

SUMMARY OF SAFETY AND HEALTH HAZARDS IN THE OFFICE

Overview

Despite common beliefs that the office provides a safe environment to work in, many hazards do exist which cause thousands of injuries and health problems each year among office workers. Since one-third of the work force are in offices, even low rates of work-related injuries and illnesses can have an immense impact on employee safety and health.

Modern offices today are substantially different from the office environment of 20 years ago. Sweeping changes have occurred in the American workplace as a result of new office technology and automation of office equipment. Consequently, office workers are faced with many more hazards.

In addition to obvious hazards such as a slippery floor or an open file drawer, a modern office may also contain hazards such as poor lighting, noise, poorly designed furniture and equipment, and machines which emit noxious gases and fumes. Even the nature of office work itself has produced a whole host of stress-related symptoms and musculoskeletal strains. For example, long hours at the visual display terminal can cause pains in the neck and back, eyestrain, and a general feeling of tension and irritability.

Leading Types of Disabling Accidents

It is estimated that office workers sustain 76,000 fractures, dislocations, sprains, strains, and contusions each year. The leading types of disabling accidents that occur within the office are: falls, strains and over-exertion; struck by or striking against objects; and caught in or between objects. In addition to these types of accidents, office workers are also injured as a result of: foreign substances in the eye; spilled hot liquids; burns from fire; and electric shock.

In recent years, illness has increased among the office worker population. This may be attributed, in part, to the increased presence of environmental toxins within the office and to stress-producing factors associated with the automated office. Resulting illnesses may include respiratory problems, skin diseases, and stress-related conditions.

Common Safety and Health Hazards in the Office

The following provides information on safety and health hazards common to the office environment and covers control measures which can reduce or eliminate these hazards.

- **Ventilation**

Sources of air pollution in the office include both natural agents (e.g., carbon monoxide, microorganisms, radon) and synthetic chemicals (e.g., formaldehyde, cleaning fluids, cigarette smoke, asbestos).

An adequate ventilation system which delivers quality indoor air and provides for

comfortable humidity and temperature is a necessity for the office. Where printing or copying machines are present, an exhaust ventilation system which draws fumes away from the employees' breathing zone should be present. Office machines and ventilation system components should be checked and maintained on a regular basis.

- **Illumination**

Lighting problems in the office include glare, shadows, and visual problems (i.e., eyestrain, fatigue, double-vision, etc.). Poor lighting can also be a contributing factor in accidents.

Controls to prevent poor lighting conditions include:

- Regular maintenance of the lighting system.
- Light-colored matte finish on walls, ceilings, and floors to reduce glare.
- Adjustable shades on windows.
- Indirect lighting.

- **Noise**

In an office, workers are subjected to many noise sources, such as video display terminals, high-speed printers, telephones, and human voices. Noise can produce tension and stress, as well as damage to hearing.

A variety of measures to control unwanted noise is available.

- Noisy machines should be placed in an enclosed space.
- Carpeting, draperies, and acoustical ceiling tiles should be used to muffle noise.
- Telephone volume should be adjusted to its lowest level.
- Traffic routes within the office should be rearranged to reduce traffic within and between work areas.

- **Physical Layout/Housekeeping**

Poor design and/or poor housekeeping can lead to crowding, lack of privacy, and slips, trips, and falls. Important factors related to office layout and orderliness include:

- At least 3 feet distance between desks and at least 50 square feet per employee.
- Keep telephone and electrical cords out of aisles.
- Group employees who use the same machines.
- Office machines should be kept away from edges of desks and tables.
- Regular inspection, repair and replacement of faulty carpets.

- Place mats inside building entrances.
- Proper placement of electrical/telephone wires.

- **Exits/Egress**

Blocked or improperly planned means of egress can lead to injuries as a result of slips, trips, and falls. If, during an emergency, employees become trapped due to improper egress, more serious injuries or fatalities may result.

Controls to ensure proper means of egress include:

- Minimum access to exit width of 28 inches.
- Generally two exits should be provided.
- Exits and access to exits must be marked.
- Means of egress, including stairways used for emergency exit, should be free of obstructions and adequately lit.
- Employees must be aware of exits and trained in procedures for evacuation.

- **Fire Hazards**

A serious problem associated with office design is the potential for creating fire hazards. Another danger found in modern offices is combustible materials (e.g., furniture, rugs, fibers) which can easily ignite and often emit toxic fumes.

