____ |
| | 7.2 | Are floors uneven or slippery? | ____ | ____ | ____ |
| | 7.3 | Does the job require frequent (daily) stair or ladder climbing? | ____ | ____ | ____ |
| | 7.4 | Do the work tasks contain significant visual components, requiring good lighting? | ____ | ____ | ____ |
| | 7.5 | Does the worker's eye have to move periodically from dark to light areas? | ____ | ____ | ____ |
| | 7.6 | Is the air temperature uncomfortably hot or cold? | ____ | ____ | ____ |

"Yes" answers reveal jobs/tasks with ergonomic risk. Efforts must be made to correct these deficiencies.

## Appendix - B

## Checklist for Evaluation of Ergonomic Stress at Workstations Equipped with Video Display Terminals

| | | Yes | No |
|---|---|---|---|
| 1. | VDT stations are arranged so that lighting does not reflect directly off the screen. | ____ | ____ |
| 2. | The seat and backrest of the chair support comfortable posture permitting occasional variation in the sitting position. | ____ | ____ |
| 3. | Seat height is adjustable so that the entire sole of the foot rests on the floor or footrest, and the back of the knee is slightly higher than the seat of the chair. | ____ | ____ |
| 4. | Backrest height is adjustable. | ____ | ____ |
| 5. | Backrest angle is adjustable. | ____ | ____ |
| 6. | Footrest provided if desired by individual. | ____ | ____ |
| 7. | The height of the surface on which the keyboard rests is adjustable, allowing the worker's forearms, with fingers resting on the keyboard, to be nearly horizontal or inclined slightly upward. | ____ | ____ |
| 8. | The workstation is adjusted so that the wrist is in a straight line, i.e., not bent up or down. | ____ | ____ |
| 9. | The topmost line of the screen is slightly below eye level. | ____ | ____ |
| 10. | Screen position can be tilted. | ____ | ____ |
| 11. | Document holder is positioned at the same height and at the same distance from the viewer as the screen. | ____ | ____ |
| 12. | Work surface is large enough to hold all needed reference material (at least 35 inches wide). | ____ | ____ |
| 13. | Paper can be easily and conveniently loaded into printers without the need for lifting heavy boxes in awkward postures. | ____ | ____ |
| 14. | Screen has color, brightness, and contrast satisfactory with the operator. | ____ | ____ |

| | | Yes | No |
|---|---|---|---|
| 15. | The illumination level at the VDT station is between 45 and 70 foot candles (500 and 700 lux). | ____ | ____ |
| 16. | Characters on the screen are clear and free of flicker or jitter. | ____ | ____ |
| 17. | There is adequate room under the work table to permit movement of operator's legs and a foot rest where necessary. | ____ | ____ |
| 18. | Task schedules allow the operator to perform duties not requiring use of the VDT at least 15 minutes during each 2-hour period. | ____ | ____ |
| 19. | Are all adjustments easy to make with a single lever or are controls known? (Equipment that is difficult to adjust will probably not be adjusted properly.) | ____ | ____ |

"No" answers reveal workstation features that pose ergonomic risk. Use one of the available resources provided to correct ergonomic risk factors in the workstation.

## Appendix – C
## Web sites for ergonomics information

The following web sites for ergonomics information are for information purposes only and not intended as an endorsement by the Coast Guard.

**Government Sites**

DoD Ergonomics Working Group:
http://chppm-www.apgea.army.mil/ergowg/default.htm

Defense Environmental Network & Information Exchange (DENIX):
https://www.denix.osd.mil/denix/Public/Library/Ergonomics/ergo.html

ErgoEASER Software Download:
http://nattie.eh.doe.gov/others/ergoeaser/download.html

National Library of Medicine MedLinePlus:
http://www.nlm.nih.gov/medlineplus/

NIOSH:
http://www.cdc.gov/niosh/ergopage.html

OSHA:
http://www.osha-slc.gov/SLTC/ergonomics/index.html

U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Ergonomics Program:
http://chppm-www.apgea.army.mil/ergopgm/ergohome.htm

**Professional Society Sites**

American Industrial Hygiene Association (AIHA):
http://www.aiha.org

Board of Certification in Professional Ergonomics:
http://www.bcpe.org/

Human Factors and Ergonomics Society:
http://www.hfes.org/

**Ergonomics Resource Sites**

ERGOWEB:
http://www.ergoweb.com/

ERGOWORLD:
http://www.interface-analysis.com/ergoworld/

Bad Human Factors Designs:
http://www.baddesigns.com

Typing Injuries "Frequently Asked Questions" (FAQ):
http://www.tifaq.org/

CTD Resource Network:
http://www.ctdrn.org/

**University Sites**

Cornell University Ergonomics Web:
http://ergo.human.cornell.edu/cutools.html

Human Factors Engineering Center (HFEC) and Department of Industrial and Systems Engineering (ISE) at Virginia Tech:
http://hfec.vt.edu

UCSF/UCB Ergonomics Program:
http://www.me.berkeley.edu/ergo/

University of Michigan Center for Ergonomics:
http://www.engin.umich.edu/dept/ioe/C4E/

UVA/EHS Ergonomics:
http://keats.admin.virginia.edu/ergo/home.html