A number of steps can be taken to reduce office fire hazards.

- Store unused records/papers in fire resistant files or vaults.
- Use flame-retardant materials.
- Smoke only in designated areas and use proper ashtrays.
- Fire extinguishers and alarms should be conspicuously placed and accessible.

- **Handling and Storage Hazards**

Improper lifting of materials can cause musculoskeletal disorders such as sprains, strains, and inflamed joints. Office materials that are improperly stored can lead to hazards such as objects falling on workers, poor visibility, and fires.

There are several controls which can reduce handling and storage hazards.

- An effective control program incorporating employee awareness and training and ergonomic design of work tasks can reduce back injuries.
- Materials should not be stored on top of cabinets.
- Store heavy objects on lower shelves and stack materials neatly.
- Try to store materials inside cabinets, files, or lockers.
- There should be no storage of materials in aisles, corners, or passageways.

- Fire equipment should remain unobstructed.
- Flammable and combustible materials and liquids should be identified and stored properly. Material Safety Data Sheets must be provided for each hazardous chemical identified.

- **Electrical Equipment**

Electrical accidents in an office usually occur as a result of faulty or defective equipment, unsafe installation, or misuse of equipment. The following guidelines should be adhered to when installing or using electrical equipment:

- Equipment must be properly grounded to prevent shock injuries.
- A sufficient number of outlets will prevent overloading of circuits.
- The use of poorly maintained or non-approved equipment should be avoided.
- Cords should not be dragged over nails, hooks, or other sharp objects.
- Receptacles should be installed and electric equipment maintained so that no live parts are exposed.
- Machines should be disconnected before cleaning or adjusting. Generally, machines and equipment should be locked or tagged out during maintenance.

- **Office Furniture**

Defective furniture or misuse of chairs or file cabinets by office workers can lead to serious injuries. Controls related to chairs and cabinets include:

- Chairs should be properly designed and regularly inspected for missing casters, shaky legs, and loose parts.
- Do not lean back in a chair with your feet on a desk.
- Do not scoot across the floor while sitting on a chair.
- Never stand on a chair to reach an overhead object.
- Open only one file drawer at a time.
- File cabinets should not be located close to doorways or in aisles.
- Use drawer handles to close file drawers.

- **Office Machinery**

Machines with ingoing nip points or rotating parts, if not adequately guarded, can cause lacerations, abrasions, fractures and amputations. Machines such as conveyors, electric hole punches, and paper shredders with hazardous moving parts must be guarded so that office workers cannot contact the moving parts. Fans must have substantial bases and fan blades must be properly guarded.

- **Ladders, Stands, and Stools**

Improper use of ladders, ladder stands, and stools can lead to falls. Controls to reduce related injuries include the following:

- Workers should always face the ladder when climbing up or down.
- Ensure ladders are in good condition and inspected regularly.
- The top of a ladder should not be used as a step.
- Be sure ladder is fully open and the spreaders are locked.

- **Office Tools**

Misuse of office tools, such as pens, pencils, paper, letter openers, scissors and staplers, can cause cuts, punctures, and related infections. Precautions when using these materials can prevent such injuries.

- Paper cutters - Keep blade closed when not in use. A guard should be provided and fingers should be kept clear.
- Staplers - Always use a staple remover. Never test a jammed stapler with your thumb.
- Pencils, pens, scissors, etc. - Store sharp objects in a drawer or with the point down. Never hand someone a sharp object point first.

- **Photocopying Machines**

Potential health hazards associated with photocopying machines include toxic chemicals, excessive noise and intense light. They can also be a source of indoor air pollution when used in offices that are not well-ventilated.

Controls to reduce these hazards include:

- Keep the document cover closed.
- Reduce noise exposure by isolating the machine.
- Place machines in well-ventilated rooms away from workers' desks.
- Have machines serviced routinely to prevent chemical emissions.
- Avoid skin contact with photocopying chemicals. Clean all spills and dispose of waste properly.

- **Video Display Terminals (VDTs)**

Health concerns relating to VDT use involve radiation, noise, eye irritation, low-back, neck, and shoulder pain, and stress.

Studies have shown that the radiation levels emitted from VDTs are well below those allowed by current standards. However, to minimize any potential exposure,

only equipment for which the manufacturer will supply data on emissions should be used.

To minimize noise, VDTs should not be clustered and sound absorbent screens can be used if needed.

Proper ergonomic design, covering the relation of the operator to the screen, the operator's posture, lighting and background, should be carefully tailored to prevent discomfort. The keyboard position, document holder, screen design, characters, and color are all factors to consider.

Vision testing should be conducted before office workers operate VDTs and annually thereafter. Work breaks and variation of tasks enable VDT operators to rest their eyes. Postural strain related to VDT use can be relieved by performing simple exercises. And, finally, a training program to inform workers of the capabilities of the equipment they are using should be conducted.

SOME DO'S AND DON'TS OF OFFICE SAFETY

1. Pencil sharpeners and typewriter carriages must not jut out into aisles.
2. Glass doors should have some conspicuous design, either painted or decal, about 4½ feet above the floor and centered on the door so people will not walk into it.
3. Frosted glass in doors gives a view through for accident prevention, but still preserves privacy. The see thru feature prevents collisions.
4. If it is necessary that a door be solid, the hazardous area that the door swings over can be marked by yellow and black tape or painted a bright color, or the path of the swinging door can be outlined by colored plastic circles. On carpeted floors, a quarter or half-circle of different colored carpet can be used.
5. Employees should not face windows, unshielded lamps, or other sources of glare. Many factors associated with poor illumination are contributing causes of office accidents. Some of these causes are: direct glare, reflected glare from the work and harsh shadows. Excessive visual fatigue may be an element leading toward accidents. Accidents may also be prompted by the delayed eye adaption a person experiences when moving from bright to dark. Some accidents which are attributed to the individuals "carelessness" can be traced to difficulty in seeing.
6. Fans in office should be placed where they cannot fall on anybody and they should be secured in place.
7. Duplicating processes should not be confined to a separate small room, unless it is vented to the outside.

8. Where possible, outlets (receptacles) should be installed to eliminate extension cords. If cords MUST cross the floors, cover them with rubber channels designed for this purpose.
9. Caution should be exercised in the use of poorly maintained or unsafe, poor quality coffee makers, radios, lamps, hotplates etc., provided by or used by employees, particularly in out-of-the-way locations. Such appliances create fire and shock hazards.
10. Switches should be provided, either in the equipment or in the cords, so that it is not necessary to pull the plugs to shut off the power.
11. Electric key switches should be avoided because people try to key the lock with hair pins and paper clips.
12. Extension cords should not rest on steam pipes or other metallic surfaces. Better still, do not use extension cords.
13. Outlets should not only be located under desks to eliminate tripping hazards but they should also be placed where they will not be accidentally kicked or used as a foot rest. When they loosen or wear, outlets can become sources of electric shock.
14. Where materials are stored on shelves, the heavy objects should be on the lower shelves.
15. No smoking should be allowed in mailing, shipping, or received rooms, or where large quantities of loose paper and other combustibles or flammable liquids are stored.
16. The casters on swivel chairs should be on at least a 20 inch diameter base, and a 22 inch base is preferred.
17. Drawers on desk and file cabinets should have safety stops.
18. Make sure the paper cutter has a proper guard.
19. Glass tops on desks and tables crack and cause safety hazards. Durable synthetic surfaces are free from this trouble and should be used instead of glass.
20. Safety ash trays should be available and large enough to safely contain smoking materials.
21. Many cut fingers have resulted when people try to move fans by grasping the guard, or tried to catch falling fans.
22. Rolling ladders and stands used for reaching high storage should have brakes that operate automatically when weight is applied to them.

23. Because the major category of office accidents is slips and falls, running in offices, particularly for elevators, should be prohibited.
24. Collisions at doors can be prevented if people do not stand directly in front of the door, but out of the path of its swing when they go to open it.
25. Do not carry stacks of materials on stairs; use the elevator.
26. Commonly, falls on stairs occur when the person is talking, laughing and turning to friends while going downstairs. Be alert while using stairways.
27. Good housekeeping is essential to prevent falls. Wipe up spilled liquid immediately, and pick up pieces of paper, paper clips, rubber bands, pencils, etc., as soon as they are spotted.
28. Broken glass should be swept up immediately. It should not be placed loose in a waste paper basket but it should be carefully wrapped in heavy paper and marked "Broken Glass". Glass which shatters into fine pieces should be blotted up with damp paper towels.
29. Leaning back in the chair and placing the feet on the desk should not be allowed.
30. Only one file drawer should be opened at a time to prevent the cabinet from toppling over. File cabinets should be bolted together or otherwise secured to prevent tipping.
31. Desk or files should never be moved by office personnel; they should be moved by maintenance people using special dollies or trucks.
32. Do not pile boxes, papers, books, or other heavy objects on top of file cabinets; this could cause cabinet to tip and the materials to avalanche on to the employee.
33. Never store pencils in a glass on the desk with points upward.
34. Razor blades, thumb tacks, and other sharp objects should not be thrown loosely into drawers. They should be carefully boxed or blades and points kept stuck in foamed polystyrene blocks.
35. Solvent-soaked or oily rags used for cleaning duplicating equipment should be kept in a metal safety container.
36. Never allow smoking on elevators.
37. Do not throw matches or cigarettes into waste baskets.
38. Accident records are absolutely necessary if an office safety program is to succeed. Office employees should report every accident, no matter how minor the injury. Near accidents should be reported because near-miss accidents are warnings of worse

accidents to come.

39. In order to develop proper safety attitudes, safety instructions should be properly given to new office employees. The employees should have "settled down" enough, however so that he/she can absorb the information.
40. A company safety program cannot succeed unless it has the whole hearted backing of its top management. The supervisor must know that his/her accident prevention performance is watched and that good performance is appreciated.
41. Supervisors are just as responsible for training their people in safe procedures as they are training them for efficiency.
42. Supervisors should personally investigate each accidental injury and they should report what caused the accident and what steps have been taken to prevent a recurrence. Also, when safety inspections are made and accident hazards are found, the report of these hazards should go to the vice president or other top officers in charge of the department. This top executive should then request a report of corrective measures directly from the supervisor responsible for the hazard. This procedure will go along way in making a safety expert of every office manager and supervisor and to reducing the office accident problem to negligible size.

OFFICE SAFETY AND HEALTH CHECKLIST

1. Is there an active safety and health program in operation?
2. Is one person clearly responsible for the overall activities of the safety and health program?
3. Is there a procedure for handling complaints regarding safety and health?
4. Do you know how to locate the nearest doctor or hospital?
5. Are emergency numbers posted?
6. Are first aid kits easily accessible to each work area?
7. Are you familiar with basic first aid procedures in case of an emergency?
8. Are all work areas clean and orderly?
9. Are floor surfaces:
 - clean?
 - dry?
 - level?

- in good condition?
- 10. Are carpets:
 - well secured to the floor?
 - free of worn or frayed seams?
- 11. Are aisles and doorways free from obstructions to permit visibility and movement?
- 12. Are there sufficient exits to permit prompt escape in case of emergency?
- 13. Are all exits clearly marked and visible?
- 14. Are emergency exits adequately lighted and free of debris?
- 15. Do you know where emergency exits are and how to reach them?
- 16. Are stairways in good condition and covered with skid-resistant materials?
- 17. Do you know where fire extinguishers are and how to use them?
- 18. Do you know where fire alarms are?
- 19. Are you familiar with fire evacuation procedures for your building and what to do in case of fire in your area?
- 20. Are electrical appliances and equipment in good condition and properly grounded?
- 21. Are a sufficient number of outlets available to eliminate overloading of circuits?
- 22. Are file cabinets arranged so that drawers do not open into aisles? Can only one drawer be opened at a time?
- 23. Are chairs in good condition with no loose casters?
- 24. Is your desk free from cluttered books or materials?
- 25. Is furniture free from sharp edges, points, and splinters?
- 26. Are all belts, wheels, fans, and other dangerous moving parts of machinery adequately guarded?
- 27. Is your office equipped with a step stool or ladder so that you can safely reach overhead objects?
- 28. Are you familiar with the correct way to use a ladder?

- 29. Are all office tools (pens, scissors, staplers, etc.) kept in their proper places?
- 30. Are photocopying machines placed in well-ventilated rooms away from workers' desks? Are machines serviced routinely?
- 31. Are you properly trained in the safe use of photocopying machines?
- 32. If you work with hazardous substances such as cleaning fluids, are you aware of the related hazards?
- 33. Are hazardous substances properly stored?
- 34. Is smoking only permitted in designated, separated, and well-ventilated areas?
- 35. Are work areas properly illuminated?
- 36. Does the ventilation system deliver quality indoor air?
- 37. Are noise levels within acceptable levels?
- 38. If you use a video display terminal (VDT), is the keyboard, table, screen, and chair adjustable?
- 39. For VDT users, are work breaks and variation of tasks incorporated into work schedules?
- 40. Are you trained in proper lifting techniques?

INTRODUCTION

The applications of computer technology and the accompanying use of VDTs are revolutionizing the workplaces of America, and their use will continue to grow in the future.

For example, according to some reports, there were only 675,000 VDTs in use in U.S. offices in 1976, in 1986, there were an estimated 28 million. The number of VDTs in use is growing rapidly, and in the 1990's, there may be anywhere from 40 to 80 million VDTs in the workplace [1, 2].

Along with this expanding use of VDTs have come reports about adverse health effects for VDT operators. In an effort to inform employers and employees, this discussion briefly examines the potential hazards and interventions employers can use to prevent or reduce the potential harmful effects of working with VDTs.

VDT Components

VDTs, comprised of a display screen, a keyboard, and a central processing unit, have rapidly replaced the use of typewriters and other office machines.

The display screen is the output device that shows what the computer is processing. Display screens can be monochrome (green, white, or orange on a black background), or color.

The keyboard is the input device that allows the user to send information to the "brains" of the computer. Keyboards are commonly used for data entry and inquiry. The keyboard is similar to a standard typewriter keyboard but with additional special keys and functions.

The central processing unit is referred to as the "brains" of the computer. It is the center of operation for all the computer processing and performs calculations and organizes the flow of information into and out of the system.

The VDT operates at high voltages, but the power supplies generating these voltages produce very little current. All data processing equipment, including VDTs, must meet stringent international safety standards in this regard.

HEALTH EFFECTS

In the wake of the expanding use of VDTs, concerns have been expressed about their potential health effects. Complaints include excessive fatigue, eye strain and irritation, blurred vision, headaches, stress, and neck, back, arm, and muscle pain. Other concerns include general physical discomfort, cumulative trauma disorders, and potential exposure to electromagnetic fields. Research has shown that these symptoms can result from problems with the equipment, work stations, office environment or job design, or from a combination of these. Some of the most common stressors, their related health effects, and their means of prevention are discussed briefly in the following sections.

Eyestrain

Visual problems such as eyestrain and irritation are among the most frequently reported complaints by VDT operators. These visual symptoms can result from improper lighting, glare from the screen, poor positioning of the screen itself, or copy material that is difficult to read. These problems usually can be corrected by adjusting the physical and environmental setting where the VDT users work. For example, work stations and lighting can and should be arranged to avoid direct and reflected glare anywhere in the field of sight, from the display screen, or surrounding surfaces.

VDT operators also can reduce eyestrain by taking vision breaks, which may include exercises to relax eye muscles after each hour or so of operating a VDT. Changing focus is another way to give eye muscles a chance to relax. The employee needs only to glance across the room or out the window from time to time and look at an object at least 20 feet away. Other eye exercises may include rolling or blinking the eyes, or closing them tightly for a few seconds.

Fatigue and Musculoskeletal Problems

Work performed at VDTs may require sitting still for considerable time and usually involves small frequent movements of the eyes, head, arms, and fingers. Retaining a fixed posture over long periods of time requires a significant static holding force, which causes fatigue.

Proper work station design is very important in eliminating these types of problems. Some variables of work station design include the VDT table, chair, and document holder. An individual work station should provide the operator with a comfortable sitting position sufficiently flexible to reach, use, and observe the display screen, keyboard, and document. Some general considerations to minimize fatigue include posture support (back, arms, legs, and feet), and adjustable display screens and keyboards. VDT tables or desks should be vertically adjustable to allow for operator adjustment of the screen and keyboard. Proper chair height and support to the lower region of the back are critical factors in reducing fatigue and related musculoskeletal complaints. Document holders also allow the operator to position and view

material without straining the eyes, or neck, shoulder, and back muscles.

The type of task performed at the VDT may also influence the development of fatigue. In designing a work station, the type of tasks involved should be considered when determining the placement of the display screen and keyboard.

VDT operators also are subject to a potential risk of developing various musculoskeletal and nerve disorders such as cumulative trauma, or repetitive motion, disorders. Carpal tunnel syndrome (CTS) is one commonly recognized cumulative trauma disorder among VDT operators. CTS is caused by repetitive wrist-hand movement and exertion. CTS is the compression and entrapment of the median nerve where it passes through the wrist into the hand--in the carpal tunnel.

When irritated, the tendons and their sheaths housed inside the narrow carpal tunnel swell and press against the nearby median nerve. The pressure causes tingling, numbness, or severe pain in the wrist and hand.

CTS usually can be reduced by stopping or limiting the activity that aggravates the tendons and median nerve (e.g., data/keyboard entry), by maintaining proper posture, or as a last resort, by having surgery. For correct posture, VDT operators should sit in an upright position at the keyboard, with arms parallel to the floor. The wrists and forearms also may require support, depending on the tasks involved.

Radiation

Another issue of concern for the VDT operator is whether the emission of radiation, such as X-ray or electromagnetic fields in the radio-frequency and extreme low frequency ranges, poses a health risk. Some workers, including pregnant women, are concerned that their health could be affected by electromagnetic fields emitted from VDTs. The threat from X-ray exposures is largely discounted because of the very low emission levels. The radiofrequency and extreme low frequency electromagnetic fields are still at issue despite the low emission levels. To date, however, there is no conclusive evidence that the low levels of radiation emitted from VDTs pose a health risk to VDT operators. Some workplace designs, however, have incorporated changes--such as increasing the distance between the operator and the terminal and between work stations--to reduce potential exposures to electromagnetic fields.

Since the possible effects of radiation from VDTs continue to concern operators, the issue is still being researched and studied. OSHA has asked the Committee on Interagency Radiation Research and Policy Coordination to nominate a panel to read and evaluate all the literature on the subject and to determine whether there is sufficient data upon which to establish a dose-response relationship or develop an assessment of the significance of risk for workers exposed to electromagnetic fields at wave lengths relevant to VDTs. NIOSH has a resource

booklet entitled, "NIOSH Publications on Video Display Terminals" and continues to study the question of VDT operator risk from exposure to electromagnetic fields.

INTERVENTIONS

There are a variety of interventions that employers can implement to reduce or prevent harmful effects associated with VDT use.

Lighting

Light should be directed so that it does not shine into the operator's eyes when the operator is looking at the screen. Further, lighting should be adequate for the operator to see the text and the screen but not so bright as to cause glare or discomfort.

There are four basic lighting factors that must be controlled to provide suitable office illumination and avoid eyestrain: quantity, contrast, and direct and reflected glare.

Quantity. In most offices, light fixtures and daylight provide illumination for work surfaces (e.g., 50-100 foot-candles). High illumination "washes out" images on the display screen; therefore, if possible, where VDTs are used, illumination levels should be somewhat lower (i.e., 28-50 foot-candles are often satisfactory).

Contrast. Contrast is the difference in luminance or brightness between two areas. To prevent the visual load caused by alternate light and dark areas, the difference in illuminance between the VDT display screen, horizontal work surface, and surrounding areas should be minimized.

Most of the tasks associated with VDTs do not require precise visual acuity, and diffuse (indirect) lighting is appropriate. The advantages of diffuse lighting are twofold: there tend to be fewer hot spots, or glare sources, in the visual field; and the contrasts created by the shape of objects tend to be "softer." The result, in terms of luminous intensities, is a more uniform visual field. Where indirect lighting is not used, parabolic louvers on overhead lights are probably the next best way to ensure that light is diffused.

Glare. Glare is usually defined as a harsh, uncomfortably bright, light. Glare is dependent upon the intensity, size, angle of incidence, luminance, and proximity of the source to the line of sight. Glare may be the result of direct light sources in the visual field (e.g., windows), or reflected light from polished surfaces (e.g., keyboards,) or from more diffuse reflections which may reduce contrast (e.g, improper task lighting). Glare may cause annoyance, discomfort, or loss in visual performance and visibility.

In many cases, the reorientation of work stations may be all that is necessary to move sources

of glare out of the line of sight. The proper "treatment" for window glare includes baffles, venetian blinds, draperies, shades, or filters. The face of the display screen should be at right angles to windows and light sources. Care should be taken, particularly when terminals are installed within 20 feet of windows, to ensure that there is some method of blocking the sun's light, such as blinds or curtains.

To limit reflection from walls and work surfaces visible around the screen, these areas should be painted a medium color and have a nonreflective finish. Work stations and lighting should be arranged to avoid reflected glare on the display screen or surrounding surfaces.

Anti-glare filters that attach directly to the surface of a VDT screen can help reduce glare. Two types of filters are available: natural density filters, which scatter and diffuse some of the light reflected off the glass display screen, and micromesh filters, which not only scatter the light but also absorb most of the light reflected from the surface of the screen by means of an imbedded interwoven grid of dyed nylon fibers.

Newer model keyboards tend to have anti-glare matte finishes. Further, lighting should be adequate to enable the operator to see the text and the screen, but not so bright as to cause glare. Where used, work station lighting should be easily adjustable and directed at source documents and not at the display screen surface.

Work Station Compatibility and Design

In the office environment, the work station consists primarily of a work surface of some type, a chair, VDT equipment, and other related items.

The employee must have adequate work space to perform each of the tasks required by the job. Individual body size must be considered and will influence the design of the chair, the height of the work surface, and access to various elements of the work station, including the display screen.

A height-adjustable work surface is an advantage. In general, a good VDT work surface will provide as many adjustable features as possible. Also, adequate legroom should be provided for the employee to stretch out and relieve some of the static load that results from sitting with the legs in a fixed position for long periods.

Chairs. The chair can be a crucial factor in preventing adverse health effects as well as in improving employee performance in office work. As the majority of office workers spend most of their time sitting, proper back and shoulder support helps to reduce fatigue. If the chair does not fit the worker properly, there can be serious physical effects, as well as effects on performance. Consequently, the appropriate types of ergonomic chairs should be made available to accommodate various worker needs.

Chair Height. When an employee must spend from 6 to 8 hours in the chair, the height of the chair and the work surface are critical. The human body dimension that provides a starting point for determining correct chair height is the "popliteal" height. This is height from the floor to the point at the crease behind the knee. The chair height is correct when the entire sole of the foot can rest on the floor or footrest and the back of the knee is slightly higher than the seat of the chair. This allows the blood to circulate freely in the legs and feet.

Seatpan Design. Size and shape are two factors to consider in the design of the seatpan of the chair. The seatpan can be slightly concave with a rounded, or "waterfall," edge. This will help distribute the weight and may also prevent sliding forward in the chair. The angle of the seatpan should also be considered. Some options include a seatpan that slopes slightly down at the back or one that has a forward tilt that produces less stress on the lower region.

Backrest. A proper backrest should support the entire back including the lower region. The seat and backrest of the chair should support a comfortable posture that permits frequent variations in the sitting position. The backrest angle and chair height should be easily adjustable. A foot rest may be necessary for shorter individuals.

VDT Design

Display Screen. Most new VDTs have separate, adjustable keyboards and display screens that allow both the keyboard and display screen to be positioned appropriately for the employee. This is important because VDT operators may spend a considerable amount of time looking at the display. The height of the display screen surface must be determined in relation to the task and the operator's height.

In addition, screens that swivel horizontally and tilt or elevate vertically enable the operator to select the optimum viewing angle.

The topmost line of the display should not be higher than the user's eyes. The screen and document holder should be the same distance from the eye (to avoid constant changes in focus) and close enough together so the operator can look from one to the other without excessive movement of the neck or back. The incline of the document holder should be adjustable.

The preferred viewing distance for VDTs ranges between 18 and 24 inches. To this distance must be added the depth of the display itself. Some displays are as much as 20 inches deep. The best way to deal with this, other than increasing table depth, is to install a keyboard extension on the front of the desk.

Legibility is also a primary consideration in selecting a display screen. Legibility factors to be considered include symbol size and design, contrast, and sharpness.

Keyboard. The keyboard should be detachable and adjustable to ensure proper position, angle, and comfort for the operator. A lower than normal work surface may be required to keep the operator's arms in a comfortable position. The thickness and the slope of the keyboard are critical in determining the preferred height. The keyboard and table, therefore, have to be selected in relation to each other, or the surface must be adjustable. Options for keyboard placement also should be considered in choosing the size and adjustability of the work surface.

The preferred working position for most keyboard operators is with the forearms parallel to the floor and elbows at the sides, which allows the hands to move easily over the keyboard. The wrist should be in line with the forearm. A padded and detachable wrist rest for the keyboard can help keep the operator's wrists and hands in a straight position while key stroking.

Operating a VDT, like any form of sustained physical or mental work, will lead eventually to fatigue. It may take the form of visual fatigue, muscular fatigue, general body fatigue, or mental and psychological fatigue. Rest pauses to alleviate or delay the onset of fatigue may be necessary. The frequency and duration should be determined by the employer and should depend on the task involved, the pattern of work, and the individual VDT operator concerned.